rapid biological inventories 10

Cuba: Siboney-Juticí

Ansel Fong G., David Maceira F., William S. Alverson, y/and Jennifer M. Shopland, editores/editors

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Carátula/Cover: *Phyllonycteris poeyi* (Phyllostomatidae), un murciélago endémico cubano, en las cuevas de la Reserva Ecológica Siboney-Juticí. Foto de Nicasio Viña Dávila./ *Phyllonycteris poeyi* (Phyllostomatidae), an endemic Cuban bat, in the caves of Siboney-Juticí Ecological Reserve. Photo by Nicasio Viña Dávila.

Carátula interior/Inner cover: El Mar Caribe baña la costa rocosa de la Reserva Ecológica Siboney-Juticí. La segunda y la tercera terrazas de la Reserva se levantan hacia arriba como escalones gigantescos (en el centro de la imagen). La Sierra de la Gran Piedra (la parte oriental de la Sierra Maestra) se ve al fondo (carátula interior anterior). El pueblo de Siboney se ubica al este de la Bahía de Santiago de Cuba y justo en el extremo este de la Reserva, con la Sierra de la Gran Piedra al fondo (carátula interior posterior). Foto de W. S. Alverson./The Caribbean Sea washes against the rocky coastline of the lowermost geological terrace of Siboney-Juticí Ecological Reserve. The second and third terraces rise like giant steps (in the center of the image). The Sierra de la Gran Piedra (the eastern part of the Sierra Maestra) is visible in the background (front inner cover). The town of Siboney is situated east of Santiago de Cuba Bay, at the eastern end of the Reserve, with the Sierra de la Gran Piedra in the background (back inner cover). Photo by W. S. Alverson.

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The Field Museum

The Field Museum is a collections-based research and educational institution devoted to natural and cultural diversity. Combining the fields of Anthropology, Botany, Geology, Zoology, and Conservation Biology, Museum scientists research issues in evolution, environmental biology, and cultural anthropology. Environmental and Conservation Programs (ECP) is the branch of the Museum dedicated to translating science into action that creates and supports lasting conservation. ECP collaborates with another branch, the Center for Cultural Understanding and Change, to ensure that local communities are involved in efforts for long-term protection of the lands on which they depend. With losses of natural diversity accelerating worldwide, ECP's mission is to direct the Museum's resources—scientific expertise, worldwide collections, innovative education programs—to the immediate needs of conservation at local, national, and international levels.

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Centro Oriental de Ecosistemas y Biodiversidad and Museo de Historia Natural "Tomás Romay"

The mission of the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO) is to carry out specialized, interdisciplinary studies in the Eastern Region of Cuba that define and characterize the most important and interesting areas for the conservation of biodiversity. BIOECO also works to establish the means and methods for conservation of these areas and the wise use of their resources, as well as to contribute to the ecological recovery and the sustainable socioeconomic and cultural development of the region.

BIOECO has four Divisions:

- The Tomás Romay Museum of Natural History
- Botanical Gardens
- Natural Sciences
- Protected Areas

These Divisions conduct scientific studies, management of protected areas, ecological planning, in-situ and ex-situ conservation, environmental education, and community projects.

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Museo Nacional de Historia Natural de Cuba

The Museum's core mission is to collect, research, conserve, and exhibit natural objects to promote scientific knowledge and cultural appreciation of nature. It is an institution comparable, in structure and function, with the international model for this kind of museum; for that reason it includes the following among its fundamental objectives:

- Research on biogeography, paleogeography, and the biodiversity of Cuba and the Caribbean;
- Conservation of the collections of Cuban minerals, rocks, fossils, plants, and animals residing in the Museum, which are part of the National Heritage;
- Broadening of these collections so that they will be representative of Cuban nature, and systematic study of the collections and of the environment from which specimens were collected; and
- Creation of exhibits about nature, with emphasis on Cuban natural history, and the education of visitors and the general public in a culture of nature.

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Our inventory in Siboney-Juticí Ecological Reserve was briefer than the typical "rapid inventory" because Hurricane Lily chased us from the Reserve. Nevertheless, during the two intense days that we had in Siboney-Juticí, we recorded some new species for the site and the region and were able to assess the status and distribution of the terrestrial habitats. These data, combined with data collected previously by biologists working with BIOECO (much of this information published here for the first time) fulfilled the basic goals of our inventory.

We would like to thank everyone who assisted us before, during, and after this inventory. Although in the following paragraphs we name some people individually, all receive our warmest gratitude.

In Havana, Nadia Pérez and Regla Balmori of the National Museum of Natural History of Cuba (Museo Nacional de Historia Natural de Cuba) shared their friendship and their organizational abilities. Reinaldo Estrada of the National System of Protected Areas (Sistema Nacional de Áreas Protegidas [SNAP]) provided very helpful comments on the results and recommendations arising from our fieldwork. Other organizational units of the Ministry of Science, Technology, and Environment (Ministerio de Ciencia, Tecnología y Medio Ambiente [CITMA]) coordinated the permits for access to the study area and for the collection of specimens. The Cuban Interests Section in Washington, D.C., kindly granted visas for the U.S. participants.

During the expedition, Emelina Martínez took charge of preparing and serving breakfasts, lunches, snacks, and dinners that are so important in the field, giving her best and preparing special treats that everyone appreciated. Drivers José L. Fabar, Ramón Cueto, and Roberto Romero provided transportation to and from the Reserve. To them, many thanks. Members of the community of Siboney were very kind and readily shared information with members of the social inventory team. The botanical team thanks Florentino Bermúdez and María del C. Fagilde for their kindness and help during the work in the herbarium at BIOECO. Ansel Fong G. is grateful to the Cleveland Zoological Society for its financial support of the first inventories of reptiles in the Reserve, and to the workers at the ecological station at Siboney for all the help that they have given during his work there. Dan Brinkmeier, Álvaro del Campo, Isa Halm, and Julie Smentek provided logistical support in the hectic days prior to the presentations of our preliminary results in Santiago and Havana.

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We thank John W. McCarter Jr. for his constant support of our program. Funds for this rapid inventory were provided by the John D. and Catherine T. MacArthur Foundation and The Field Museum.

The goal of rapid biological and social inventories is to catalyze effective action for conservation in threatened regions of high biological diversity and uniqueness.

Approach

During rapid biological inventories, scientific teams focus primarily on groups of organisms that indicate habitat type and condition and that can be surveyed quickly and accurately. These inventories do not attempt to produce an exhaustive list of species or higher taxa. Rather, the rapid surveys (1) identify the important biological communities in the site or region of interest and (2) determine whether these communities are of outstanding quality and significance in a regional or global context.

During social asset inventories, scientists and local communities collaborate to identify patterns of social organization and opportunities for capacity building. The teams use participant observation and semistructured interviews to evaluate quickly the assets of these communities that can serve as points of engagement for long-term participation in conservation.

In-country scientists are central to the field teams. The experience of local experts is crucial for understanding areas with little or no history of scientific exploration. After the inventories, protection of wild communities and engagement of social networks rely on initiatives from host-country scientists and conservationists.

Once these rapid inventories have been completed (typically within a month), the teams relay the survey information to local and international decision makers who set priorities and guide conservation action in the host country.

REPORT AT A GLANCE	
Dates of fieldwork	27-28 September 2002
Region	The inventory took place in Siboney-Juticí Ecological Reserve in southeastern Cuba, approximately 10 km southeast of Santiago de Cuba and immediately west of the community of Siboney (Figs. 1, 2A). The Reserve's area is 20.8 km^2 (2,075 ha), of which 1,434 ha are terrestrial habitats and 641 ha are marine habitats (Figs. 2A, 2B). It retains all of its original terrestrial habitats, including coastal and precoastal xeromorphic scrub (*matorral xeromorfo costero y precostero*; Fig. 2C) and semideciduous microphyll forest (*bosque semideciduo micrófilo*) (the two most important vegetation types for conservation), as well as representatives, in good condition, of the three other original habitats of the area—mangrove stand (*manglar*), sea-grape woodland (*uveral*), and rocky-coastal vegetation complex (*complejo de costa rocosa*; Fig. 2D).
Sites surveyed	The biological inventory team used BIOECO's ecological station, situated at the eastern end of the Reserve, as its base of operations (Fig. 2A), from which they explored the Reserve on foot. The social inventory team conducted interviews and observations in the community of Siboney and at the ecological station.
Organisms surveyed	Terrestrial vascular plants, terrestrial mollusks, spiders and other arachnids, butterflies, hymenopterans (ants, bees, and wasps), amphibians and terrestrial reptiles, and birds. Collaborators provided additional data from previous studies in the area on liverworts, mosses, vascular plants, mammals, and marine biodiversity (algae, corals, mollusks, fishes, reptiles, and mammals). The community of Siboney and the staff of the Reserve collaborated in the social inventory.
Highlights of results	Most of Siboney-Juticí Ecological Reserve has not been altered substantially by human activity. Apparently, the first human inhabitants of the area (the Ciboneys) caused little impact, which was restricted to the coastal and riparian zones of the Reserve. The Spanish, Cuban residents, and North American investors later developed a road, a railroad, and agricultural fields along the coastal plain of the Reserve, on the first geological terrace. Old fields, a dirt road, and a gravel pit (the last of the three adjacent to, but outside, the Reserve) are all that remains of this development. The dry, inhospitable areas of the interior of the Reserve—the limestone areas of the second and third terraces—retain almost all of their native vegetation. Our inventory was interrupted by the arrival of Hurricane Lily. Using the information that we obtained during the two days of fieldwork, complemented by additional data from other collections, the literature, and unpublished studies,

Highlights of results (continued)

we record the following significant results. We begin with the nonhuman terrestrial groups, follow with marine groups, and end with human communities.

Birds: We recorded 48 species of birds during the inventory. Of these, Bay-breasted Warbler (*Dendroica castanea*) is a new record for Eastern Cuba, and 4 species are new records for the Reserve. The inventory increased the total number of species known from the Reserve to 72. We observed 5 of the 10 species of Cuban endemic birds that inhabit the area. Individuals of some endemic species were very abundant, such as Cuban Gnatcatcher (*Polioptila lembeyei*, with a large, important population in the xerophytic coastal vegetation of the Reserve; Fig. 5E), Oriente Warbler (*Teretistris fornsi*; Fig. 5F), and Cuban Vireo (*Vireo gundlachii*). Although we did not see Bee Hummingbird (*Mellisuga helenae*; Fig. 5G) during the inventory, the presence of this Cuban endemic has been documented in the Reserve. We also observed many individuals of Prairie Warbler (*Dendroica discolor*), as well as 8 other species of migratory warblers. The Reserve appears to be an important reprovisioning stopover for many species of migratory birds.

Amphibians and reptiles: During the inventory, we recorded 21 of the 28 species known in the Reserve. Of these, 4 are amphibians (3 frogs and 1 toad), and 24 are reptiles (18 lizards, 4 snakes, and 2 blind snakes). The low number of amphibians is attributable to the arid characteristics of the area. In terms of number of species, the genera *Anolis* (8 species), *Sphaerodactylus* (4), and *Eleutherodactylus* (2) predominate, and xeromorphic scrub had the greatest number of species (26). Three of the 4 species of amphibians and, in contrast, 13 of the 24 species of reptiles are Cuban endemics. Our records during the inventory of the frog *Eleutherodactylus etheridgei* (Fig. 5A) constitute two new localities for the species, which formerly was known only from one record in Santiago de Cuba and another at the Naval Base at Guantánamo.

Mammals: Twenty-one species of terrestrial mammals have been reported in the Reserve. Of the 19 native species, 18 are bats and 1 is a rodent (the hutia *Capromys pilorides*). Only 2 introduced species of mammals have been recorded: the Norway rat (*Rattus norvegicus*), which is widespread in the Reserve, and the house mouse (*Mus musculus*), which is restricted to the buildings at the ecological station. Of the bats, 15 species are known from live specimens and 3 species from bones deposited in cave sediments in the Reserve. Three of the bat species are Cuban endemics: *Antrozous koopmani, Stenoderma falcatum*, and *Phyllonycteris poeyi* (Fig. 6B, and cover photograph). This last species forms enormous colonies and is a key species for the extensive subterranean ecosystems of the Reserve.

Highlights of results (continued)

Invertebrate animals: During the inventory, we observed 21 of the 22 species of **terrestrial mollusks** recorded for the Reserve. This species richness is extremely high, probably because of the abundance of rock containing calcium carbonate (Figs. 4E-G). Twenty (90.9%) of these species are endemic, including *Macroceramus jeannereti*, which is endemic to Siboney-Juticí Ecological Reserve. Only 2 of the species are not endemic to Cuba.

The Reserve is very rich in **spiders**. Ninety species, grouped in 30 families and 69 genera, have been recorded within its boundaries. Of these, 20 are Cuban endemics and 24 are new records for the Reserve (Figs. 4A, 4B). We observed 17 species of **other arachnids**, which constitute all of the species known in the Reserve: 8 scorpions, 3 amblypygids, 2 schizomids, 2 solpugids, 1 ricinuleids, and 1 uropygid (Figs. 4C, 4D). Of these, 4 are local endemics of the Reserve. The Reserve covers only 0.01% of the surface area of Cuba, but many species of these arachnid groups are represented.

Of the insects, we observed 37 species of **butterflies** and we predict that approximately 50 species inhabit the Reserve. We found 107 species of hymenopterans (**ants, bees, and wasps**) in the Reserve, of which the ants (family Formicidae) were the most numerous group, with 36 species. Other families with high numbers of species were Sphecidae (a group of wasps) and Apidae (the bees).

Plants: On the two days of the inventory, we recorded 150 species of **vascular plants** (ferns and flowering plants), of which some were new records (not included in the previous work of Bermúdez et al. 2001). We recorded 672 species in at least 78 families, or 9.9% of Cuba's vascular flora, and we estimate that approximately 750 species occur in the Reserve. Of the species reported here, 159 are Cuban endemics (a concentration of 5.0% of Cuba's endemic vascular plants in 0.01% of the country's surface area). Seven species are endangered, or are considered vulnerable, worldwide: the chicharrón (*Synapsis ilicifolia*) and *Tabebuia polymorpha*, both in the Bignoniaceae; *Doerpfeldia cubensis* and the bruja (*Ziziphus* [*Sarcomphalus*] *havanensis* var. *havanensis*), both in the Rhamnaceae; Cuban mahogany (*Swietenia mahagoni*, Meliaceae); the chicharrón de costa (*Pouteria aristata*, Sapotaceae); and lignum vitae (*Guaiacum officinale*, Zygophyllaceae; Fig. 3D).

In Siboney-Juticí Ecological Reserve are found 8 species of **liverworts** belonging to 4 families. Some, like the *Frullania* species and the 4 ephemeral species of the genus *Riccia*, show morphological or ecological characteristics that allow them to survive in the arid conditions of the Reserve, which would be lethal for most liverworts. The Reserve also presents conditions extremely unfavorable for

Highlights of results
(continued)

the development of most **mosses**. For that reason, only 7 infrageneric taxa of mosses have been recorded; all are of the families Pottiaceae and Fissidentaceae. Only 1 Cuban endemic (*Fissidens duryae*) has been recorded.

Marine biodiversity: Within its marine zone, Siboney-Juticí Ecological Reserve encompasses eight ecosystem types: coast with sandy beach (*costa de playa arenosa*), rocky coast (*costa rocosa*), mangrove stand (*manglar*), marine meadow (*pasto marino*), sandy bottom (*arenal*), coral terrace (*terraza coralina*), flat rocky terrace (*terraza rocosa llana*), and submarine canyon (*cañón submarino*). We recorded 22 species of **marine algae** belonging to 7 families. The high percent cover of algae at the mouth of the San Juan River suggests that they flourish because of contributions of organic matter. We found 23 species of **corals** in 10 families (of the 60 species, subspecies, and forms reported for the Cuban archipelago). Within this area we observed two diseases of this group: white-band disease and black-band disease.

In the first inventory of **marine mollusks** for this zone, we recorded 12 species in 2 classes and 6 families. Of the 94 species of **fishes** encountered, fishers capture 59; the most sought-after are the 21 species belonging to the families Haemulidae (grunts), Lutjanidae (snappers), and Serranidae (sea basses). Also in this zone, the green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) **sea turtles** and a **marine mammal**, the West Indian manatee (*Trichechus manatus*), have been observed.

Human communities: Around 2000 B.C.E. the Ciboneys emigrated from present-day Venezuela to the coastal zone of what is now the Reserve. These people, as well as Arawak agriculturalists, also used the region's caves. In the sixteenth century, Spanish settlers drove native peoples out of the area. Two hundred years later, they fortified the coast with structures that remain today. A railroad into the region, constructed by Juragua Iron in the 1880s, was dismantled in the 1930s.

The coastal community of Siboney has a concentrated population of more than 1,000 inhabitants. Its beach is visited during all seasons of the year, both by Cuban and by foreign tourists. Employment level in the community is high: residents receive income through supplying the necessities for tourism, and more than 25 economic and service centers employ community members. Siboney has three educational centers—for primary, secondary, and postgraduate instruction—which have intensified and spread activities of environmental education throughout the population. Many of the residents interviewed indicated an interest in conserving the biodiversity of the area. During its survey and monitoring, the social inventory team verified that activities that harm natural resources—

REPORT AT A GLANCE

Highlights of results (continued)	logging, charcoal production, and the extraction of the Reserve's vegetation for domestic uses, among others—have been minimized, and in some cases eliminated. Nevertheless, the rapid inventory identified other problems, such as sand extraction and illicit fishing; although these activities are not carried out by community members, they constitute a menace to the conservation of the area. In the opinion of the social inventory team, the activities of the community of Siboney are not insuperable threats for the conservation and protection of the natural, historic, and cultural values of the Reserve, if systematic work in education is intensified and if alternative solutions to economic problems, from local to national scales, are sought.
Main threats	Extensive habitat destruction is not an immediate threat to Siboney-Juticí Ecological Reserve. Areas of the Reserve formerly degraded by human activities (e.g., alteration of vegetation by domestic animals) are now in recovery. Nevertheless, the following threats (which originate outside the Reserve's boundaries) put its biodiversity at risk: ▪ **Clandestine extractive activities** (e.g., hunting of sea turtles, the manatee, the Cuban iguana, and the hutia; overfishing; cutting of shrubby vegetation for fuel, and of trees for precious woods; sand extraction). Although people from outside the coastal zone probably cause the most serious impacts, local populations also are involved in some of these activities. ▪ **Habitat degradation in the foraging areas of the bats** that have their diurnal refuges in Siboney-Juticí. Most of these areas lie outside the Reserve and have no formal protection at the moment. ▪ **Unplanned tourism in the coastal zone.** Uses of the beach that are incompatible with conservation could place entire ecosystems at risk.
Current status	The area was approved as an Ecological Reserve (Reserva Ecológica) by an agreement with the Provincial Government of Santiago de Cuba after a formal process of reconciliation. It also has been approved at the national level by the Council of Ministers (Consejo de Ministros) of Cuba. Siboney-Juticí Ecological Reserve was 1 of the first 32 reserves approved through Decree 201 of the National System of Protected Areas, which took effect with the publication of the decree in the Official Gazette of 24 December 1999.

REPORT AT A GLANCE

Principal recommendations for protection and management

- **Eliminate clandestine extractive activities along the coast.** Integrate marine and coastal biodiversity, as well as terrestrial life, into protection strategies.
- **Develop management programs in the foraging zones of the bats,** after identifying their specific locations. At the same time, protect the cavern systems inside the Reserve that give refuge not only to bats but also to endemic species such as several arachnids.
- **Continue the process of capacity building and involvement of local residents** in the protection and management of the Reserve. Work with their economic interests in the benefits of tourism to plan the use, compatible with conservation, of coastal zones by national and foreign tourists.

Long-term conservation benefits

- **Strengthened management of a protected area outstanding in Cuba** for its extensive area of xeromorphic scrub and for its intact rocky-coastal vegetation complex
- **Protection of many conservation targets at risk in Cuba and worldwide:** endemic species and species with restricted distributions, rich faunas of certain groups (e.g., arachnids and terrestrial mollusks), irreplaceable populations of bats and other cave-dwelling fauna, species that are threatened or endangered at the global level, and a reprovisioning stopover for migratory passerine birds
- **A local human population that gains benefits**—tangible and intangible—**from collaborating in this protection and management**

Why Siboney-Juticí?

On any day of the year, at sunset in Siboney-Juticí Ecological Reserve, a river of life slices the sky as it emerges from the bowels of the earth. It is not a monster, or a figment of your imagination, just the largest colony of bats in Cuba, which has come out in search of food.

The coastal strip between Santiago de Cuba Bay and the community of Siboney is a conjunction of characteristics that make it a priceless place for the conservation of the Cuban biota. Here you find yourself in an amazing world where marine terraces, carved into the rock by the waves, seem to rise from the sea like a stairway for giants.

Intense processes of superficial limestone formation have created a landscape full of sharp-pointed rocks and cavities. Soil is restricted to a few places where it has been deposited over thousands of years. This region is also extremely dry, as a result of its position south of the mountains that block humidity coming from the north. Both of these landscape features generate a strong water stress to which the flora has had to adapt itself, in order to conserve moisture. And, below ground, several kilometers of caves, with very distinctive characteristics, have created perfect niches for a great diversity of fauna and have facilitated the forces that produce new species.

Nonetheless, the flora and fauna of the Reserve, and the ecological processes that sustain them, are not invulnerable to the pressures of the world outside. Although it is not a serious threat at present, clandestine resource extraction could re-emerge, in the marine as well as in the terrestrial zone. The most serious threat to Siboney-Juticí is the lack of a comprehensive plan for management and monitoring, with strategies that range from the development of conservation-compatible tourism to the protection of areas outside the Reserve where its bats forage.

In carrying out this rapid inventory, we aimed to fill significant information gaps on the biological diversity and the social assets of the inhabitants of Siboney-Juticí—gaps that stand in the way of planning a secure future for this extraordinary landscape.

Conservation/Information Design

WHAT IS CONSERVATION/INFORMATION DESIGN?

Rapid inventories of a landscape's diversity lay the groundwork for two processes that lead to a site conservation plan. *Conservation design* uses biological and cultural values, and threats to those values, to establish conservation goals and strategies. These "products" of conservation design are our basis for action. *Information design* drafts blueprints for further scientific inquiry that will support our goals and strategies directly.

In conservation design, we

01 **Define the site.** What is the geographic scope of our conservation efforts?

02 **Describe the ecological context.** How does this site work?

03 **Choose conservation targets.** What do we want to protect or enhance within this site?

04 **Establish visions.** What do we want these targets to look like in the future, in terms of quantity, quality, and time?

05 **Identify risks and opportunities.** What could prevent us from achieving our visions for these targets? On what strengths can we draw to confront these threats?

06 **Set goals.** What should we accomplish to offset threats to specific targets?

07 **Create strategies.** What will we do to reach these goals?

Through information design, we create a scientific program for

01 **Ecological research,** a systematic approach to posing and answering questions that reveal the linkages between cause and effect;

02 **Ecological inventory,** a snapshot of current conditions that establishes a baseline against which to measure change over time; and

03 **Ecological monitoring,** a process for measuring progress toward conservation goals.

Our entry points into these design processes are rapid biological and social inventories, combined with earlier studies focused on a particular landscape. In this section we present the elements of conservation design and information design that emerged from our inventory of Siboney-Juticí Ecological Reserve.

SITE DEFINITION

Siboney-Juticí Ecological Reserve was 1 of the 32 initial reserves approved through Decree 201 of the National System of Protected Areas of Cuba, published in the Official Gazette of 24 December 1999. The Reserve lies in the province of Santiago de Cuba, to the east of the city of the same name, between 19°56'26" and 19°58'13" N and between 75°49'32" and 75°42'24" W. The protected area covers 2,075 ha, including a terrestrial sector of 1,434 ha (0.01% of Cuba's terrestrial surface area) and a marine sector of 641 ha. The boundaries were drawn to protect the largest possible extent of the natural areas of the coastal sector east of Santiago de Cuba Bay, which include zones of high biodiversity value.

For additional information about the defining characteristics of the Reserve, see Why Siboney-Juticí? and the Technical Report: Overview of Inventory Site.

ECOLOGICAL CONTEXT

During the rapid biological inventory, we visited several of Siboney-Juticí's terrestrial vegetation types (see the Technical Report: Vegetation), but these represent only one of three very distinct ecosystem types that overlap in the Reserve: above-ground ecosystems, extensive subterranean ecosystems, and nearshore marine ecosystems.

Above-Ground Ecosystems

Above-ground ecosystems cover terrain predominantly rough at both large and small scales. The uplifted terraces (see Why Siboney-Juticí?) present broken, towering, vertical faces to the lowermost terrace and the adjacent sea (Figs. 2C, 2D). These upper terraces are eroded karst covered with daggerlike projections (*diente de perro*, Fig. 3C) as well as pits and crevices of all sizes. Only on the lowermost terrace, on portions of the uppermost terrace along the north edge of the Reserve, and on the banks of the two small rivers has much soil accumulated. The low rainfall, the high evaporation, the dearth of soil, the effect of the wind, and the salinity have determined that the predominant aspect of the Reserve is dry and harsh. These pressures, combined with the insularity of Cuba, have shaped the fauna and flora in readily perceptible ways.

Nearshore terrestrial ecosystems are typical of those found elsewhere in the Caribbean, but two kinds of native vegetation found on the second and third terraces—xeromorphic scrub (*matorral xeromorfo*) and semideciduous microphyll forest (*bosque semideciduo micrófilo*)—harbor many Cuban endemics and native species. Fortunately, these two kinds of habitat have been little altered by humans within the Reserve, in part because of the hostile terrain. A portion (less than 20% of the area) of the lowest terrace is dominated by non-native species, particularly along a long-established roadway and in old fields and pastures.

Species richness of terrestrial organisms varies from high-moderate to low, depending on group. Terrestrial organisms dependent on easy access to water don't do well here: cacti (13 species) outnumber liverworts (8), mosses (7), or ferns (5) approximately two to one. The Reserve's vascular plants (672 species reported here), liverworts, and mosses often show pronounced adaptations to dry environments. Likewise, only 4 species of amphibians live in the Reserve, versus 24 species of reptiles, which are less water-dependent. Yet these same conditions provide opportunities for other terrestrial organisms. Arachnids are abundant and well represented, with 107 species. The Reserve also is rich in species (22) of terrestrial mollusks; the raw materials for shell construction are abundant in this karstic landscape. Other terrestrial animals are represented in moderate numbers: butterflies (37 species), hymenopterans (107), and birds (72).

Patterns of endemism differ from those of species richness. Terrestrial mollusks and non-spider arachnids both show high species richness and a very high degree of endemism (91% and 94%, respectively, confined to Cuba or to limited areas within Cuba). In contrast, although few species of amphibians are present, a large proportion (75%) of them also are Cuban endemics. Groups showing less extreme (but very significant) Cuban endemism include the reptiles (54%) and the vascular plants and spiders (each group 23-24% endemic). Endemism of birds, mammals, and mosses is 14%. No liverwort species is endemic, and comprehensive data were not available for the insects.

In contrast to these irregular patterns of endemism, the great preponderance of native species over exotic, introduced species is uniform across all terrestrial plant and animal groups. None of the species of liverworts, mosses, terrestrial mollusks, amphibians, or reptiles present are non-native. Only 14 vascular plant species (2% of the species present) are exotic—a remarkably low number, given centuries of human habitation of the area. Only 1 of 17 non-spider arachnids (a scorpion) is introduced, and this is confined to areas with human disturbance. The group with the highest proportion of introduced species (10%) is the terrestrial mammals. One of the 2 non-native nonhuman species, the house mouse, seems to be confined to the ecological station, but the Norway rat is widespread in the Reserve. Overall, however, the impact of exotic species on the Reserve, in terms of both numbers of species and their distribution (concentrated on the long-disturbed lower terrace), is very limited—an asset for long-term maintenance of the Reserve.

No human settlements fall within the Reserve's boundaries, but the community of Siboney (with more than 1,000 inhabitants) lies just to the east. The standard of living of Siboney's residents is relatively high and on the increase, with income from tourism. Protection both "natural" (via forbidding physical features and vegetation) and legal has minimized human interaction with much of the Reserve's native above-ground biodiversity. Nevertheless, direct human use of wild resources, as well as collateral interactions (such as alteration of microhabitats), may exert strong selective pressures on some plant and animal species in above-ground ecosystems (see Conservation Risks and Opportunities, below).

Subterranean Ecosystems

The Reserve shelters a huge array of underground ecosystems, some of which are driven by energy provided indirectly by bats. Returning from nocturnal foraging, the bats' bodies carry large volumes of insects, fruit, and other materials back to the extensive caves, where they deposit them in the form of guano. No sunlight reaches these cave habitats, but the guano transfers its energy to vast numbers of decomposers (invertebrates and fungi), and to the consumers and predators that feed upon them. This energy cycle has generated and maintained unique biological diversity. For example, of the Reserve's 17 species of non-spider arachnids (scorpions, whipscorpions, etc.), at least 8 species are confined to caves or make extensive use of them.

Another example is the Cuban flower bat (*Phyllonycteris poeyi*; see cover and Fig. 6B), one of three endemic bats known from the Reserve. The structure of "cold" caves in the Reserve causes air to flow as if through a chimney, but warm air can accumulate in other caves with a domed interior. In some of these "hot" caves, occupied by enormous colonies of *P. poeyi*, the temperature reaches 38°C with 90% relative humidity. Such extreme microclimate change restructures a "hot" cave's ecosystem and provides new opportunities for adaptation, divergence, and endemism.

These cave ecosystems, and their component species, are in great need of study. Many new species, including fossils, are likely to be found, and fundamental questions remain to be answered. For example, what are the limits of the area used by the bats in their nightly foraging? Will habitat alteration in those areas create changes in the Reserve's cave ecosystems? How have the introduced rats altered these systems?

Humans occasionally enter the caverns, but they are not a significant component of the ecosystem.

Marine Ecosystems

The marine ecosystems along two-thirds of the coastline of the Reserve have been protected from the shoreline to a depth of 200 m. The area comprises eight major habitat types, whose living components are—with a few

exceptions—in good condition. To date, algae, vascular plants, corals, marine mollusks, fishes, reptiles, and mammals have been subject to inventory (see the Technical Report: Marine Biodiversity, and Appendix 12). Like the cave systems, the marine portions of the Reserve still hold more biodiversity secrets than above-ground terrestrial ecosystems.

Human foragers, both local residents and outlanders, regularly venture into many of the Reserve's marine ecosystems. Their use of some resources there is heavy enough to have caused conservation concern for some marine fishes, the 2 sea turtle species, and the only known marine mammal (a manatee) (see Conservation Targets, as well as Conservation Risks and Opportunities, below). Human changes to nearshore terrestrial ecosystems also spread to the sea through the complex ecological interactions between the two.

CONSERVATION TARGETS

Conservation targets are the elements of physiographic, biological, or cultural diversity that we want to persist in the landscape. We used the following criteria to choose these targets:

C1 Wild vegetation types or aquatic habitats that are the foundations of native biodiversity

C2 Vegetation types or aquatic habitats that are especially species rich, diverse, or threatened

C3 Wild communities/assemblages that are especially species rich, diverse, or abundant in comparison to those of other landscapes in the country or region

C4 Species, subspecies, or communities/assemblages that are endemic to the country, to the region, or to the locality

C5 Species, subspecies, or communities/assemblages that are rare, threatened, endangered, vulnerable, or declining (including species of economic importance)

C6 Species or subspecies under such intense local harvesting pressure that their populations may be in jeopardy (sufficient information is lacking)

(Codes continued on next page)

The following are the conservation targets that we identified for Siboney-Juticí Ecological Reserve during the rapid inventory. Site managers and planners will need further studies to refine these choices. Codes in parentheses refer to the criteria to the left. A detailed list of targets for each group of organisms appears at the beginning of the group's account in the Technical Report.

Physiographic Features	▪ Caves (C10) ▪ Coastal and inland sites on the first geomorphic terrace that have concentrations of sand (C10)
Terrestrial Vegetation Types	▪ Original vegetation types on the Reserve's second and third geomorphic terraces, including coastal and precoastal xeromorphic scrub and semideciduous microphyll forest (C2) ▪ Functional representatives of the other original vegetation types (mangrove stands, sea-grape woodlands, rocky-coastal vegetation complex) (C1)
Nonvascular Plants	▪ Four range-restricted species of the **liverwort** genus *Riccia* (C5) ▪ The endemic **moss** *Fissidens duryae* (C4)
Terrestrial Vascular Plants	▪ Five species (including Cuban mahogany [*Swietenia mahagoni*]) considered Endangered worldwide by IUCN-The World Conservation Union's criteria (C5) ▪ Two Vulnerable species (one in the Sapotaceae and the other in the Bignoniaceae) (C5)
Terrestrial Faunal Assemblages	▪ Cave-dwelling fauna, especially endemic and threatened groups (C3, C4, C5)

Conservation Targets (continued)

C7 Concentrated populations of migratory species (either as passage migrants or as seasonal residents) that may be vulnerable through their dependence on the landscape's resources

C8 Institutions, social assets (including human resources), or built structures that are significant for the diversity of the landscape, especially if threatened

C9 Human land uses and social/ecological practices that apparently support or are compatible with biodiversity conservation

C10 Physiographic features of the landscape that harbor significant native biodiversity and are at risk

Terrestrial Mollusks	▪ Two threatened endemic species (C4, C5) ▪ Seven endemic species with geographic ranges restricted to the southeast coast (C4)
Arachnids	▪ Populations of 20 endemic **spider** species present in the Reserve, especially 3 species known only from a few localities in the Sierra Maestra and 3 other species known only from the type locality inside the Reserve (C4) ▪ Four species of **non-spider arachnids** that are endemic to the Reserve (C4)
Insects	▪ *Parides gundlachianus*, a charismatic **butterfly** species endemic to Cuba (C4, C5) ▪ Five hymenopteran species endemic to Cuba (four **ants** and a **bee**) (C4)
Amphibians and Terrestrial Reptiles	▪ Four species (a frog and three lizards) with restricted geographic distributions (C4) ▪ Two species (an iguana and a snake) persecuted by humans and considered Vulnerable and Near Threatened, respectively, by IUCN criteria (C5)
Birds	▪ An endemic species (Cuban Gnatcatcher) with a restricted distribution in Cuba (C4) ▪ A threatened Cuban endemic (Bee Hummingbird) that appears to occur seasonally in the Reserve (C4, C5) ▪ Two Cuban endemic species with large populations in the Reserve (C4) ▪ Migrant passerines from North America (C7)

Terrestrial Mammals	▪ Three endemic bat species (C4) ▪ Five bat species on the IUCN 2004 Red List (C5) ▪ Bat communities (C3) ▪ Populations of hutias under local hunting pressure (C4, C6)
Marine Biodiversity	▪ Three species (green sea turtle, hawksbill turtle, and West Indian manatee) considered Threatened by IUCN criteria and under pressure for human consumption as food or as materials for handicrafts (C5, C6) ▪ Functional representatives of the eight types of marine ecosystems in the Reserve (C1)
Human History	▪ Fort Sardinero, Muerto Cave, and the Sardinero archeological site (C8)
Human Communities	▪ An educational system compatible with conservation education, including the staff needed for implementation (C8, C9) ▪ Institutions for the study of biodiversity, as well as their scientists, with experience in the area, who can support conservation activities (C8, C9) ▪ The ecological station near the community of Siboney—a potential base of operations for ecological interpretation and conservation education (C8, C9)

A VISION FOR CONSERVATION IN THE REGION

Given the first-cut ecological context and conservation targets that emerged from the rapid inventory, as well as the current protection status and management efforts, what is an ambitious but realistic *vision* for the future of wild and human communities in Siboney-Juticí Ecological Reserve?

- Undisturbed caves that retain the ecological processes sustaining their fauna
- Intact or recovering areas with sandy substrates
- Original vegetation types and marine ecosystems that have lost no surface area and have not been degraded from their current (2002) condition
- Vegetation types (such as shrubby secondary forests) and marine ecosystems that have recovered from significant alteration by human activity
- Coordinated management of areas adjacent to the Reserve (for example, to protect the foraging areas of resident bat populations, as well as to protect marine organisms) on which the Reserve's ecological integrity depends
- Plant and animal targets (communities/assemblages and species/subspecies/varieties) that are persisting in the long term and include (1) local, regional, and national endemics; (2) range-restricted species; (3) species that are vulnerable, threatened, or endangered; and (4) migratory species that depend on the Reserve's resources
- Landmarks of the Reserve's human history that are protected for the future
- A thriving ecological station that (1) supports scientific inquiry on behalf of the Reserve's biological and cultural diversity and (2) is a platform for involving residents of the community of Siboney, as well as visitors from other areas, in active conservation of this diversity
- A local human population that gains benefits—both tangible and intangible—from conservation behavior (for example, managed marine fishing, logistical support of tourism compatible with the Reserve's values)

CONSERVATION RISKS AND OPPORTUNITIES

THREATS

What *threats* stand in the way of this conservation vision for Siboney-Juticí Ecological Reserve? How do large-scale threats endanger the entire landscape? How do large- or smaller-scale threats affect particular conservation targets? Although a detailed threats analysis was beyond the scope of our rapid inventory, the following first-cut list would be a basis for a more-detailed analysis in the future. For details about the targets affected, see the taxonomic accounts in the Technical Report.

Current Threat	Target(s) Affected
Hunting pressure on terrestrial species	Hutias; Cuban iguana; Cuban boa
Overharvest of marine species for food or as materials for handicrafts	Marine mollusks, fishes, turtles, and mammals
Habitat degradation in bat foraging areas outside the Reserve	Endemic and endangered/threatened bat species; bat communities; other cave-dwelling species that depend on the environmental conditions regulated by roosting bats
Insufficient or ineffective regulatory signs	All terrestrial vegetation types and their inhabitants; caves and cave-dwelling fauna (including endemic spiders, other arachnids, and bats)
Unplanned tourism (coastline)	Sandy beaches; nearshore vegetation types (including mangrove stands, sea-grape woodlands, and rocky-coastal vegetation complex)
Shortage of material and financial resources	An educational system that supports conservation education; scientific institutions and their staff; the Reserve's ecological station
Extraction of sand for commercial construction	Coastal and interior sites on the first terrace that have concentrations of sand

Conservation Risks and Opportunities (continued)

Potential Threat	Target(s) Affected
The road that traverses the area, facilitating human access	All terrestrial vegetation types and their inhabitants
Uncontrolled entry by local residents or visitors from other areas	Caves and cave-dwelling fauna; all above-ground terrestrial vegetation types
Unplanned tourism (interior and marine)	All terrestrial vegetation types, marine ecosystems, and their inhabitants
Resurgence of human activities (e.g., damage to vegetation) that have degraded terrestrial habitats in the past	All terrestrial vegetation types and their inhabitants; migrant passerines from North America
Illicit extraction of precious woods	Cuban mahogany and other native tree species; semideciduous microphyll forests; plant and animal species dependent on forest habitats
The commercial pet trade	Bird species, especially Cuban Bullfinch and Yellow-faced Grassquit
The same unknown forces that have caused declines and extinctions of amphibians on other Caribbean islands	Amphibian species
Human-set fires	Some terrestrial vegetation types
Catastrophic events (such as hurricanes) that can eliminate entire local populations	Range-restricted species, including several species of terrestrial mollusks and arachnids, as well as a frog, three lizards, a bird, and bats
Erosion by wind and water, and collection of historical artifacts by tourists	Historic landmarks

ASSETS

What *assets* of this landscape work on behalf of the conservation vision? What assets do particular organism groups or human communities bring to bear? Although a formal asset-mapping exercise is necessary to answer these questions in depth, the following strengths emerged during the rapid biological and social inventories at Siboney-Juticí Ecological Reserve.

- Rough terrain and dense vegetation that provide natural protection against human access to wild areas in the Reserve's terrestrial sector
- The low number of non-native species, which seem to have little impact on native biodiversity
- Permanent staff at the Reserve's ecological station
- Elimination, through Reserve regulations and active management, of most of the destruction and degradation of terrestrial habitats that occurred in the past
- Expertise in systematic biology, ecology, sociology, and conservation practice that has created a basis for understanding the Reserve's wild and human diversity and history
- Links to the community of Siboney and to other population centers that have the potential to support conservation programs
- Small-scale economic activities (such as rental of houses to Cuban and foreign visitors) that have established incentives for well-planned regional tourism

RECOMMENDATIONS FOR GOALS AND STRATEGIES

Given the web of conservation targets, assets, and threats at Siboney-Juticí Ecological Reserve, we recommend the following preliminary *goals and strategies* for protection and management, and for further scientific inquiry (inventory, research, and monitoring). Collaboration among local communities, scientists, managers, and governments will provide deeper and broader content for our goals and strategies. For more-detailed, organism-specific recommendations, see the Technical Report.

Protection and management

- **Minimize local harvesting pressure** on hutias and the Cuban iguana (hunted for food), on the Cuban boa (killed for food and out of fear), and on small birds (caught for the pet trade). Combine (1) legal restrictions and enforcement with (2) conservation education and exploration of alternative food sources.
- **Reduce or eliminate the overharvest of marine animal species.** Combine legal restrictions and enforcement with an increase in environmental education programs.
- **Eliminate the extraction of precious woods from the Reserve.** Increase surveillance and control in the Reserve, and continue to develop plans for environmental education in the community of Siboney.
- **Eliminate the extraction of sand from coastal and interior sites.** Implement stronger legal restrictions and ensure that they are enforced. Increase efforts in environmental education. Increase surveillance and patrolling in the Reserve.
- **Restrict access to the Reserve's caves** to protect them from direct disturbance to habitats and species, as well as from microhabitat alteration.
- **Produce regulatory signs and place them in key areas of the Reserve,** including the coastal sector.
- **Increase patrolling of these key areas** to reduce uncontrolled entry by local residents and visitors. Focus attention on areas accessible by road. Watch for potential resurgence of fuelwood extraction, habitat damage from domestic animals, or other uses of the Reserve's biodiversity that are incompatible with conservation.
- **Establish practices for protecting the Reserve from human-generated fires.**
- **Preserve the Reserve's historic landmarks**—Fort Sardinero, Muerto Cave, and the aboriginal archeological site at Sardinero—from degradation by weather and curio collection by tourists.

- **Consolidate the management plan and develop a financial plan for the Reserve.** Use the financial plan as the basis for supporting conservation education and scientific studies on behalf of conservation.
- **Continue the process of capacity building and involvement of the Reserve's human neighbors** in protecting and managing the site. Intensify efforts in conservation education. Create community exhibitions for biodiversity conservation. Train and involve community leaders and students at all levels of education in (1) legal regulations for the conservation of the coastal zone and (2) educational approaches.
- **Incorporate a plan for regional tourism development into the Reserve's management plan.** Zone and manage activities to minimize damage to beaches, nearshore marine ecosystems, and coastal vegetation types.
- **Create better access routes for scientific investigators** to reach the highest areas of the Reserve's northern section.

Further inventory

- **Conduct a quantitative inventory of the seven species of vascular plants considered Endangered or Vulnerable (IUCN) worldwide.** Stratify the survey by habitat and location in the Reserve, with the objective of determining if these populations need active management for long-term persistence.
- **Survey the mollusk fauna found in sediments for species that formerly existed or were formerly more abundant in the Reserve.** Use the results to evaluate the possibility of reintroducing these species into the area.
- **Focus on the three-plus species of spiders endemic to the Reserve,** to determine (1) current population distributions, (2) habitat requirements, and (3) the description of the male of *Araneus faxoni*.
- **Conduct more-intensive inventories of populations of migratory bird species.** Use the results to identify key areas for habitat protection.

Research

- **Study the successional stages of xeromorphic scrub, semideciduous microphyll forest, and degraded habitats in need of restoration.** Use the results to implement programs for restoration of native vegetation.
- **Document changes over time in floristic composition under passive management.** Establish a sufficient number of permanent plots, chosen at random in disturbed and undisturbed parts of the Reserve, to allow for change detection.
- **Study the population ecology of endemic species of non-spider arachnids** to evaluate their long-term stability in the Reserve.
- **Determine the impact of the pet trade** on populations of Yellow-faced Grassquit and Cuban Bullfinch.
- **Determine the variables that contribute to the high population density of some permanent-resident bird species** in disturbed areas dominated by *Acacia macracantha*.
- **Document the value of the Reserve as a provisioning stopover** for avian passage migrants.
- **Conduct studies on rare, endemic, vulnerable, or threatened mammals in the Reserve** to determine the effects of threats on their populations. Use the results to (1) guide management action and (2) serve as a baseline for monitoring the effectiveness of these actions.
- **Carry out studies to determine the location of bat foraging zones outside the Reserve.** Use this information to develop management plans for these zones or to recommend conservation action. Use the existence of a Biosphere Reserve that includes parts of these areas.

Monitoring

- **Develop a regional monitoring program** through which site managers and local communities can measure progress toward conservation goals set in the Reserve's management plan. We recommend particular attention to the following projects, once goals are set:
  - **Continue and strengthen the Reserve's amphibian monitoring program,** which began in early 2002.
  - **Track populations of terrestrial mollusk species** that have restricted ranges or are threatened endemics.

OVERVIEW OF INVENTORY SITE

Author: Nicasio Viña D.

Siboney-Juticí Ecological Reserve was 1 of the first 32 reserves approved through Decree 201 of the National System of Protected Areas, which took effect with the publication of the decree in the Official Gazette of 24 December 1999. The Reserve lies in Santiago de Cuba Province, east of the city of the same name, between 19°56'26" and 19°58'13" N and between 75°49'32" and 75°42'24" W (Figs. 1, 2A). Its total area is 2,075 ha, which includes a terrestrial sector of 1,434 ha (0.01% of the terrestrial surface area of Cuba) and a marine sector of 641 ha (Figs. 2A, 2B). The Reserve is narrow and elongated: its east-west axis is 12.4 km wide and its widest north-south axis 3 km. Total length along the coastline is 10.4 km. Elevations in the Reserve range from 200 m below to 120 m above sea level.

The Reserve lies in a zone where the most significant geographic feature is the presence of marine terraces that create the impression of giant stairsteps in the local landscape (see the inner cover). Eight levels of marine terraces, both emergent and submerged, are present. Expanses of dogtooth rock (*diente de perro*, or *lapiéz*, which is superficial, highly weathered limestone) cover a large percentage of the area (Fig. 3C). Other karstic features include ravines, sinkholes, small canyons, red-soil depressions, small faults, and drainage lines that cut across the terraces (Fig. 3A). The limestone feature of greatest importance to the area's fauna is the system of 33 caves and grottos, with distinctive morphological and microclimatic characteristics.

The mean annual temperature of the Reserve varies between 24 and 26°C. The annual mean maximum is 28-32°C and the annual mean minimum 20-22°C (Montenegro 1991). The mean annual relative humidity is 70-80%. Sea breezes of up to 12 km/h predominate during the day and are replaced at night by light trade winds, intensified by the *terral* (a nocturnal wind that blows from land to sea) and mountain breezes (Montenegro 1991).

Precipitation in the area of the Reserve does not exceed 800 mm; the annual mean is approximately 650 mm (Bermúdez and Durán 1991). Evaporation varies from 1,700 to 1,900 mm per year. The climate produces fogs that are either catabatic (produced during the night by the drainage of cold air from higher ground

to the north) or of occasional, localized radiation of heat to the atmosphere. Cloudiness is moderate during the rainy season (May-October); cumulus clouds of convective origin cover 50% of the sky and produce 600 mm (mean) precipitation. During the dry season, poorly developed cumulus cloud cover is 25% and precipitation is less than 200 mm.

Although the Reserve is bounded on the east by the Carpintero River watershed and on the west by the watershed of the San Juan River, it is not traversed by any permanent superficial watercourse, since the Sardinero and Juticí washes, which are the only ones that cut through the area, have small beds and run only after heavy rains (Fig. 2A). These watersheds combined cover 200 km^2 (not a large area, but it should be taken into account in management planning for the Reserve, because intensive human activity, including settlements, occurs within it).

The conjunction of karstic features, climate, and location of the area has influenced the characteristics of the Reserve's biota and has contributed to processes of speciation and high species richness. According to the classification of "natural" and human-dominated regions of Cuba by Núñez Jiménez et al. (1989), the Reserve falls into the Eastern Region, Sierra Maestra Subregion, Area of Southern Coastal Terraces of the Sierra Maestra, and Subarea of Coastal Terraces of the Green Baconao Sea.

SITE VISITED BY THE BIOLOGICAL TEAM

The primary routes for vehicle access are the Siboney highway and the road to Sardinero. From the north one can enter the Reserve through secondary routes such as the network of forest roads in the Brujo zone and the road to Palenque. The rapid biological inventory team entered the Reserve from the east (through Siboney) and used BIOECO's ecological station (ca. 19°57'41" N, 75°42'55" W; Fig. 2A) as a base camp during fieldwork in the Reserve from 27 to 28 September 2002. Our work was interrupted by the arrival of Hurricane Lily, which forced us to evacuate. We explored the Reserve on foot, and we focused principally on the lowest emergent terrace (the "first") and portions of the second terrace near the ecological station.

COMMUNITY VISITED BY THE SOCIAL TEAM

The rapid social inventory team worked in the community of Siboney, immediately east of the Reserve, from 27 to 28 September 2002.

TERRESTRIAL VEGETATION

Participants/Authors: Orlando J. Reyes and Félix Acosta Cantillo

Conservation targets: Original vegetation types on the Río Maya and La Cruz Formations, including coastal and precoastal xeromorphic scrub and semideciduous microphyll forest (the most important types for conservation, because they harbor the majority of endemics present) (C2); functional representatives of the other original vegetation types (mangrove stand, sea-grape woodland, rocky-coastal vegetation complex) (C1)*

INTRODUCTION

The vegetation of Siboney-Juticí Ecological Reserve is varied because of the multitude of ecological conditions and human disturbances. In geomorphic terms, the Reserve is characterized by several levels of terrestrial and marine terraces (Fig. 2A, and inner cover).

The first terrestrial terrace consists of the Jaimanitas Formation, which has sandy soil and has been disturbed greatly by human activity. On the second terrestrial terrace and part of the third, the Río Maya Formation consists of fragmented limestone of organic origin, which manifests as dogtooth rock (*lapiéz*). Often the soil is Rendsina or nonexistent; as a result, the soil environment is extreme. Behind and to the north of these terraces, the La Cruz Formation is marl and more highly weathered limestone, with brown, strongly carbonated soil, which is less stressful ecologically.

Because it is in the rainshadow of the Sierra de la Gran Piedra, the Reserve's climate is distinctive: it falls under the influence of a typical stressful Föhn (drying winds that have descended from the mountains). Annual rainfall reaches approximately 700 mm and is separated by two dry seasons. About nine months are ecologically arid. The mean annual relative humidity

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

varies from 75 to 80%; evaporation reaches approximately 2,000 mm (Montenegro 1991). This is one of the regions of Cuba where solar radiation is most intense and the temperatures highest; monthly averages of the latter range from 24 to 28°C (Lapinel 1989).

Marine winds laden with salt, which blow principally from the southeast, are also of great ecological importance. These beat forcefully against the vegetation, which shows stress-induced physiological and morphological adaptations (Figs. 2D, 3G).

METHODS

Because of the speed of the inventory, we mapped habitats directly, using 1:25,000 maps. To do this, we made rounds of the study area and took GPS readings.

RESULTS (HABITATS)

We encountered nine basic habitat types. Of these, five were forests, two were scrub formations, and two were grasslands (Fig. 2B).

Semideciduous microphyll forest (*Bosque semideciduo micrófilo*)

This vegetation type occurs on shallow, brown soils of the La Cruz Formation (limestone and marl). The topography is gently rolling and the microrelief is relatively flat, with a few surface rocks. Humus is poorly represented: layer L reaches 10-15 mm and layer F approximately 5 mm; layer H is absent.

The arboreal layer is 8-14 m tall with variable cover. Species dominance varies locally. In some places the most important species are *Bursera simaruba* (Burseraceae) and *Amyris elemifera* (Rutaceae); in others they are *Picrodendron baccatum* (Euphorbiaceae) and *Plumeria obtusa* (Apocynaceae); in yet others they are *Picrodendron baccatum* and *Pseudocarpidium avicennioides* (Verbenaceae), or *Senna atomaria* and *Acacia macracantha* (Fabaceae). In the extreme southeastern part of the Reserve, *Phyllostylon brasiliensis* and *Celtis trinervia* (Ulmaceae) dominate.

The shrub layer is dense. The principal species are *Gymnanthes lucida* (Fig. 3B) and *Croton lucidus* (Euphorbiaceae), although *Bursera simaruba, Erythroxylum havanense* (Erythroxylaceae), *Pilosocereus brooksianus* (Cactaceae; Fig. 3E), and *Turnera ulmifolia* (Turneraceae) are also important. The following also occur: *Acacia macracantha, Exostema caribaeum* and *Randia aculeata* (Rubiaceae), *Plumeria obtusa, Commicarpus scandens* (Nyctaginaceae), a *Coccoloba* species (Polygonaceae), *Senna atomaria, Colubrina elliptica* (Rhamnaceae), *Lantana montevidensis* (Verbenaceae), and *Varronia globosa* (Boraginaceae).

This forest does not have an herbaceous layer, except for a few individuals of *Bothriochloa pertusa* (Poaceae) and *Turnera ulmifolia*. Lianas found here are *Stigmaphyllon lineare* and *S. sagraeanum* (Malpighiaceae); epiphytes are *Tillandsia fasciculata* (the more important species) and *T. recurvata* (Bromeliaceae).

Shrubby secondary forest in semideciduous microphyll forest ecotopes (*Bosque arbustoso secundario en ecótopos de bosque semideciduo micrófilo*)

This forest occurs on shallow, carbonated brown soils of the La Cruz Formation. Humus layers are poor: layer L is approximately 10 mm deep; layers F and H are mixed and are roughly 5 mm deep.

This transitional vegetation type has a very dense shrub layer between 5 and 7 m tall. The most important species are *Exostema caribaeum*, *Bourreria virgata* (Boraginaceae), *Senna atomaria, Gymnanthes lucida, Bursera simaruba*, and *Diospyros grisebachii* (Ebenaceae). The following species also occur here: *Picrodendron baccatum*, a *Coccoloba* species, *Tecoma stans* (Bignoniaceae), *Croton lucidus, Turnera diffusa, Acacia macracantha, Caesalpinia violacea* and *Leucaena leucocephala* (Fabaceae), *Randia aculeata* (Rubiaceae), *Varronia globosa, Amyris elemifera*, and *Zanthoxylum fagara* (Rutaceae).

The herbaceous layer is dispersed. *Lantana montevidensis* and *Gymnanthes lucida* are important species; we also observed *Oplonia tetrasticha* (Acanthaceae), *Lantana camara*, and *Acacia macracantha*. Lianas included *Passiflora santiagana* (Passifloraceae), *Commicarpus scandens, Stigmaphyllon sagraeanum*, and *Triopteris rigida* (Malpighiaceae).

Shrubby secondary forest dominated by *Acacia macracantha* (*Bosque arbustoso secundario con dominancia de* Acacia macracantha)

This secondary forest occurs on the first terrace (Jaimanitas Formation) in a continuous swath between the Juticí River and half the distance between the Sardinero River and the western boundary of the Reserve (Figs. 2A, 2B).

The soil is sandy, rich in gravel and rocks, of a yellowish ocher, sometimes with reddish tones. Holes of the crabs that remove this material are everywhere. The humus is scattered and poorly developed; because *Acacia macracantha*, which is the greatest contributor of leaf litter, has small, soft leaflets, decomposition is very rapid.

The closed canopy is 6-8 m tall, with complete dominance of *Acacia macracantha*. Below it are some very dispersed shrubs and lianas. Occasionally one finds clearings with a predominance of *Varronia globosa* or *Tecoma stans*, and near the San Juan River are a few clearings with *Bothriochloa pertusa*.

In the valleys cut into the terraces by the Juticí and Sardinero Rivers (Figs. 2A, 2B), the soil is brown and gravelly and has rocks and stones on its surface. In these narrow, deep valleys, hydrological conditions are more favorable than in the surrounding area; that is, they are less extreme ecologically. For that reason, the forest has two layers: arboreal and shrub. The arboreal layer reaches about 8 m and is very dense, dominated by *Acacia macracantha*. Isolated individuals of *Cupania glabra* and *Melicoccus bijugatus* (Sapindaceae), *Guazuma ulmifolia* (Sterculiaceae), *Andira* (*Geoffroea*) *inermis* and *Samanea saman* (Fabaceae), *Spondias mombin* (Anacardiaceae), and *Ficus populoides* (= *F. citrifolia*, Moraceae) stand out. In the shrub layer are *Erythroxylum havanense, Tecoma stans, Gymnanthes lucida, Turnera ulmifolia, Adelia ricinella* (Euphorbiaceae), and *Lonchocarpus longipes* (Fabaceae). *Acacia macracantha* has rapid growth with great vigor and competitive strength under these ecological conditions; for that reason, it constitutes the first step of ecological succession in the region.

Coastal and precoastal xeromorphic scrub (*Matorral xeromorfo costero y precostero*)

This vegetation type occupies the second and third terraces, which are composed principally of limestone of the Río Maya Formation. The soils, where they exist, are red and brownish red Rendsinas and appear in small hollows of dogtooth rock (*lapiéz*). The leaf-litter layer (L) is substantial and consists primarily of whole leaves. Also, nonleafy plant parts (flowers, fruits, and twigs) are abundant; very decomposed plant tissue and humus are less abundant; the low quantity of fine humus is notable. In some small hollows of the dogtooth rock, where soil is nonexistent, layer L is 20-30 mm deep; layer F is frequently imperceptible or is less than 5 mm deep. Beneath them is a thick, dry, grayish brown humus, with some roots and rootlets.

This is the most important and characteristic community of the coastal zone, as well as the least disturbed of those in the Reserve. The vegetation is extreme—xeromorphic and sclerophyllous—because of the scarcity of rainfall, its irregular distribution, the strong solar radiation, and the high temperatures and evaporation (Montenegro 1991), as well as the porous soil, the dearth of nutrients, and the influence of sea winds. In some places the scrub is characterized by trees and is generally semideciduous with two layers. The arboreal layer is 5-8 m tall and irregular, in which *Acacia macracantha, Colubrina elliptica, Amyris elemifera, Adelia ricinella, Plumeria tuberculata*, and *Gymnanthes lucida* (Fig. 3B), are abundant, among others. The shrub layer is generally denser and reaches 1.0-1.5 m; the most abundant species are *Tecoma stans, Croton lucidus, Adelia ricinella, Gymnanthes lucida, Erythroxylum alaternifolium* (Erythroxylaceae), and *Rhytidophyllum acunae* (Gesneriaceae), among others.

This stratification is absent in many areas, where the scrub has an irregular structure and, because of its large extent, shows local differences in species dominance. The most extensive types are 3-6 m tall, with an abundance of *Croton lucidus, Colubrina elliptica*, and cacti (Figs. 3E, 3F); next in extent are areas where *Celtis trinervia* is notable; in other places *Croton linearis*

(Euphorbiaceae), *Agave underwoodii* (Agavaceae), *Gymnanthes lucida, Tecoma stans*, and cacti predominate.

Characteristic of a segment of this habitat is the large number of cacti, especially *Consolea macracantha* (Fig. 3F), *Harrisia eriophora, Opuntia stricta* var. *dillenii*, and *Dendrocereus nudiflorus*. Among the epiphytes, *Tillandsia recurvata* is notable; it covers most of the branches of trees and shrubs. Among the lianas, the most abundant are *Serjania diversifolia* (Sapindaceae), *Cissus verticillata* (Vitaceae), *Stigmaphyllon sagraeanum*, and *S. periplocifolium*.

On the upper faces of the most windswept terraces (Fig. 2C), this vegetation scarcely reaches a height of 1 m and appears crushed against the rock surface, taking characteristic shapes deformed by the wind. *Tabebuia myrtifolia* (Bignoniaceae) predominates in these stands of scrub.

Mangrove stand (*Manglar*)

This habitat occurs in a small area at the mouth of the Sardinero River, which runs only during heavy rains. This mangrove stand is 16-18 m tall and is composed of *Rhizophora mangle* (Rhizophoraceae) at its center, near the riverbed, and *Conocarpus erectus* (Combretaceae) in the outer zone.

The mangroves lie in a depression protected by a sandbar from the direct impact of the waves. The area is swampy, flooded during high tide. The soil is sandy-clayey and brownish yellow, with the water table lying on the soil surface or just below it. Here, crabs, especially species of *Uca*, extract blackish particles of clay.

Sea-grape woodland (*Uveral*)

This well-established habitat forms a band behind the rocky-coastal vegetation complex (see below, and Fig. 2D).

The soil is a mixture of sand, fine gravel, stones, and particles of humus. The first horizon is approximately 12 cm deep, below which the humus begins to thin out but the other components remain. The entire horizon contains roots and rootlets. The soil is covered with a leaf-litter layer of *Coccoloba uvifera* (Polygonaceae), 2-6 leaves deep, with the upper leaves fresher. Below this layer the proportion of these leaves gradually diminishes. Here the fauna appears to play an important role in the downward movement of humus; the sandiest area of the woodland is completely filled with crab burrows.

In much of the Reserve, this habitat is characterized by a mixture of *Coccoloba uvifera* and *Conocarpus erectus*. Scattered individuals of *Acacia macracantha* also occur here. In general, *Conocarpus* dominates in the area closest to the sea and *Coccoloba uvifera* inland from this area. The action of the wind sculpts the vegetation into a smooth, inclined plane that gradually rises to a maximum of approximately 8 m (Fig. 2D). For that reason, this vegetation serves an important function as a windbreak, because it forms a barrier that protects the plants behind it, which do not show deformation by wind.

Rocky-coastal vegetation complex (*Complejo de costa rocosa*)

This habitat is found in the southern part of the Reserve, which is bathed by the Caribbean Sea. The coast is rocky and tall, about 2 m above sea level, belonging to the Jaimanitas Formation. This vegetation forms a narrow band just behind the zone that is constantly damp from normal wave action (Fig. 2D).

This open community has small shrubs and ground cover with fleshy leaves. In general, plants emerge from rock cavities with no visible soil. The most abundant plants are *Strumpfia maritima* (Rubiaceae; Fig. 3G), *Mallotonia* (*Tournefortia*) *gnaphalodes* (Boraginaceae), *Borrichia arborescens* (Asteraceae), *Conocarpus erectus*, and a species of *Chamaesyce* (Euphorbiaceae). In the larger microdepressions, where sand accumulates, and sometimes on the rock surface, patches of *Sesuvium portulacastrum* (Aizoaceae) appear.

Anthropogenic shrub savanna (*Sabana arbustiva antrópica*)

This vegetation type occurs especially in the locality of Juticí (Figs. 2A, 2B), in a small area that once was a

vineyard and later was planted in other crops and finally in *Aloe vera* (sábila, Liliaceae).

It has a shrub layer approximately 1 m tall, with 40% cover of *Acacia macracantha*. The herbaceous layer is composed principally of *Bothriochloa pertusa*, which covers the entire surface.

Secondary grasslands (*Pastizales secundarios*)

These grasslands occupy very small areas, which are scattered and of small diameter, dominated by the grasses *Bothriochloa pertusa* or *Panicum maximum*. These areas, of minimal importance, are relicts of former human occupation.

THREATS AND RECOMMENDATIONS

We identified no significant threats to the vegetation of the Reserve. Occasional fires alter some areas within it, but to date their effects have not been intense. The proximity of the Reserve to densely populated areas is a potential threat, if effective education programs are not undertaken or if the awareness and support of local communities remain insufficient.

We recommend that (1) a plan for the protection of the Reserve against fire be established; (2) studies be carried out on the successional stages of coastal and precoastal xeromorphic scrub, of semideciduous microphyll forest, and of the habitats that are most altered by human activity and are most in need of restoration (anthropogenic shrub savanna, secondary grasslands, and shrubby secondary forest dominated by *Acacia macracantha*); and (3) efforts in environmental education be intensified for the local human population.

LIVERWORTS

Author: Kesia Mustelier Martínez

Conservation targets: Four very distinctive species of the genus *Riccia*, few of which have formal protection status and which in Cuba are found only in similar places (C5)*

INTRODUCTION

Liverworts belong to the Division Hepatophyta within the nonvascular plants (Margulis and Schwartz 1998). They are most abundant in humid forests because of their dependence on water for their life cycles. Some species, which are drought tolerant, can be found under extreme environmental conditions because of unusual morphological adaptations that allow them to capture water and to resist high temperatures and insolation, as well as periods of desiccation. These species have wider distribution.

METHODS

I conducted a literature review and a review of the bryological section of the Herbarium of the Eastern Center for Ecosystems and Biodiversity (Herbario del Centro Oriental de Ecosistemas y Biodiversidad [BSC]), where I found samples of liverworts collected in the study area and identified according to the traditional criteria for this group of plants (Gradstein et al. 2001).

RESULTS

In Siboney-Juticí Ecological Reserve occur eight species of liverworts belonging to four families (Appendix 1). Four species are epiphytes, on boles and very close to the soil, in secondary forests of *Acacia*: (1) one from the genus *Frullania*, which has leaf lobes modified into water sacs, as well as a reddish pigmentation that allows it to live in xeric environments and to receive solar radiation directly; (2, 3) two species of the genus *Lejeunea*, one of them a member of the subgenus *Heterolejeunea* that grows ordinarily in open, well-lit environments, and the other, a smaller liverwort of the

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

subgenus *Nanolejeunea*, one of the most drought-tolerant of the Lejeuneaceae (the most abundant family of liverworts in its diversity and ecological plasticity); and (4) a thallose species in the genus *Metzgeria*.

In the sinkholes of dogtooth rock (*lapiéz*) in the coastal xeromorphic scrub, and near caves, but only after rains, one can see the four species of the genus *Riccia*. The species of this genus are usually pioneers on open soils that are often somewhat disturbed and periodically humid, and on rocks covered with shallow soil. They are adapted to surviving prolonged periods of drought and are never found in humid forests. In Cuba, records of *Riccia* species are known (1) for the Western Region, from Tampa, La Habana; (2) for the Central Region, from Motembo, Santa Clara; and (3) for the Eastern Region, from Siboney-Juticí Ecological Reserve and from La Tabla, Tercer Frente, both in Santiago de Cuba. (Fifty-four species have been recorded for Tropical America, 8 for the Antilles, and 7 for Cuba.)

THREATS AND RECOMMENDATIONS

The principal threat to liverworts, especially for species in the genus *Riccia*, would be habitat destruction. For this reason the xeromorphic scrub should be protected through increased control of outsiders' entry into the area, as well as through environmental education.

MOSSES

Authors: María E. Potrony and Ángel Motito Marín

Conservation targets: *Fissidens duryae*, an endemic to several districts in eastern Cuba (C4)*

INTRODUCTION

Siboney-Juticí Ecological Reserve presents conditions extremely unfavorable for the occurrence of the great majority of mosses. Vegetation formations here grow under xerophytic conditions, but humidity is a fundamental necessity for most mosses, which require water for reproduction. Nevertheless, some groups can survive in xeric conditions through morphological adaptations. In Cuba, xerophytic mosses are represented primarily by the families Pottiaceae and Fissidentaceae.

METHODS

We obtained data on the mosses of the Reserve through the review of specimens collected in the study area and deposited in the Herbarium of the Eastern Center for Ecosystems and Biodiversity (Herbario del Centro Oriental de Ecosistemas y Biodiversidad [BSC]). We analyzed the data on samples that we examined, as well as those reported in the literature, through the database HERBARIO.MUS. The taxonomic criterion used was that of Gradstein et al. (2001).

RESULTS

In Siboney-Juticí Ecological Reserve only seven infrageneric taxa of mosses, of the families Pottiaceae and Fissidentaceae, have been recorded (Appendix 2). The genera present—*Fissidens, Barbula*, and *Hyophila*—are typical of habitats in the Reserve. The estimated number of species is the same as the number collected; any other representatives of these genera are unlikely to be present, because the area has been well explored for this botanical group. The most abundant infrageneric taxa are of the genus *Fissidens*. For the Reserve only one Cuban endemic has been recorded: *Fissidens duryae*, considered an endemic to several districts in eastern Cuba. No moss taxa in the Reserve are considered threatened.

THREATS AND RECOMMENDATIONS

We recommend the protection and management of the phanerogamic flora that occurs in these ecosystems. The infrageneric taxa that have been recorded depend on (1) their ecological relationships with other plants in the forest, i.e., species that provide substrates, shade from the sun, and humidity in the environment, and (2) soils and rocks, which mosses in the study area colonize.

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

TERRESTRIAL VASCULAR PLANTS

Participants/Authors: Eddy Martínez Quesada and William S. Alverson

Conservation targets: Five species considered Endangered worldwide by IUCN (IUCN 2004): *Synapsis ilicifolia* (Bignoniaceae), *Swietenia mahagoni* (Meliaceae), *Doerpfeldia cubensis* and *Ziziphus* (*Sarcomphalus*) *havanensis* var. *havanensis* (Rhamnaceae), and *Guaiacum officinale* (Zygophyllaceae; Fig. 3D) (C5); two Vulnerable species: *Tabebuia polymorpha* (Bignoniaceae) and *Pouteria aristata* (Sapotaceae) (C5)*

INTRODUCTION

In Siboney-Juticí Ecological Reserve few floristic studies, or studies of vegetation related to vascular plants, have been conducted. To date we know of only four (Martínez et al. 1996; Oquendo and Reyes 1998; Reyes et al. 1999; Bermúdez et al. 2001). Nonetheless, the study site is of particular importance for this group of plants because, in spite of its small area (2,075 ha), it has a significant number of species adapted to extreme ecological conditions.

METHODS

On the two days of the inventory, we made forays without fixed routes through the accessible habitats of the study area. We collected botanical material that was of interest, doubtful, or unknown. The rest of the species were identified and noted in a field notebook. The first author consulted the collections in the Herbarium of the Eastern Center for Ecosystems and Biodiversity (Herbario del Centro Oriental de Ecosistemas y Biodiversidad [BSC]), as well as the list prepared by Bermúdez et al. (2001). Manuel J. G. Caluff contributed information on ferns. We used the work of Walter and Gillett (1998) and IUCN (2004) to define level of threat. We also took photographs that are available on the Web (*www.fmnh.org/rbi*).

RESULTS

Species richness and endemism

For Siboney-Juticí Ecological Reserve, 676 species, subspecies, and varieties, belonging to 79 families, have been reported (Bermúdez et al. 2001). During our survey of the area, we observed some 150 of them. We recorded others as new to the area, and we could not confirm another 5. Also, 8 species previously reported were excluded because they are not likely to occur in the Reserve's habitats; therefore, we report 672 species (including the 5 species of ferns, Appendix 3). This figure is significant because the whole area contains 9.9% of Cuba's vascular flora. We estimate that approximately 750 species occur in the entire Reserve. We could not identify one species of the family Nyctaginaceae.

Byttneria microphylla and *Caesalpinia violacea* are new records for Siboney-Juticí. *C. violacea* is also a new record for the Eastern Region of Cuba; Barreto (1998) suggested that this species is found in Western and Central Cuba as far as Camagüey Province, which was the easternmost point of its known distribution.

The families with the greatest number of species, subspecies, and/or varieties are Fabaceae s.l. (75), Rubiaceae (48), Euphorbiaceae (47), Boraginaceae (37), Asteraceae (29), Convolvulaceae and Malvaceae (both with 25), and Verbenaceae (24).

In the Reserve occur 159 species endemic to Cuba, which represent 23.6% of the species of vascular plants reported here for the Reserve, and 5.0% of the endemic species of vascular plants in Cuba. The families with the highest percentages of endemism are Bignoniaceae and Theophrastaceae (83.3%), Gesneriaceae (75.0%), Ebenaceae (66.7%), Acanthaceae (63.6%), Rubiaceae (54.2%), Myrtaceae and Rhamnaceae (50.0%), Malphigiaceae (40%), and Verbenaceae (37.5%).

Native and introduced species

Although the majority of species are native, we found 14 that had been introduced (just 2.0% of the vascular

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

flora of the Reserve). Many of these non-native species have been present for decades, or even centuries, as on the first terrestrial terrace (in the Jaimanitas Formation), which has had a long history of disturbance, including the railroad route that enters from the eastern part of Santiago (see Human History, below). Few exotic (non-native) species are found on the upper (second and third) terraces, which harbor the majority of intact native vegetation in the Reserve, probably because native species are better adapted to the extreme xerophytic conditions encountered there. At present, none of the introduced species seems to have an impact on the ecosystem, as their populations are stable, or at least have not grown in excessive numbers. Some individuals of certain exotic species grow in isolation.

Dominant species

In the less disturbed areas of the Reserve, occupied by coastal and precoastal xeromorphic scrub on the second and third terraces, the dominant species vary from one place to another (see Vegetation, above), but the common species of the arboreal layer are *Gymnanthes lucida* (Fig. 3B) and *Adelia ricinella* (Euphorbiaceae), *Acacia macracantha* (Fabaceae-Faboideae), *Colubrina elliptica* (Rhamnaceae), *Amyris elemifera* (Rutaceae), *Plumeria tuberculata* (Apocynaceae), and *Tabebuia myrtifolia* (Bignoniaceae). In the semideciduous microphyll forest, *Acacia macracantha* and *Senna atomaria* usually are common.

Acacia macracantha is a very common species, or the dominant species, in several native habitats; it also forms very dense populations. It is the only species that establishes itself along roadsides, e.g., on the first terrace. Normally it has taken over terrain that has been devastated by rock extraction in quarries, as in those adjacent to the Reserve.

THREATS AND RECOMMENDATIONS

We identified no significant threats to the flora of the Reserve, but site managers must remain vigilant to prevent illicit extraction of precious woods. The introduced species that now occur in the Reserve have been present for many years and do not appear to be altering intact native habitats on the second and third terraces, or on the coast itself. Only the first terrace has been affected heavily. We do not know if the vegetation along the road, and in the anthropogenic grasslands and savannas, will revert in time to native vegetation without active management, and without further disturbance by human activity.

We encourage two lines of study: (1) the establishment of a sufficient number of permanent plots, chosen randomly in the disturbed and undisturbed parts of the Reserve, to document changes over time in floristic composition under passive management; and (2) a quantitative inventory of the seven species considered Endangered or Vulnerable globally, stratified by habitat and by location in the Reserve, with the objective of determining if these populations need active management to assure long-term persistence in the Reserve.

TERRESTRIAL MOLLUSKS

Participant/Author: David Maceira F.

Conservation targets: Threatened endemic species (*Polymita venusta* [Fig. 4F] and *P. versicolor*) (C4, C5); endemic species with geographic ranges restricted to the southeastern coast (*Chondropomatus l. latum, Juannularia a. arguta* [Fig. 4G], *Chondropoma abnatum, Macroceramus inermis, M. jeannereti, Caracolus s. sagemon, Hemitrochus cesticulus*) (C4)*

INTRODUCTION

The Cuban malacofauna shows a high level of endemism (96.1%, Espinosa and Ortea 1999), and many of its species show an affinity for karst. Inventories of localities are very important for Cuba's mollusk fauna; these had their peak in the middle of the past century (Maceira F. 2001). Karst is abundant in Siboney-Juticí Ecological Reserve; this substance is very important for the formation of the shells of terrestrial snails. The greatest values of species richness are recorded in localities with karstic soil. Among the past

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

inventories conducted are (1) those in the Sierra de Casas and the Sierra de Caballos, Isla de la Juventud (28 species, Henderson 1916), and (2) one in Carso de Baire (24 species, Maceira F. 2000).

METHODS

In this report I combine field observations during the rapid inventory with my previous observations of the mollusk fauna. I carried out fieldwork in the following habitats: semideciduous microphyll forest, caves, xeromorphic scrub, sea-grape woodland, coastal vegetation (except mangroves), and secondary vegetation. I noted locality, date, and habitats and microhabitats used, using an ad lib search of individuals and surveying all possible biotopes for each habitat. I classified species for relative abundance, as uncommon, common, or abundant.

I considered the species *Polymita versicolor* present in Siboney-Juticí Ecological Reserve because of records in the literature, and I included it in calculations of percentages, given its importance as a threatened species and the salience of the Reserve as the western limit of its distribution.

RESULTS

Species richness

I observed 21 species of terrestrial mollusks of the 22 recorded for Siboney-Juticí Ecological Reserve (Appendix 4). Only the species *Polymita versicolor* (a threatened endemic of the Eastern Region of Cuba) has not been observed. The species belong to 10 families and 18 genera. Fifteen (68.1%) belong to the Subclass Pulmonata and 7 (31.8%) to the Prosobranchia; I did not record any representatives of the Subclass Gymnomorpha.

Species richness in Siboney-Juticí Ecological Reserve is extremely high, very close to that recorded for Carso de Baire, Tercer Frente, Santiago de Cuba Province, with 24 species (Maceira F. 2000). Probably this high value results from the presence of rocks containing calcium carbonate, which are the predominant soil substrate in both localities.

Endemic species

Of the Reserve's species, 20 (90.9%) are endemic. One species, *Macroceramus jeannereti*, is endemic to Siboney-Juticí Ecological Reserve. Four species (18.1%) are endemic to the Sierra Maestra Subregion, 11 (50.0%) to the Eastern Region of Cuba, and 1 (4.5%) to the East-central Region; 3 (13.6%) are endemics at the national level. The high percentage of endemism is very close to that cited for Cuba (96.1%), for the Eastern Region (95.6%), and for Alejandro de Humboldt National Park (88.1%) (Maceira F. 2001).

Microhabitats, habitats, and abundance

In the Reserve we can divide the mollusk fauna into species that use soil microhabitats (6), arboreal species (12), and rock-dwelling species (4). The vegetation types with the greatest species richness are semideciduous forest and xeromorphic scrub. Semideciduous forest has 15 species, of which 7 are uncommon, 3 common, and 5 abundant (Appendix 4). In xeromorphic scrub, 11 species have been observed, of which 2 are uncommon, 6 are common, and 3 abundant (and, in contrast to the level of endemism in semideciduous forest, all species in scrub are endemic).

Among the soil mollusk fauna I found *Succinea tenuis* (a native species with moderately broad distribution in Cuba), and *Lacteoluna selenina* and *Hawaiia minuscula* (the nonendemic species).

In the rock-dwelling mollusk fauna, the presence of the following species is striking: *Annularisca heynemanni* and *Chondropomatus l. latum* (which has not been observed for more than 50 years); and *Juannularia a. arguta* (Fig. 4G) and *Chondropoma abnatum*. All belong to the family Annulariidae and have not been studied since the monographs of Torre and Bartsch in 1932 and 1948. They are small mollusks with an affinity for limestone walls.

In the arboreal mollusk fauna, the species *Polymita venusta* (Fig. 4F) and *P. versicolor* are notable; they belong to the genus of land snails considered the most beautifully colored in the world (Fernández and Martínez 1987). Of all the species in the genus,

P. venusta has the largest distribution in Eastern Cuba. Although *P. versicolor* was not observed during the mollusk inventory, from the scientific literature we know of its existence in the area. This species is distributed in coastal and subcoastal vegetation of the southern coastline from Jauco, Maisí, Guantánamo Province, to Siboney-Juticí Ecological Reserve. Equally important in the arboreal mollusk fauna is *Liguus fasciatus crenatus* (Fig. 4E), a large mollusk (7 cm long) that is white with green bands on the last coil of its shell, and that occupies the same microhabitats that *Polymita venusta* uses.

Other notable records

Oleacina solidula, an endemic mollusk that preys on other mollusks, is noteworthy as an indicator of a well-developed mollusk fauna. Notable as well is the presence of *Eurycampta exdeflexa*, because Siboney-Juticí Ecological Reserve is the western limit of its distribution.

The Reserve is one of only three localities known in the world for *Caracolus s. sagemon*; all are on the southern coast. The other two are Jauco, Guantánamo Province, and El Francés, west of Santiago de Cuba Bay. The other species, *Coryda alauda*, is endemic to Eastern Cuba and has a larger distribution than the other arboreal species: *Caracolus s. sagemon*, *Polymita venusta, P. versicolor*, and *Liguus fasciatus crenatus*. The rock-dwelling species *Annularisca heynemanni, Chondropomatus l. latum, Juannularia a. arguta*, and *Chondropoma abnatum* serve an important function in the formation of rocks and sand, which are abundant in the Reserve.

THREATS AND RECOMMENDATIONS

At this time the only threat to the mollusk fauna is the restricted distribution of the population of the endemic *Macroceramus jeannereti* (found only in the Reserve), which leaves it vulnerable to any damage. For that reason, I recommend surveillance of its populations, as well as those of the threatened endemics *Polymita venusta* and *P. versicolor*. I suggest that the study of the mollusk fauna found in sediments could reveal the species that formerly lived and were abundant in the Reserve, as is the case for *Polymita versicolor*. We should evaluate the possibility of reintroducing this species to the area.

SPIDERS

Participant/Author: Alexander Sánchez-Ruiz

Conservation targets: Populations of 20 endemic species present in Siboney-Juticí Ecological Reserve (Appendix 5), particularly (1) 3 species (*Stenoonops hoffi, Oonopoides pilosus*, and *Nops siboney* [Fig. 4B]) that are known only from a few localities within the Sierra Maestra and (2) 3 species (*Oonops minutus, Araneus faxoni*, and *Selenops siboney*) known to date only from the type locality within the Reserve's boundaries (C4)*

INTRODUCTION

Since the middle of the twentieth century, only a few collections, and very few studies, of spiders have been carried out in Siboney-Juticí Ecological Reserve. The oldest records correspond to species deposited in the Museum of Comparative Zoology (Harvard University) and mentioned by Bryant (1940). Since that year, several authors have recorded or described other species, through isolated collections made in the vicinity of the community of Siboney and within some of the caves that today are part of the Ecological Reserve. The greatest contributions to the spider fauna of this area were made during the joint Cuba-Romania Expedition, from which new species were described and new records were noted for the area (Georgesco 1977; Dumitresco and Georgesco 1983; Gruia 1983; Dumitresco and Georgesco 1992).

The study of the spider fauna of this protected area has not been systematic, and the existing background information is based specifically on the work just mentioned and sorely lacks studies of ecology, behavior, or species distribution. In addition, an intensive collection effort outside the current protected area has never been undertaken.

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

METHODS

This report combines fieldwork carried out during the rapid inventory and data obtained from a characterization of the spider fauna conducted in Siboney-Juticí Ecological Reserve from January to June 2002. During the rapid inventory, because of our short stay in the area, I limited sampling to forays through the Reserve. I observed and/or collected all the spiders encountered, for the most part on vegetation, under rocks, in or on the soil, in the leaf litter, on fallen tree trunks, and inside epiphytic bromeliads. I conducted these surveys along the entire canyon of the Juticí River, since this area had not been sampled before.

In the study prior to the rapid inventory, I used three sampling methods: (1) a pitfall trap, consisting of 13 metal receptacles 7.5 cm in diameter and 10 cm tall, separated from each other by 3 m; (2) 10 vegetation plots (each one with an area of 4 m^2) in which I used constant search during 15 minutes for each plot, collecting all the spiders found in the area spanning from the top of the head to the ankles; and (3) diurnal and nocturnal collection rounds at some points where I did not use the previous methods.

To estimate the potential number of species present in the Ecological Reserve, I used the first-order jackknife index: $Jack\ 1 = S + L(m - 1/m)$, which is based on the number of species that appear in a single sample (L), where S is the total number of species in a sample and m is the number of samples (in this study, $m = 120$). This index reduces the underestimation of the true number of species in a community, based on the number represented in a sample, reducing the bias by $1/m$ (Palmer 1990). The *Jack 1* index gives an estimation value much more accurate and less biased than those of other estimators of species richness (Moreno 2001; Palmer 1990). For the calculation of this index I used the statistical program EstimateS Ver. 5.0b1 created by Robert K. Colwell (1997).

For the compilation of the species list, I took into account previous records for the study area. For this purpose I reviewed the following work: Alayo (1957), Alayón (1972, 1976, 1977, 1980, 1981, 1985, 1992, 1993a, 1993b, 1995a, 1995b, 1995c, 2000), Alayón and Platnick (1993), Bryant (1936, 1940), Dumitresco and Georgesco (1983, 1992), Franganillo (1934, 1936), Georgesco (1977), Gruia (1983), Levi (1959), and Sánchez-Ruiz (2000, 2004).

RESULTS

Richness of taxa observed and percentage of endemism

During the entire course of fieldwork in the Reserve, I examined 385 individuals, of which 274 (71.2%) were identified to the species level. From the literature consulted I extracted 66 records for the area now covered by the Reserve, of which I was able to confirm the presence of 37 species. When I combined the literature records with 24 species that I found before and during the rapid inventory, the number of species of spiders present in Siboney-Juticí Ecological Reserve reached 90 (Appendix 5), grouped into 30 families and 69 genera. Although it covers a very small area compared to that occupied by the Sierra Maestra or by Cuba, the Reserve has high values for the richness of species, genera, and families of spiders (Table 1).

Table 1. Representation of spider taxa in Siboney-Juticí Ecological Reserve

Taxonomic category	Number in Cuba	% Cuban taxa in the Reserve	Number in the Sierra Maestra	% taxa of the Sierra Maestra in the Reserve
Species	568	15.8	230	39.1
Genera	243	28.4	130	53.1
Families	53	56.6	38	78.9

Data for Cuba taken from Alayón (2000) and data from the Sierra Maestra taken from Sánchez-Ruiz (2000)

The families best represented were Araneidae, Salticidae, Tetragnathidae, and Theridiidae. Table 2 shows the families with more than 9 species present in the Reserve and the percentage of endemism in each.

Table 2. Families of spiders with highest species richness in Siboney-Juticí Ecological Reserve

Family	Number of species	% of these species endemic to Cuba
Salticidae	16	37.5
Theridiidae	16	18.8
Araneidae	14	21.4
Tetragnathidae	10	20.0

Of the 247 species endemic to Cuba that are included in the most recent list of spiders of Cuba (Alayón 2000), 20 were found in the Reserve, constituting 8.1% of the endemics recorded for the Cuban archipelago and 22.0% of the 91 species endemic to the Sierra Maestra. Of these endemic species present in the Reserve, 5 (26.3%) are known only from the Sierra Maestra massif and 3 others (15.8%) are restricted to a single locality. Of the 69 genera present in the Reserve, only *Bryantina* (Pholcidae) and *Pelegrina* (Salticidae) are Cuban endemics.

Estimated species richness

From the data obtained during the study prior to the rapid inventory, I calculated the first-order jackknife index for 120 samples. The *Jack 1* value (see Methods) was 178 ± 5 species. If we compare this value with the number of species known to date (90), we get an idea of the level of knowledge for this group in the area. Judging from the value obtained for this index, I conclude that approximately 80 species remain to be found in Siboney-Juticí Ecological Reserve. In addition, this index gives us an estimated value of species richness that will be useful for conservation planning.

New and significant records

For the Ecological Reserve I noted 24 new species, including 4 new records of families: (1) the family Hahniidae, of which I collected a juvenile specimen, (2) Sparassidae, represented by the species *Heteropoda venatoria* (Fig. 4A, which, although it is a human symbiont very common in houses in the countryside, had never before been recorded from localities within the Ecological Reserve), (3) Sicariidae, with the species *Loxosceles cubana* and *Loxosceles caribbaea*, of which I collected several individuals inside caves and under *Agave* sp. plants (Agavaceae), and (4) Deinopidae, represented by the species *Deinopis lamia*, of which I collected two individuals in semideciduous forest in the locality of Juticí.

The species *Stenoonops hoffi* (Oonopidae) is noteworthy, as it is known, in Cuba, only from Siboney, in the sinkhole in front of Cantera Cave, and from the vestibule of Virgen Cave (Dumitresco and Georgesco 1983). This species was described from Jamaica and has been recorded in Cuba only from these points within the Ecological Reserve. Another interesting record is the species *Loxosceles caribbaea* (Sicariidae), recorded for Cuba by Pérez (1995) from the cave of El Cuzco (El Salvador, Guantánamo) and by Sánchez-Ruiz (2001) from three localities in the Sagua-Baracoa massif. During the rapid inventory I found several adult individuals of *L. caribbaea* under *Agave* sp. plants; this find extends the species distribution to the Sierra Maestra massif.

Oonopoides pilosus (Oonopidae) was recorded for Cantera Cave (Siboney-Juticí Ecological Reserve) and for Bariay Cave (Pilón, Granma) by Dumitresco and Georgesco (1983), and to date the species is known only from these two caves in the Sierra Maestra.

Also noteworthy is *Nops siboney* (Caponiidae; Fig. 4B), found in the vicinity of the ecological station (Sánchez-Ruiz 2004) and recorded also for Boca de Cabañas, Santiago de Cuba (27 km west of Playa Siboney). Recently, in surveys along the southeastern coast of Cuba, I found this species in Cajobabo, Imías, Guantánamo, east of the type locality. Apparently this species is distributed along the entire southeastern coast of the country, but more sampling effort will be necessary in this area to establish its actual distribution.

Notable also are 3 local endemic species with small populations in the Ecological Reserve (see below).

THREATS AND RECOMMENDATIONS

We must take into account the vulnerability of species populations with limited distributions, since these without doubt are the first to disappear in the event that

habitat loss intensifies. For that reason, in the specific case of the spider fauna of Siboney-Juticí Ecological Reserve, we must pay particular attention to populations of the three local endemic species found within its borders:

Oonops minutus (Oonopidae) is known only from Golondrinas Cave; nevertheless, the population may be distributed throughout the cavern system of Siboney, although to date no individuals have been found in nearby caverns. Loss of its natural habitat is the principal threat to this species.

Araneus faxoni (Araneidae) was described from Siboney by Bryant (1940) and up to the present only the type specimen is known; the male still has not been described. This rare spider belongs to the group of the Araneidae for which individuals are smallest, measuring only 2.5 mm in length; for this reason, finding individuals of the species becomes more difficult. This araneid builds its webs only in shrubby vegetation, as do the rest of the species of the genus; therefore, indiscriminate cutting of shrubs in its natural habitat (for example, for charcoal production) could reduce the only known population considerably.

Selenops siboney (Selenopidae) apparently is restricted to xeromorphic scrub in this reserve. The loss of its natural habitat constitutes the principal threat to this species.

We recommend the following actions to protect the arachnofauna of the Reserve:

- Prevent the cutting of vegetation and emphasize the protection of xeromorphic scrub and shrubby vegetation in general.
- Protect Siboney's cavern systems, restricting access to the caves by unauthorized persons.
- Undertake studies of the population dynamics at least of the three local endemic species, to determine (1) the actual distribution of populations within the Reserve, (2) location and description of the male of *Araneus faxoni*, and (3) actual habitat requirements for these three species.

OTHER ARACHNIDS

(Orders Scorpiones, Amblypygi, Schizomida, Solpugida, Ricinulei, and Uropygi)

Participant/Author: Rolando Teruel

Conservation targets: The four local endemics: the scorpion *Alayotityus delacruzi* (the only scorpion of the family Buthidae known to be restricted entirely to caves; Fig. 4C), the schizomids *Cubazomus orghidani* and *Rowlandius* sp. nov., and the uropygid *Mastigoproctus* sp. nov. (Fig. 4D) (C4); their cave habitats (two of these endemics live only in this environment) (C1, C2) *

INTRODUCTION

Arachnids constitute a group ecologically important among the arthropods, both for the large number of species included and for their largely predatory role in ecosystems. For that reason they are one of the elements of biodiversity most susceptible to the effects of human activity, a risk increased by the convergence of two other variables that are equally important: the limited geographic distribution of the majority of species and the concentration of the greatest values of this group's taxonomic richness and endemism in zones that are arid or that have coastal vegetation, all of which are highly vulnerable ecologically. For that reason, studies of the group's diversity are particularly noteworthy.

Several prior works have recorded some of the taxa of these orders for Siboney-Juticí Ecological Reserve: scorpions (Armas 1973, 1974, 1976, 1977a, 1984, 1988; Armas and Alayón 1984; Silva Taboada 1974; Teruel 1997, 2000a, 2000b, 2001a, 2001b; Vachon 1977), amblypygids (Armas and Alayón 1984; Quintero 1983; Silva Taboada 1974; Teruel 2000b, 2001b), schizomids (Armas 1989, in press; Armas and Alayón 1984; Dumitresco 1977; Reddell and Cokendolpher 1995; Silva Taboada 1974; Teruel 2000b,

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

2001b), solpugids (Armas and Teruel in press; Teruel 2000b, 2001b), ricinuleids (Armas 1977b, 1980; Armas and Alayón 1984; Dumitresco and Juvara-Bals 1973; Silva Taboada 1974; Teruel 2000b, 2001b), and uropygids (Teruel 2000b, 2001b).

METHODS

I detected individuals visually through direct search by turning over rocks and fallen tree trunks, removing the bark from dead trunks and branches, and examining the interior of epiphytic bromeliads; I also sampled at night with an ultraviolet light, in the case of scorpions. I captured specimens less than 5 mm long with the help of a paintbrush dipped in 80% ethanol, and those larger than this size with entomological tweezers appropriate for their sizes and for the hardness of their exoskeletons. I preserved all material in 80% ethanol and deposited it in the collections of BIOECO, properly labeled.

RESULTS

Species richness and endemism

I captured 17 species, belonging to 6 orders, 8 families, and 14 genera (Appendix 6), confirming the presence of all species of scorpions, amblypygids, schizomids, solpugids, ricinuleids, and uropygids previously recorded in the Reserve (see citations above). This diversity value is high and corresponds to the tendency of several of these orders, such as Scorpiones, Schizomida, Amblypygi, and Solpugida, to have higher species richness in areas that are low-lying or coastal or that contain xerophytic vegetation (Teruel 1997, 2000b, 2001b).

Table 3 shows a comparison between the arachnofauna (except spiders) of the Reserve (this study) and the Sierra Maestra (Teruel 2000b, 2001b).

In the Reserve are found the following percentages of species representation by order, with respect to all species of that order present in the Sierra Maestra: Scorpiones (36%), Amblypygi (43%), Schizomida (17%), Solpugida (50%), Ricinulei (100%), and Uropygi (100%). This reserve covers only 0.3% of the area of the Sierra Maestra; therefore, the great relevance of these values is evident. The 16 endemic species include endemism at the level of Cuba (2 scorpions and 1 amblypygid), of the Eastern Region (4 scorpions, 2 amblypygids, the 2 solpugids, and the ricinuleid), and of the Reserve (1 scorpion, the 2 schizomids, and the uropygid). The only species not endemic to Cuba is the scorpion *Centruroides gracilis*, a species introduced accidentally by humans in the Cuban archipelago and of wide distribution throughout the country (Armas 1988; Teruel 1997, 2000b, 2001b); within the Reserve it is found exclusively in human-dominated sites.

New and significant records

Four species are local endemics for the Reserve: the scorpion *Alayotityus delacruzi* (the only scorpion of the family Buthidae known to live exclusively in caves; Fig.

Table 3. Taxa of arachnids (except spiders) in the Sierra Maestra and Siboney-Juticí Ecological Reserve

	Sierra Maestra				Siboney-Juticí Ecological Reserve			
Order	Families	Genera	Species	Cuban endemics	Families	Genera	Species	Cuban endemics
Scorpiones	2	5	22	20	2	5	8	7
Amblypygi	2	3	7	4	2	3	3	3
Schizomida	1	5	12	11	1	2	2	2
Solpugida	1	2	4	4	1	2	2	2
Ricinulei	1	1	1	1	1	1	1	1
Uropygi	1	1	1	1	1	1	1	1
TOTALS	**8**	**17**	**47**	**41**	**8**	**14**	**17**	**16**

4C), the schizomids *Cubazomus orghidani* and *Rowlandius* sp. nov., and the uropygid *Mastigoproctus* sp. nov. (Fig. 4D).

Three species were found for the first time in the locality of Juticí: the scorpion *Alayotityus juraguaensis*, the ricinuleid *Pseudocellus paradoxus*, and the schizomid *Rowlandius* sp. nov. All three had been found in other parts of the Reserve but had never been captured before in this locality.

THREATS AND RECOMMENDATIONS

During the present study I did not identify specific threats to these arachnids in the Reserve, but the small population sizes of some species render them vulnerable to possible habitat change. We must protect the local endemics for the importance that they have in the arachnofauna of the Reserve and of Cuba. At the same time, we should ensure strict preservation of the caves in this area, since 2 of these endemics live exclusively in them and 6 other species frequent them, with the result that 47% of the 17 species in the area normally use the caves as their habitat. We also need more studies of the population ecology of the Reserve's endemic species to evaluate the potential stability of their populations in the future.

BUTTERFLIES

Participant/Author: Jorge Luis Fontenla Rizo

Conservation targets: *Parides gundlachianus*, a charismatic species endemic to Cuba (C4, C5)*

INTRODUCTION

Before the rapid inventory of September 2002, no documentation existed on the butterflies of Siboney-Juticí Ecological Reserve, except for a few specimens collected in Siboney and deposited in the butterfly collection of the Institute of Ecology and Systematics (Instituto de Ecología y Sistemática).

METHODS

I made observations in the Siboney sector of the Reserve (the eastern part), up to the entrance to the Juticí sector, about 3-4 km to the west.

RESULTS

I observed 37 species (Appendix 7). In general, lower-elevation zones and forests in Cuba, like those of Siboney, are the richest in butterfly species. The number of species in the area is likely to be approximately 50.

Parides gundlachianus (Papilionidae) is found in some areas of the Eastern and Western Regions of Cuba. Siboney is one of the areas of Cuba where a stable and relatively abundant population of this species is found. *Burca braco*, also present, is a rare species associated with coastal zones.

THREATS AND RECOMMENDATIONS

Deforestation is a potential threat, but it is not occurring in the Reserve at present. Opportunities exist for the conservation of rare species or habitat specialists like *Calisto sibylla, Anaea cubana*, and *Hypna clytemnestra* in the Reserve.

HYMENOPTERANS

Participants/Authors: Eduardo Portuondo F. and Jorge Luis Fontenla Rizo

Conservation targets: The five species endemic to Cuba (C4)*

INTRODUCTION

Siboney-Juticí Ecological Reserve has among its objectives the preservation of a series of ecosystems specific to the southeastern coast. Because of their climatic, geological, and edaphic peculiarities, these systems support a biota with great heritage value, given the high degree of endemism of the flora and fauna. Of the latter, the groups best studied have been the vertebrates.

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

For hymenopterans, Alayo (1970) cites the locality of Siboney and neighboring areas as significant for their species numbers. Portuondo (2000) monitored the area for a year with yellow plates. This study showed which species were most common, as well as the seasonality of their abundance. The level of endemism still has not been determined, because a complete revision of the species of this order in Cuba does not exist.

METHODS

The method consisted of the use of a Malaise trap for 48 h, but because of the weather dilemma created by Hurricane Lily, the collections were not abundant. For that reason, in Results we also include information obtained during a previous study (Portuondo 2000). E. Portuondo and J. L. Fontenla (ants only) identified the specimens.

RESULTS

Hymenopterans were represented by at least 107 species of 10 families (Appendix 8). Of these, Formicidae and Sphecidae were the most abundant, both in number of individuals and in number of species. The ants constituted a preponderant group because of the large number of individuals and of species. The ant fauna of this reserve is rich in comparison with those of other localities. We recorded 36 species, of which *Forelius pruinosus, Paratrechina longicornis, Dorymyrmex insanus*, and *Solenopsis geminata* were the most abundant.

Of the Sphecidae, we identified 19 species, among which the species of *Trypoxylum* are the most frequent. Equally common is a complex of at least 4 species of the genus *Liris*. Five species of the genus *Tachysphex* recorded for Cuba are present, including *T. dominicanus* (reported by Pulawski [1988]). Two interesting records are the presence in the Reserve of (1) *Solierella sola*, which was described recently (Genaro and Portuondo 2001) and (2) a species of the genus *Nitela* not yet identified. Both of these species were found during the work before the rapid inventory.

The family third in number of individuals was Apidae (all bees), but only 9 species were identified; of these, *Ceratina cockerelli* and *Apis mellifera* were the preponderant species. We also found a complex of at least 3 species of the genus *Lasioglossum*. We encountered a high percentage of the genera of Bethylidae recorded for Cuba.

Among the parasitic hymenopterans, we found at least 12 genera of scelionids (Scelionidae) in the Reserve. Of these, the most common was a genus not yet described (Masner pers. com.), which is distributed in the Antilles and contains more than 1 species. Individuals of the genus *Scelio*, with at least 2 species, were also common. Next in abundance were braconids, represented by the genera *Opius* and *Chelonus*.

THREATS AND RECOMMENDATIONS

The principal threat to the biodiversity of the Reserve is the pressure generated by the growth of neighboring population centers. For this reason, the use of legal means and of education to confront and prevent human pressure is essential. At the same time, we need a well-developed management plan to recover the flora of the Reserve, an action that would benefit populations of native insects as well.

AMPHIBIANS AND TERRESTRIAL REPTILES

Participant/Author: Ansel Fong G.

Conservation targets: Four species with restricted geographic distributions (*Eleutherodactylus etheridgei* [Fig. 5A], *Sphaerodactylus docimus*, two undescribed species of the genus *Sphaerodactylus* [Fig. 5B]) (C4); two species (*Cyclura nubila*, *Epicrates angulifer* [Fig. 5D]) persecuted by humans and considered Vulnerable and Near Threatened, respectively, by IUCN (C5)*

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

INTRODUCTION

Extreme climatic conditions, soil type, and vegetation with characteristics unique in Cuba seem to have favored the presence of faunal communities with high species richness and elevated endemism in Siboney-Juticí Ecological Reserve. The amphibians and reptiles of this reserve are no exception; nevertheless, before now they had not been studied and no publication existed that treated them either separately or as part of the entire fauna.

In spite of the importance of these groups for the conservation of the Reserve, essentially nothing is know of their composition, status, and ecology, and very little action for conservation or management has been directed toward amphibians and reptiles, mainly because of lack of information.

METHODS

In this report I combine data obtained (1) during fieldwork on 27 and 28 September 2002 and (2) from previous observations that I made in Siboney-Juticí Ecological Reserve between 1996 and 2002. This prior work concentrated mainly on the Siboney sector, with isolated visits to the Sardinero locality and its vicinity.

For the fieldwork I noted species observed or heard, using an active search for the animals both during the day and at night. The search covered all microhabitats where amphibians and/or reptiles can be found, from the soil to the treetops, including leaf litter, rocks, fallen trunks, branches and trunks of trees and shrubs, bromeliads, dead agaves, and the undersurface of bark. I also collected data for all casual observations, for example during the trips from one site to another. I collected specimens of species only when they were necessary for corroborating identification in the laboratory; these were deposited in the herpetological collections of BIOECO (BSC.H) and of Carlos de la Torre Natural History Museum in Holguín (Museo de Historia Natural "Carlos de la Torre" de Holguín [MHNH]).

As a way of evaluating abundance in each habitat, I noted the number of individuals observed per species, as well as the length of time devoted to the search and the number of persons participating. With these data I calculated an index of relative abundance in the form of number of individuals observed per person-hour of observation ("ind/h-h" in Appendix 9).

RESULTS

Species richness and habitats

During the fieldwork I observed 21 species, which, combined with others recorded in previous samples, give 28 species for the Reserve: 4 amphibians and 24 reptiles (Appendix 9). These include 1 toad, 3 frogs, 18 lizards, 4 snakes, and 2 blind snakes. Of the 7 species not observed during this inventory, the gecko *Sphaerodactylus docimus* is the rarest; it is known only from a specimen collected in this reserve (in the locality of Juticí) at the beginning of the twentieth century. During the fieldwork I did an intensive search of that locality but did not find the species.

Taking into account the small area of this reserve (20.8 km^2) and the fact that it covers only 0.01% of the surface area of the island of Cuba, the number of reptiles present here is high, constituting 17.6% of Cuban species and 34.8% of the species of the Sierra Maestra, the massif in which the area of study is nestled.

In the herpetofauna of the Reserve, the genera *Eleutherodactylus, Sphaerodactylus*, and *Anolis* predominate in terms of number of species (Appendix 9); the same is true for the Cuban fauna in general and in the Sierra Maestra in particular (Fong 2000). With respect to abundance, the lizards *Anolis jubar, A. argenteolus*, and *Ameiva auberi* dominate during the day and the small frog *Eleutherodactylus ionthus* at night. Another lizard, *Leiocephalus carinatus*, is also abundant, but mainly in areas with less vegetation and nearer the sea.

With respect to habitat types, in xeromorphic scrub I observed the largest number of species (Appendix 9); the only species that I did not find there were 2 reptiles, the lizard *Anolis sagrei* and the snake *Epicrates angulifer* (Fig. 5D) (within the Reserve the former lives only in secondary vegetation and the latter

in caves). In this habitat type also live 8 species (28.6% of the total) that are not found in other vegetation types in the Reserve. Secondary vegetation and caves harbor the lowest numbers of species, just 2 in each (Appendix 9); the other vegetation types had intermediate numbers of species (between 4 and 11).

The high number of species in xeromorphic scrub and the low number in secondary vegetation could be an indicator of the condition of this reserve, showing that natural habitat has conserved the majority of the species that originally lived in it, and that few species have had to move out of the area or adapt to human-dominated areas. This indication should be considered in the management of the Reserve (see Threats and Recommendations, below).

Endemic species

The low number of amphibians in the Reserve is a result of the arid characteristics of the area, the high temperatures and insolation, the low relative humidity, and the scarce precipitation—adverse conditions for amphibians, and the reason that only a few resistant species can live here. Nevertheless, the endemism of amphibians is high. Three of the 4 species are Cuban endemics; 1 of these is exclusive to the massifs of the Eastern Region of Cuba, and another is a local endemic known only from three sites on the southern coast of Guantánamo and Santiago de Cuba Provinces (Appendix 9).

In comparison, 13 endemic species of reptiles are present (54.2% endemism), a value that is low if we compare it with that for Cuba or for the Sierra Maestra (81.6 and 71.9%, respectively; Fong 2000). This relatively low number of endemics is important because more than one-third (5 species) are endemic to the Eastern Region of Cuba and 3 of them are known only from a strip of about 250 km in the coastal zone in the southern part of Granma and Santiago de Cuba Provinces. Significant also is the contrast between the low percentage of Cuba's surface area covered by the Reserve and the 11.7% of reptiles endemic to Cuba and the 26.5% endemic to the Sierra Maestra that are protected here.

New and significant records

Among the most interesting records is the presence of *Eleutherodactylus etheridgei* (Fig. 5A) in some areas of the Reserve. I collected this small frog in Siboney and Juticí, both new localities for the species, which was known formerly only from Santiago de Cuba (one specimen) and the Naval Base at Guantánamo (Schwartz and Henderson 1991). This record is also important because these are the only localities for this species that fall within Cuban protected areas. Such protection favors the conservation of this species, which is already considered threatened (Vale et al. 1998).

Other range extensions are the presence in Siboney of the gecko *Hemidactylus haitianus* and of a species of blind snake of the genus *Typhlops* that can be assigned to the species *T. biminiensis*. I collected just one specimen of the latter species; therefore, the confirmation of its occurrence requires the capture of more individuals and the publication of descriptions of the new species of this genus, now in preparation (Hedges 1999, in prep.).

During this trip I observed in the Siboney sector, and collected for the first time in the Juticí locality, specimens of an undescribed species of the genus *Sphaerodactylus* (Fig. 5B). This gecko was discovered a few years ago and is now in the process of being described (Fong and Díaz in press). Its distribution is limited to three localities within the Reserve: Siboney, Juticí, and Sardinero. I collected another species of this same genus, also in the process of being described, within the Reserve, but it does not seem to be abundant there. Its distribution spans several points on the southeastern coast of Santiago de Cuba Province, in a strip that extends about 80 km east-west (Fong and Díaz in press).

THREATS AND RECOMMENDATIONS

The presence within Siboney-Juticí Ecological Reserve of four threatened species—three reptiles and a frog—increases its importance for Cuba's herpetofauna and especially for the conservation and protection of the most sensitive elements of that fauna.

Two species of reptiles are included on the Red List of Threatened Species (Hilton-Taylor 2000): the Cuban iguana (*Cyclura nubila*) and the Cuban boa (*Epicrates angulifer*; Fig. 5D). These reptiles are threatened by hunting and by persecution in Cuba, since the human population uses them for food, and since the boa is often killed out of fear and ignorance. The current pressure that members of local communities exert on these two species is unknown, but the efficiency of protection should be increased, and programs of environmental education that might support the protection and conservation of these threatened reptiles should be strengthened.

Two other species, although not included on the Red List, are considered threatened in the National Study of the Biodiversity of Cuba (Estudio Nacional de Biodiversidad de Cuba) (Vale et al. 1998). These species are the frog *Eleutherodactylus etheridgei* (Fig. 5A) and the gecko *Sphaerodactylus docimus*, whose status in the Reserve has already been explained in this report. Both are included in the Vulnerable category because of their restricted geographic distributions and the destruction that their habitats are suffering.

The broad extent of xeromorphic scrub, the presence of unique species in this vegetation type, and its high species richness make this habitat of principal interest for the conservation of amphibians and reptiles in the Reserve. We need strict control of wood extraction, fires, and the entry of persons from outside the Reserve, as these agents cause the destruction of this habitat and its microhabitats, harming the amphibian and reptile fauna. One important effort that would support the conservation of xeromorphic scrub, as well as its fauna, would be environmental education programs for the human population near the Reserve, as mentioned earlier.

The population declines and extinctions that have occurred in amphibians almost worldwide (Barinaga 1990; Wake 1991) and the observation of similar declines on Caribbean islands (Hedges 1993; Joglar and Burrowes 1996), as well as the disappearance of some Cuban species in places where their original habitats have been modified (Fong 1999), create the concern that this phenomenon may be occurring in Cuba also, even more so if we consider the lack of studies on this subject on the island. Therefore, we should be studying amphibians to detect any change that might be happening in their populations. At present a monitoring program for the Reserve's amphibians is being initiated. This program could provide a rapid alarm system for population decreases or massive extinctions in the area.

BIRDS

Participants/Authors: Luis O. Melián Hernández, Douglas F. Stotz, Debra K. Moskovits, and Freddy Rodríguez Santana

Conservation targets: One endemic species with restricted distribution in Cuba (*Polioptila lembeyei*; Fig. 5E) (C4); a threatened Cuban endemic that apparently occurs seasonally in the Reserve (*Mellisuga helenae*; Fig. 5G) (C4, C5); two species endemic to Cuba that have large populations in the Reserve (*Vireo gundlachii* and *Teretistris fornsi*; Fig. 5F) (C4); migratory passerines from North America (C7)*

INTRODUCTION

Siboney-Juticí Ecological Reserve, on the southeastern coast of Cuba, is covered almost entirely with shrubby, xerophytic vegetation. For this reason, the resident avifauna is not as diverse as that found in protected areas that have a greater diversity of forests and freshwater habitats. Nevertheless, the Reserve has a large population of one of the endemic birds with the most restricted distribution in Cuba: Cuban Gnatcatcher (*Polioptila lembeyei*; Fig. 5E). Also, its geographic location may make this site extremely important for migrant passerines from North America that pass through the Caribbean in the spring and in the fall.

METHODS

Melián H., Stotz, and Moskovits were the ornithologists in charge of the bird inventory in Siboney-Juticí

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

Ecological Reserve from 27 to 28 September 2002. Rodríguez S. provided additional information about other species observed previously in the area. Walking on trails and roads, we observed and recorded every bird seen or heard. Sampling began from half an hour to an hour before sunrise. We remained in the field as long as light was available, except during a period of about two hours during midday. We summed the number of individuals observed for each bird species so that we would know the relative abundance of the bird in the area.

RESULTS

During the inventory of 27-28 September 2002, we recorded 48 species. Of these, Bay-breasted Warbler (*Dendroica castanea*) is a new record for Eastern Cuba, and 4 species are new records for the Reserve: Yellow-throated Vireo (*Vireo flavifrons*), Blackpoll Warbler (*Dendroica striata*), Prothonotary Warbler (*Protonotaria citrea*), and Bay-breasted Warbler. For the area of Siboney-Juticí Ecological Reserve, 68 species had been known previously. With these new records its species count rises to 72 (Appendix 10).

Endemic species

Twenty-two species of birds endemic to Cuba are known (if one includes Cuban Martin, *Progne cryptoleuca*, which nests only in Cuba but leaves the country during the winter). We observed 5 of these endemics during the inventory (*Dives atroviolacea, Polioptila lembeyei* [Fig. 5E], *Teretistris fornsi* [Fig. 5F], *Todus multicolor, Vireo gundlachii*). In addition to these, 5 other endemic species are known from the Reserve (*Glaucidium siju, Mellisuga helenae* [Fig. 5G], *Priotelus temnurus, Tiaris canora*, and *Xiphidiopicus percussus*).

In spite of the adverse environmental conditions, 10 species of birds endemic to Cuba can be seen in the Reserve, though many of them occur in low densities. Nevertheless, the abundance of Cuban Gnatcatcher (*Polioptila lembeyei*; Fig. 5E) and Oriente Warbler (*Teretistris fornsi*; Fig. 5F) was very high, as was the abundance of Cuban Vireo (*Vireo gundlachii*). All these species were found regularly in groups of up to 8 individuals in the case of Cuban Gnatcatcher and 16 for Oriente Warbler, and Cuban Vireo usually appeared in pairs within mixed flocks composed of these species and species of migratory warblers (especially Prairie Warbler, *Dendroica discolor*).

Restricted to xerophytic coastal vegetation of southeastern Cuba as well as a small area in Sancti-Spiritus and on a few cays north of Cuba, Cuban Gnatcatcher (Fig. 5E) is not threatened. Nevertheless, because of its small distributional range, within which tourism is being developed (or potential exists for its development), and because of its susceptibility to hurricanes, it should be considered vulnerable. The large population in the Reserve may be the most important for this species.

Although during the rapid inventory we did not detect the presence of Bee Hummingbird (*Mellisuga helenae*; Fig. 5G), its occurrence in the Reserve is known through other work carried out in the area, and it has even been filmed by colleagues from Cornell Laboratory of Ornithology. Apparently its presence in the Reserve fluctuates in time; it appears there in particular during the period of major flowering, especially of *Agave underwoodii*. Studies of this threatened endemic bird would be useful, especially studies focused on its relationship with migratory species, which have been observed using the same food resources as Bee Hummingbird and which we assume compete with it.

Migratory species

In spite of the early period in the season when we carried out the rapid biological inventory, the considerable number and species richness of migratory warblers that we saw suggest that migrants were congregating along the coast, waiting for favorable conditions for continuing their migration south. Numerous studies along the Gulf Coast of North America (e.g., Able 1972; Moore and Simons 1992; Yong and Moore 1997; Moore 2000) have pointed out the importance of stopover sites of high quality on the coast itself for migratory birds that make long-distance

flights across the Gulf of Mexico. Studies in Hispaniola indicate that on that island, migratory birds preferentially use a similar type of scrub as stopover habitat (Latta and Brown 1999). Probably the southeastern coast of Cuba, and Siboney in particular, play a significant role during both spring and fall migration as a stopover site for migratory passerines passing through the Caribbean Sea. Studies of habitat use in Siboney would be an important basis for a conservation plan for these birds.

Prairie Warbler (*Dendroica discolor*) is extremely common in Siboney, with several individuals of this species present in each of the mixed flocks observed. In all, we observed nine species of migratory warblers in addition to Yellow-throated Vireo (*Vireo flavifrons*), which is a new record for Siboney. Almost all these birds are found in mixed flocks. The most notable observation among these migratory species was an individual of Bay-breasted Warbler (*Dendroica castanea*), observed on 28 September, which is a new record for this species for the Eastern Region of Cuba. Also, we observed 10 individuals of Blackpoll Warbler (*Dendroica striata*) and a Prothonotary Warbler (*Protonotaria citrea*); each of these observations is the first record of the species for the Reserve.

THREATS AND RECOMMENDATIONS

The cutting of trees for fuelwood and charcoal, as well as the presence of domestic animals in some areas of the Reserve, constituted a threat for the biodiversity of the area in recent times. These activities should be tracked and considered during the development of management plans, to offset threats caused by these practices. Another action that puts biodiversity at risk is the capture of birds for the pet trade, for the most part Yellow-faced Grassquit (*Tiaris olivacea*) and Cuban Bullfinch (*Melopyrrha nigra*). We still do not know the possible damage that this activity may cause for populations of these species. The presence of a road through the lowest-lying area (on the first terrace, which is already degraded) facilitates outsiders' access for carrying out extractive activities. Controlling access by this route could contribute to eliminating most of the threats mentioned previously.

Siboney-Juticí Ecological Reserve, and the coastal xeromorphic scrub of southern Cuba, appear to be important areas for wintering and reprovisioning for many species of migratory birds from North America twice a year. For that reason, this area could serve as an ideal site for studies of the migration ecology of these species. We suggest the following inventories and research:

- More complete inventories of populations of migratory species
- Ecological studies of the populations of Cuban Gnatcatcher, Bee Hummingbird, Cuban Vireo, and Oriente Warbler, especially in disturbed areas dominated by *Acacia*: Why are the populations of these species so dense in habitats apparently so simple, with low species richness of plants?
- Documentation of the value of Siboney-Juticí Ecological Reserve as a reprovisioning stopover for passage migrants

In general, we need better access routes to the highest part of the northern sector of the Reserve, to facilitate research activities.

TERRESTRIAL MAMMALS

Participant/Author: Nicasio Viña D.

Conservation targets: Endemic species of bats (*Antrozous koopmani, Phyllonycteris poeyi* [front cover, and Fig. 6B], and *Stenoderma falcatum*) (C4); species of bats on the 2004 IUCN Red List (*Tadarida brasiliensis muscula, Mormoops blainvillei* [Fig. 6F], *Pteronotus macleayi macleayi, Pteronotus quadridens quadridens,* and *Phyllonycteris poeyi*) (C5); bat communities, because they are the most numerous in individuals and species in the country (C3); populations of hutias (*Capromys pilorides*), because of the hunting pressure on this species in the Reserve (C4, C6)*

INTRODUCTION

The presence of limestone rock in a large part of Cuba favors the creation of caves, in which a varied fauna has developed. Within Siboney-Juticí Ecological Reserve is

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

found a suite of caves that is of great importance for Cuba's cave-dwelling biodiversity because of the number of species and individuals present in them. This cave system has particular value for the bat fauna; in the small area of the Reserve, many of the species native to Cuba have been reported.

METHODS

This report is based on existing data from several years of work in the area, which have increased our knowledge of the mammal species present, and on a literature review (Alayo 1958; Kratochvil et al. 1978; Silva Taboada 1979; Viña Dávila 1991).

RESULTS

This work deepens our understanding of the species distributions and especially of the threats to which these species are now subjected. For the area of Siboney-Juticí Ecological Reserve, 21 species of terrestrial mammals have been recorded, of which 18 have extant populations in the Reserve and 2 are non-native but established species.

Chiroptera (Bats)

Eighteen species of chiropterans have been recorded in the area of the Reserve (Appendix 11); 2 of them have been found only in sediments and 1 is extinct. The number of species reported from live individuals is 15. *Antrozous koopmani* is very rare and has been collected alive on few occasions, and never in the Reserve, where, like *Stenoderma falcatum*, it is known only from skeletal remains. A fossil subspecies, *Natalus stramineus primus*, has also been reported; its remains were found in Cantera Cave.

Majáes Cave (with 11 species) and Cantera Cave (with 6) harbor between them 87% of the living bat species recorded in the Reserve. (The two caves have several species in common; Appendix 11.) The Reserve protects 55% of the living species of Cuban bats and is therefore very important for the conservation of Cuba's bat fauna.

Of the species recorded, 3 are endemic: *Antrozous koopmani, Stenoderma falcatum*, and *Phyllonycteris poeyi* (Fig. 6B). This last species forms enormous colonies in Majáes Cave. *P. poeyi* is responsible for the high temperatures of the chambers where it lives, because of its strong gregarious instinct and its high body temperature. In these chambers, known as "hot caves," temperatures reach 38°C, which, combined with values of relative humidity that exceed 90%, generate very distinctive microclimatic conditions.

The species recorded show different feeding habits: 10 are insectivorous; 3 eat pollen, insects, and seeds; 1 feeds on pollen and insects, and 1 only on fruits (Fig. 6). Food sources should be taken into consideration in the development of a conservation strategy. These species seek and capture food, for the most part, in areas outside the Reserve, which have been notably transformed, in particular through the decrease in forest cover. To achieve the conservation of bat species that take diurnal refuge in the Reserve, we need management action outside the Reserve's borders to secure their food sources.

Studies of sediments carried out in caves show layers where the skeletal remains of bats are found, indicators of times when the number of individual deaths has been greater than normal. These periods of higher mortality seem to coincide with extreme natural phenomena like hurricanes. The passage of Cyclone Flora in 1963 created several days of intense and continuous rain over the entire Eastern Region of Cuba; this prevented the bats from foraging or strongly limited the availability of food, causing many deaths in the colony at Majáes Cave.

Variation in forest cover and use of pesticides may be the reasons for changes in the colonies present in the Reserve but have not been considered in studies carried out to date.

Rodentia (Rodents)

In the Reserve are found three species of rodents. The hutia *Capromys pilorides*, a species distributed throughout the area, has been hunted historically with

traps and firearms. Although it is protected by a permanent hunting ban, it continues to be captured illicitly. No studies exist on its populations or of the impact that hunting may have on them.

The Norway rat (*Rattus norvegicus*) is a species introduced accidentally with the arrival of Europeans. In the Reserve it is distributed widely, even in Majáes Cave, where an established population exists. The impact of this species on the native fauna of the Reserve has never been evaluated. Individuals of the house mouse (*Mus musculus*), also introduced, have been observed, but only in existing structures in the Reserve.

THREATS AND RECOMMENDATIONS

The most important threat to the mammal fauna is that the majority of the feeding areas of bats are not included in the Reserve, and that no plan of action and no activities yet exist for the management of these zones. Such protection would be important also for the maintenance of the cave-dwelling fauna that is tightly connected to bats. The fauna present in caves depends, in direct or indirect form, for its food on the organic material accumulated from the feces of the bat species that live there. For that reason, a conservation strategy for bat species would also protect the rest of the cave-dwelling fauna.

The hunting of the hutia is one of the extractive activities that still occur in spite of action taken to eliminate them. Protective actions must continue.

Studies of populations of rare, endemic, vulnerable, or threatened mammals in the Reserve would provide information on the effects of ecological context and possible threats on these species. This information would guide management action. These studies also would serve as a baseline for monitoring the effectiveness of these actions.

MARINE BIODIVERSITY

Participants/Authors: Leopoldo Viña D., David Maceira F., Jorge Tamayo F., Eddy Martínez Q., and Nicasio Viña D.

Conservation targets: Species considered Threatened by IUCN: *Chelonia mydas* (green sea turtle, Endangered), *Eretmochelys imbricata* (hawksbill turtle, Critically Endangered), and *Trichechus manatus* (West Indian manatee, Vulnerable) (all of which are also subject to capture for food or for use in handicrafts) (C5, C6); functional representatives of the eight types of marine ecosystems in the Reserve (C1)*

INTRODUCTION

Siboney-Juticí Ecological Reserve has a marine sector where, before the rapid biological inventory, several studies had been carried out but had not been published. This inventory is indispensable for planning management action. The marine sector lies between the coastline and the 200-m isobath, with an area of 641 ha. The coast is 10.4 km long.

METHODS

Between 1999 and 2001, we conducted the inventory of the Reserve's marine sector, in which we characterized marine algae, mollusks, hard corals, and fishes. We carried out all the work using free (SCUBA) diving suits for a team of three people, in which two took notes and one was the lead diver. Each type of written record was always made by the same person.

For each kilometer of coastline we did a survey perpendicular to the coast (for a total of eight), from the shoreline out to waters 20 m deep. The information that we obtained was complemented by observations throughout the area to determine species composition. This ad lib observation also allowed us to record the presence of reptiles, mammals, and vascular plants.

Along each survey line we determined the ecosystems present and their variations, which we georeferenced with a GPS. We noted the species observed and mapped the macrohabitats encountered. The work in the intertidal zone was based on samples

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

in five quadrats of 1 m^2, separated from one another by 25 m, covering a sector of 100 m; the centers of the quadrats usually coincided with the starting points of the surveys.

RESULTS

Characterization of marine ecosystems

Increasing our knowledge of the location of marine ecosystems and their characteristics is an important step toward defining management in the marine part of the Reserve. The National Biodiversity Study (Estudio Nacional de Biodiversidad) (Vale et al. 1995) suggests that, among the principal elements of the biotopes of the Cuban marine platform, the following variables play a predominant role:

- The structure and distribution of superficial sediments;
- The components of relief, the most noteworthy being hard substrate, coral reefs (reef crests, patch reefs, etc.), and other structures, either natural or human-built;
- The hydrological and hydrochemical regimes, which are strongly affected by waters originating on land in some regions, and/or from the ocean in others; and
- The aquatic vegetation: e.g., *Thalassia testudinum* (Hydrocharitaceae), in addition to being a principal element of primary production (like mangroves), constitutes an unusual habitat that gives refuge and food to a great variety of organisms.

In the study area, all these elements are present although with different intensities and extents. To classify the ecosystems present in the Reserve, we reviewed several literature sources: the National Biodiversity Study (Vale et al. 1995), the classification of CARICOMP (UNESCO 1998), the map of Marine Ecosystems of the New National Atlas of Cuba (Ecosistemas Marinos del Nuevo Atlas Nacional de Cuba) (Sánchez-Herrero et al. 1989), and the Rapid Ecological Assessment of Guantanamo Bay (Roca and Sedaghatkish 1998).

Taking into account all of these studies, we developed a classification that allows a high level of resolution and detail, but of generalization as well. This categorization is comparable with those for other parts of the country and the region. We distinguished 8 types and 18 subtypes in the Reserve (Fig. 2B):

- Coast with sandy beach (*costa de playa arenosa*)
- Rocky coast (*costa rocosa*)
  - with cliffs (*de acantilado*)
  - low, with dogtooth rock (*baja de diente de perro*)
- Mangrove stand (*manglar*)
- Marine meadow (*pasto marino*)
- Sandy bottom (*arenal*)
  - with isolated corals (*con corales aislados*)
  - with isolated corals and very scarce *Syringodium* (*con corales aislados y* Syringodium *muy escaso*)
  - with very scarce *Syringodium* (*con* Syringodium *muy escaso*)
  - with large isolated reefs (*con cabezos grandes aislados*)
  - with small isolated reefs (*con cabezos pequeños aislados*)
  - with rocks and isolated reefs (*con piedras y cabezos aislados*)
- Coral terrace (*terraza coralina*)
  - simple with abundant *Sargassum* (*simple con abundancia de* Sargassum)
  - with low ridges (*de camellones bajos*)
- Flat rocky terrace (*terraza rocosa llana*)
  - simple (*simple*)
  - with isolated corals (*con corales aislados*)
  - with isolated corals and isolated gorgonias (Gorgonaceae) (*con corales aislados y gorgonias aisladas*)
  - with isolated corals and abundant gorgonias (*con corales aislados y abundancia de gorgonias*)
  - with isolated corals and abundant *Sargassum* (*con corales aislados y abundancia de* Sargassum)
  - with isolated corals and abundant algae (*con corales aislados y abundancia de algas*)

  - with frequent crevices, isolated corals, and a high percent cover of different algae species (*con frecuentes oquedades, corales aislados, y alto porcentaje de coberturas de diferentes especies de algas*)
  - with algae and isolated gorgonias (*con algas y gorgonias aisladas*)
- Submarine canyon (*cañón submarino*)

In the locality of Sardinero (Figs. 2A, 2B) is a small barrier reef, for which we had difficulty in differentiating the classic parts (lagoon bank, reef plateau, and battering zone). We also found a small reef lagoon and lagoon reefs; because all were of small scale, we did not incorporate them into the classification.

Algae

We recorded 22 species belonging to 7 families (Appendix 12). In the study of algae in the intertidal zone, we determined percent cover in each of the five quadrats of the sectors studied. The results varied from 20 to 90% cover, with the exception of a single quadrat in the Punta Sardinero locality, where the percent cover was zero. The high percentages of cover found near the mouth of the San Juan River (Fig. 2A) indicate a possible correlation with contributions of organic material from the river.

Corals

Corals react rapidly to such variables as increases in sediments, algal growth, and temperature variations. In this area we recorded 23 species and 10 families (Appendix 12). These figures are significant if we take into account that 60 species, subspecies, and forms have been reported for the entire Cuban archipelago. Within the study area we observed two of the diseases of this group: white-band disease and black-band disease, although in few individuals.

Mollusks

In general, the Reserve's marine mollusks are of Caribbean distribution. To date no inventory had been conducted; the group was known only from the contributions of Alayo (1960) and of Freire and Alayo (1947). In the Reserve we found 2 classes, 6 families, 8 genera, and 12 species (Appendix 12). For the Class Polyplacophora we noted only the family Chitonidae, with 4 species belonging to 2 genera. For the Class Gastropoda we recorded 5 families, 6 genera, and 8 species. We found the highest representation in the Gastropoda: 66.7% of the species and 75.0% of the genera.

The density values are small for the 11 species of marine mollusks recorded in the plots sampled: they vary between 0.4 individuals/m^2 for *Fissurella nodosa* and 35 individuals/m^2 for *Nodilittorina ziczac*.

Fishes

We observed 94 species belonging to 38 families (Appendix 12). We subdivided them by the habitats that they preferred or where they were seen most frequently. The results are as follows:

- Wide distribution (not requiring specific habitats): 21 species
- Mangrove stands: 6
- Sandy areas and marine meadows: 9
- Reefs and rocky substrates with protection: 58

Of these species, fishers capture 59; the most sought-after are the 21 species belonging to the families Haemulidae, Lutjanidae, and Serranidae.

Reptiles and mammals

Three species that have been observed in the area are elements of high priority for conservation. The marine reptiles *Chelonia mydas* (green sea turtle) and *Eretmochelys imbricata* (hawksbill turtle) have been observed in the area, and remains of these turtles have been found as a result of illicit capture by fishers. The third species is the marine mammal *Trichechus manatus* (West Indian manatee); fishers have recently reported them several times in the area. All three species are included on the 2004 IUCN Red List.

THREATS AND RECOMMENDATIONS

We found that the mollusk species under heaviest harvesting pressure in the area were the queen conch

(cobo, *Strombus gigas*) and the West Indian topshell (sigua, *Cittarium pica*), given the high number of remains encountered. Nevertheless, according to our interviews, fishers also trade in species of the genera *Cyphoma* and *Cyprea*.

Illicit marine fishing occurs within the boundaries of the marine zone of the Reserve. We do not have direct information on the impact that fishing imposes on populations of marine fishes in this zone. Nevertheless, 2 species that are considered Vulnerable by IUCN—the queen triggerfish (verraco pluma, *Balistes vetula*, Balistidae) and the gag (aguají, *Mycteroperca microlepis*, Serranidae)—inhabit the waters of the Reserve. Among the other 21 species captured most often by local fishers, decreases in individual size have been observed; this information comes from interviews with fishers and with experts familiar with the area.

Clandestine marine fishing also threatens populations of marine turtles, already damaged by global impacts: the overexploitation of eggs and adult females on their nesting beaches, the capture of juveniles and adults in their foraging areas, secondary mortality from fishing activity, and the degradation of their marine and nesting habitats. Of the 2 species of marine turtles found in the Reserve, the green sea turtle is considered Endangered and the hawksbill turtle Critically Endangered by IUCN.

The West Indian manatee receives strict legal protection in Cuban waters, but it is considered Vulnerable at the global level by IUCN. For centuries this species has suffered from hunting in the Caribbean for its meat, hide, fat, and bones.

We recommend that the fishing of marine species be reduced or eliminated in the Reserve and that strategies be strengthened for the promotion of a regional environmental culture that would sustain the use of marine resources compatible with conservation.

HUMAN HISTORY

Author: José Jiménez Santander

Conservation targets: Fort Sardinero, Muerto Cave, and the Sardinero aboriginal archeological site (C8)*

Siboney is an emblematic settlement near Santiago de Cuba where the beauty of the Caribbean Sea meets the elegance of the landscape's terraces. It combines nature and history, the known and the unknown.

Groups of Ciboneys, originating in areas of present-day Venezuela, invaded the Antilles and all of Central America (with an economy based on gathering, hunting, and fishing). Around 2000 B.C.E. they established themselves in coastal areas near the estuaries of streams in the Reserve, in small groups with a negligible impact on the environment. They maintained control of the entire area of the Reserve until a period between the sixth and eighth centuries C.E., when Arawak agriculturalists arrived and founded an important community in Sardinero, as well as other smaller settlements at the mouths of the San Juan, Juticí, and Siboney Rivers (Fig. 2A). On sailing through this area on 1 May 1494, Christopher Columbus wrote, "The Indians from the Island who came in their canoes to the ships were without number" (Las Casas 1875).

These communities used caves within the Reserve, among them Muerto Cave. This cave has international fame because it was used by the Ciboneys and by Arawak agriculturalists. Scientific work on Muerto Cave has been published in Cuba and in the United States of America: for example, the book *Cuba Before Columbus* by North American archaeologist Mark R. Harrington (1921).

In 1515, after the Spanish "founding" of the town of Santiago de Cuba (in quotes because a small Arawak settlement already existed there), all of these groups were expelled from their land, with the false pretext of converting the natives of Cuba, and were interned in the settlement of El Caney, 6 km east of the recently founded town.

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

After that, the area now covered by the Reserve remained depopulated until the middle of the eighteenth century, when Spain decided to fortify the harbors near the city that were suitable for landing ships, during the 1740 war with England. Aguadores Castle, Fort Sardinero, Fort Justicí, and Fort Siboney were built at this time.

The entire defense system of the southeastern coast was active during the nineteenth century, including the period of the three wars for Cuban independence between 1868 and 1898. In the latter year, the fortifications passed into the hands of the army and of the U.S. government, during the first North American occupation government in Cuba. In July 1898, 6,000 soldiers of the United States Army landed on the beaches of Siboney and Daiquirí and confronted Spanish troops at Las Guásimas, 5 km north of Siboney. They engaged in the Battle of San Juan at the gates of Santiago de Cuba and took the city.

The largest economic investment in the Reserve's lands was undertaken by the North American company Juragua Iron, beginning in 1883. It built a railroad across the entire coast, between the port of the city of Santiago and the mines of Juraguá and Daiquirí. In 1936 the company liquidated its operations on the southeastern coast, and at the end of 1938 it decided to dismantle the railroad.

In 1915, North American archaeologist Mark R. Harrington conducted the first scientific research known in the Reserve, in a project sponsored by the Heye Foundation of New York. He surveyed the whole coast from Siboney to Aguadores, some 12 km west, and published his results in the book *Cuba Before Columbus*.

In 1962 the Ëmil Rakovitza Academy of Sciences of Cuba (Academia de Ciencias de Cuba "Ëmil Rakovitza") established a laboratory of subterranean studies in the Reserve. In the 1970s the most important aboriginal idol ever to be found in Santiago de Cuba Province was discovered at the Sardinero archaeological site, within the Reserve. It is anthropomorphic, constructed of rock, an irrefutable example of the aboriginal art of Cuba, which at present is in the hands of its discoverer, the archaeology enthusiast Abdón Martínez.

HUMAN COMMUNITIES

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Conservation targets: An educational system that allows the implementation of environmental education in the community (C8, C9); professional and technical staff equipped for developing these activities (C8, C9); institutions for the study of biodiversity in the area, as well as their staff: specialists and investigators (zoologists, botanists, environmental educators, sociologists, and geographers, for the most part from BIOECO) who could guide the development of conservation education (C8, C9); the ecological station near the community of Siboney, which could be a base of operations for activities of interpretation and environmental education (C8, C9)*

INTRODUCTION

In the area that includes Siboney-Juticí Ecological Reserve are based only seven individuals: two are reserve guards and five are technical staff and specialists who work at the ecological station. Their basic role is to protect, manage, and monitor the Reserve. According to previous studies, the proximity of the community to the protected area allows access to and use of its resources, such as wood extraction, grazing, and the building of ovens for charcoal production, among others (Salmerón López 2000).

At present, these uses have changed because of the Reserve's management category as a protected area. Among the activities that are promoted, and in which community members participate, are environmental education and interpretation. Also, Reserve managers recognize the potential of the area for tourism and the benefit that the population of the community of Siboney could obtain through these activities (e.g., renting their houses to visitors). Therefore, they are developing activities of ecological tourism and recreation, directed both to the local population and to tourists visiting the community and the Reserve.

METHODS

In the area, the Protected Areas Division of BIOECO, responsible for the administration and management of

* Category codes for conservation targets (C1, C2, etc.) are explained in the Conservation/Information Design section on pages 97-98 of this report.

the Reserve, is carrying out several projects on social characterization. One of these (Salmerón López 2000) provided us with information on the perception and use of the Reserve's natural resources by the local community.

We used a literature review to bring known data up to date and at the same time to acquire new information. During visits to the town of Siboney, we used observation and interviews at random with key actors and community members: for example, the delegate or mayor of the community, the family medicine practitioner, and other official and popular leaders, who gave us information on the composition, structure, and current conditions of the community and on the current use of resources present in the Reserve.

RESULTS

The community of Siboney

This coastal community is a concentrated human settlement with a population of more than 1,000. Living conditions in general are good. Its beach is visited during all seasons of the year, both by Cubans and by foreign tourists.

The influx of foreign tourism has caused a change in the attitude and behavior of some residents, even in the customs of rural life specific to the place. These changes include a growth in the activity of renting rooms for international tourism, as well as the sale of handicrafts and of food prepared by residents. As a result, family income has raised the standard of living in this community. The level of employment in the community is high: more than 25 economic and service centers employ community members.

The town has three educational centers—for primary, secondary, and postgraduate instruction—which have intensified and spread activities of environmental education throughout the population. Through the inclusion of an environmental dimension in the study programs of primary and secondary schools, students learn the values and the importance of protecting nature. Through experiential classes they gain an understanding of the local natural environment. The students in the primary school are linked to Circles of Interest (Círculos de Interés) advised by specialists and technical staff from the Protected Areas Division of BIOECO, specifically on the subject of protected areas and their importance.

During interviews of residents, many appeared very interested in knowing more about the natural values that they enjoy by living near a protected area. During an earlier project (Salmerón López 2000), 52% of residents indicated their willingness to form groups for environmental activism. These attitudes are an opportunity for establishing programs of community participation in the comanagement of the Ecological Reserve.

Human activities

In our survey and monitoring we verified, through interviews and our own observations on affected areas, that activities that harm natural resources—such as logging, charcoal production, and the extraction of the Reserve's vegetation for domestic uses, among others—have been minimized, and eliminated in some cases. Nevertheless, according to information from those interviewed, one use that has been engaged in for many years still persists: illicit fishing in the marine zone of the Reserve. A more recent use is the extraction of sand by people from places other than the community of Siboney (primarily the city of Santiago de Cuba and other provinces). They use the sand to fill playing fields and to supply housing construction. Both uses constitute a menace to conservation in the Ecological Reserve; even though they do not take place frequently, they occur very close to and even inside the protected area.

In our opinion, the activities of the community of Siboney are not insuperable threats for the conservation and protection of the natural, historic, and cultural values of the Reserve, because the population already has a level of awareness that produces a feeling of belonging to the protected area. Also, the work developed and proposed by the Protected Areas Division of BIOECO involves the residents themselves in its conservation efforts; these participants then act as multipliers of conservation messages. This state of

affairs does not at all mean that all problems are resolved. We believe that necessary actions include intensifying the preventive and educational work with the local population, as well as searching for alternative solutions to economic problems that the community must confront today.

The people of Siboney have used some natural resources in a way that is incompatible with conservation. These resources have been harvested to satisfy the need for fuel in the community. With the distribution plan for cooking gas, the cause for wood extraction is reduced or eliminated. The threats to conservation on the part of the community could diminish with (1) the creation of an environmental culture among community members, one that would reveal the values that are protected very near them; and (2) the generation of activities of recreation, interpretation, and ecological tourism, which would be to the benefit, economic as well as spiritual, of these residents. To accomplish these objectives, the Management Plan for Siboney-Juticí Ecological Reserve is being developed at this time; it includes among its programs and actions the ones suggested here.

THREATS AND RECOMMENDATIONS

Threats

- The scarcity of the resources necessary for the work of environmental education: transportation, books, didactic materials, paper, pencils
- Insufficient or ineffective regulatory signs in the protected area
- The influx of people from other communities into the coastal zone of the Reserve. Up to the time of this study, no plan of action was in effect to involve these nonresidents in processes of environmental education and citizen participation in the protection and conservation of the resources that they use. But such actions have been taken into account in the proposal for public use that the Management Plan for the Protected Area will contain.
- Negative impacts on some resources by people who visit the coastal zone of the Reserve and who come, for the most part, from the city of Santiago de Cuba. For example, the inappropriate collection of mollusks such as the West Indian topshell (sigua, *Cittarium pica*), the queen conch (cobo, *Strombus gigas*), and the Caribbean helmet (casco de mulo, *Cassis tuberosa*) cause the decrease of their populations; this capture of adult individuals prevents their reproduction. Another example is sand extraction for commercial purposes.
- The absence of carefully developed nature tourism in the area. To date, only beach tourism occurs in Siboney. Nevertheless, favorable conditions exist for the option of nature tourism, which would bring another type of visitor to the community and perhaps sources of income for individuals who serve as tour guides in areas of the Reserve.

Recommendations

- Undertake fundraising projects for the work of conservation in the Reserve. Acquire materials, and resources in general, that would contribute to environmental education: folding chairs, brochures and posters, paper, didactic materials, binoculars, compasses, and guides to the local fauna and flora. Create exhibits for community residents. Foster other initiatives that would strengthen the promulgation of the values of the region, including the coastal zone.
- Build and place signs in key areas of the Ecological Reserve, including the coastal area.
- Build capacity in community leaders and students at all levels of education in the community. Equip these leaders and students with the legal regulations for the conservation of the coastal zone, the means for explaining and promoting them, and their application to all visitors to this area.
- Undertake the development of a plan for tourism in the zone—a framework that will reconcile the interests of the Management Plan for the Reserve with the economic interests of the community, as well as Siboney's requirements for consistently raising its standard of living.

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