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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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Cornell Lab of Ornithology

The "Lab" is a nonprofit membership institution whose mission is to interpret and conserve the earth's biological diversity through research, education, and citizen science focused on birds. Our programs work with citizen scientists, government and nongovernment agencies across North America and beyond. We believe that bird enthusiasts of all ages and skill levels can and do make a difference. From backyards and city streets to remote forests, anyone who counts birds can contribute to the Lab's research. Data from the projects described below are used to monitor bird populations and outline conservation efforts.

The Lab's conservation work is based on sound science and draws extensively from the efforts of other Lab programs. Our conservation staff produces guidelines and manuals to help professional land managers and private landowners make informed, conservation-minded management decisions. Lab staff belong to a number of conservation alliances, including Partners in Flight and the International Whaling Commission, which work hard to affect broad-scale conservation policy.

Education is a vital component of the Lab's mission. We provide to the public a growing number of education projects and courses, and are committed to empowering educators with the tools they need to provide science-based programs to their students.

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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	February 1–10, 2004
Region	This inventory took place in La Bayamesa National Park, located in the central part of the Sierra Maestra Mountains, approximately 36 km directly south of the city of Bayamo (Fig. 1). It covers 241 km^2, of which 197 km^2 are located on the southern slope and only 44 km^2 on the northern slope. The highest point is Pico Bayamesa at 1,752 m.
Sites surveyed	During the rapid inventory, the biological team concentrated research efforts around two camps: Barrio Nuevo and El Zapato (Fig. 1B).
Organisms studied	Terrestrial vascular plants (ferns and fern relatives, and seed plants), terrestrial mollusks, spiders and other arachnids, aquatic insects, butterflies, hymenopterans (ants, bees, and wasps), amphibians, reptiles, and birds. We also studied the condition and distribution of the Park's vegetation types. Collaborators provided additional data from studies conducted previously in the area on liverworts, hornworts, and mosses.
Highlights of results	This mountainous park retains the majority of its original terrestrial habitats (Figs. 2, 3), including montane rainforest, natural pine forests, cloud scrub formations, cloud forest, and evergreen forests. Large portions of the Park that were disturbed mostly at the beginning of the twentieth century are now being regenerated by natural succession (see Main Threats in this section and Vegetation in the Technical Report). The Park is adjacent to Turquino National Park (Fig. 1B). From a biological point of view, this situation is very favorable because it creates a large block of continuous forest habitat that provides better, long-term protection for some organisms (such as birds) than would two parks at a distance from each other. Using the information we obtained during our fieldwork, supplemented with additional data from other collections, literature, and unpublished studies, we report the following highlights. **Birds:** We recorded 76 species in La Bayamesa National Park (55 species in Barrio Nuevo and 68 in El Zapato). Based on L. Melián's previous work in the area, we estimate that approximately 120 species inhabit the Park. We recorded 4 threatened species—Gundlach's Hawk (*Accipiter gundlachi*), Sharp-shinned Hawk (*A. striatus*), Gray-fronted Quail-Dove (*Geotrygon caniceps*), and Stygian Owl (*Asio stygius*)—and it is likely that the threatened Black-capped Petrel (*Pterodroma hasitata*; Fig. 7D) is also present.

Highlights of results (continued)

We found 11 species endemic to Cuba. The forests seem to harbor exceptional densities of two endemic resident species: Cuban Trogon (*Priotelus temnurus*; Fig. 7B), and Cuban Solitaire (*Myadestes elizabeth*; Fig. 7A). Most likely, they are more abundant here than in any other part of Cuba. The Park also harbors exceptionally high densities of wintering migrant birds, notably Black-throated Blue Warbler (*Dendroica caerulescens*; Fig. 7C), which occurs here in higher densities than in any other site in the Caribbean (possibly more than 50% of its world population winters here). A small population of a rare wintering migrant, Bicknell's Thrush (*Catharus bicknelli*), could be present as well.

Amphibians and reptiles: We recorded 16 amphibian and 20 reptile species (Fig. 6); we observed the Cuban boa (*Epicrates angulifer*) outside the area's borders, but rural farmers claim to have seen it within the Park. One amphibian (*Bufo peltacephalus*) and two reptiles (*Anolis noblei* and *A. guazuma*) are not included on our list, but they probably exist within the Park. With their inclusion, the total number of species increases to 39 (17 amphibians and 22 reptiles). We did not find species of the genera *Arrhyton*, *Amphisbaena*, or *Typhlops*, probably because their reclusive habits make them extremely difficult to detect.

Of all the species recorded, 15 amphibians and 17 reptiles (93.8% and 85.0%, respectively) are endemic to Cuba, and of those, 7 amphibians and 4 reptiles are endemic to Sierra Maestra. More significantly, 3 species inhabit only areas within the Park (Appendix 12), and 5 others are known to inhabit only this Park and adjacent Turquino National Park. Of the endemics, 10 amphibians (*Eleutherodactylus* spp.; Figs. 6A-C) and 2 reptiles, *Chamaeleolis chamaeleonides* (Fig. 6D) and *Epicrates angulifer*, are also considered threatened.

Mammals: We did not survey mammals in the Park.

Invertebrates: We observed 8 families, 11 genera, and 13 species of **terrestrial mollusks** in the Park (Figs. 5A-B). Species richness is high. All of the Park's montane rainforest species are endemic: 5 (38.5%) are endemic to Sierra Maestra, 6 (46.2%) are endemic to the Eastern Region, 1 (7.7%) is endemic to both the Central and Eastern Regions, and 1 is endemic to Cuba in general.

There are 65 species of **spiders**, grouped in 54 genera and 24 families. Of these, 21 species and 3 families were new records for the Park. Best-represented families included Araneidae, Theridiidae, Salticidae, and Tetragnathidae. We found 17 of Cuba's endemic species (including 3 that are restricted to the Sierra Maesta), which represents 6.9% of the country's endemic species. Of the Park's endemics, *Argyrodes cubensis* is only known to exist from its populations in two localities in the Eastern Region.

We observed 6 species (all endemic to Cuba) belonging to 6 genera, 4 families, and 3 orders of **other arachnids** (scorpions, amblypygids, and schizomids). Our inventory was the first effort to study these groups in the zone. The most interesting record was a new species of *Cubazomus*. This is the second known species of this genus in the Order Schizomida within Sierra Maestra, and recorded at a high altitude: 1,100 m (the other species lives below 300 m).

We collected 2,033 individual **aquatic insects** assignable to 65 species, 35 families, and 7 orders. Compared to other Cuban data, the number of aquatic insects in the Park is high: its 65 species represent 31.1% of all known Sierra Maestra species and 12.7% of those known for Cuba. We found 26 species endemic to Cuba (40% of all the species found), of which 3 are local endemics: *Hagenulus sextus* (Ephemeroptera, Leptophlebiidae), *Campsiophora mulata* (Trichoptera, Glossosomatidae), and *Paltostoma palominoi* (Diptera, Blephariceridae). The Orders Ephemeroptera, Odonata, and Trichoptera were especially rich in endemic species.

We observed 23 **butterfly** species and predict that 35 occur in the Park. Four are endemic to Cuba, and 2 (*Anetia briarea* and *A. cubana*) are considered near threatened globally.

The Park harbors a significant diversity of **hymenopterans** (ants, bees, and wasps). We found 200 species belonging to 10 families and estimate that the number of species easily surpasses 400. We registered 6 genera of the Family Ichneumonidae (*Clistopyga*, *Eruga*, *Exenterus*, *Protichneumon*, *Symplecis*, *Zatypota*) and one Braconidae (*Macrostomion*) that are new records for Cuba (Fig. 5D)—most of these probably represent species new to science as well. We predict that endemism could be significant for some hymenopterans in the Park because of its altitude, good state of conservation, and relative isolation; rates are close to 40% for the hymenopteran families for which there are data available in Cuba. Results from this inventory suggest that La Bayamesa National Park is a "hot spot" for groups of parasitic wasps, and without a doubt, the area is the most important for the Ichneumonidae in the country.

Nonvascular plants: Many Cuban and foreign botanists have visited the Sierra Maestra. Despite their efforts, each additional visit brings new finds, showing that research on its flora is far from complete. The Sierra del Turquino, in which La Bayamesa National Park is found, is one of the most important areas for nonvascular species richness and endemism. There are 172 species of **liverworts and related plants**, belonging to 63 genera and 19 families, which is a significant portion of the hepaticological flora recorded for the country. Six endemic species occur in the Park, which represent 26% of all the Cuban

Highlights of results (continued)

endemics and 46% of those endemic to Sierra Maestra. Twelve species are globally threatened: 8 Endangered and 4 Vulnerable.

The **moss** flora is represented by 142 infrageneric taxa belonging to 78 genera and 32 families (Fig. 4A). Based on the highest numbers of infrageneric taxa, the following genera are best-represented: *Fissidens*, *Campylopus*, *Leucobryum, Macromitrium*, and *Syrrhopodon*. Two taxa are endemic: *Dicranella hioramii* var. *hioramii* and *Syrrhopodon elongatus* var. *elongatus*, and 22 taxa are threatened globally.

Vascular plants: The Park harbors a rich pteridoflora (**ferns and fern relatives;** Fig. 4B). We registered 346 species, 74 genera, and 25 families, representing 53% of all Cuban fern species. We found 2 species that are possibly new to science (*Pityrogramma* and *Pteris*), two new records for Cuba (*Ophioglossum harrissii* and *Danaea urbanii*), and 6 new records for the Park. There are 21 endemic and 4 possibly endemic species, for an endemism rate of 7.2%; of these, 3 are found only in the Park, an additional 7 are endemic to Sierra Maestra, and 12 are endemic to eastern Cuba. We recorded 44 species categorized or listed as candidates for categorization as threatened; of these, 10 are found in Cuba only in the studied area. There are 3 naturalized, highly invasive species.

We recorded 553 taxa of **spermatophytes** (seed-bearing plants; Figs. 4C-D) belonging to 315 genera and 103 families, of which 6 or 7 are new records for the Park, Sierra Maestra, or Cuba. We estimate that approximately 700 species exist in the area. Of those recorded for the Park, 6 are considered globally threatened. The families with the most species are Asteraceae (38), Orchidaceae (37), Rubiaceae (32), Poaceae (29), and Fabaceae (28). The percentage of native species is probably over 90%. There are 37 known introduced species; when compared to other protected areas where we have conducted similar inventories, this number is high, probably because human settlements within and around the Park facilitated their introduction and dispersal.

We identified 6 **native vegetation** types in the Park (Figs. 2, 3): cloud forest (above 1,500 m), cloud scrub (over 1,700 m), montane rainforest (between 800 and 1,400 m), natural pine forest (the most extensive found between 700 and 1,100 m), mesophyll evergreen forest, and gallery grassland. Montane rainforest covers the largest surface area within the Park. There are also areas of anthropogenic vegetation, including plantations of *Pinus cubensis* and *P. caribaea* that are not native to the Park.

Main threats

01 **Native habitat destruction and alteration.** During the rapid inventory, we observed some areas (mostly in the western portion) where forest cover had been eliminated sometime in the early twentieth century by settlements, logging, and the creation of pasture and cropland (Fig. 2). Because of this, vegetation in many areas is regenerating via natural succession (Fig. 8A). However, in some areas along the Park's periphery, and in some lower elevation valleys, forest is being fragmented or degraded by human activities—despite the fact that it is formally protected. We did not detect any significant contamination in rivers or streams.

Subtle fragmentation of fragile habitats (covering a small area of the Park), such as cloud forests and natural cloud scrub above 1,400 m, is of particular concern. This fragmentation threatens flora and fauna because it creates habitat "islands," separating species from one another and isolating populations. New roads and trails, unless carefully planned, could increase human presence in susceptible habitats in upper altitudes.

02 **Introduced plants.** The presence of exotic species that displace native vegetation represents a significant potential threat. Some introduced plants of concern include eucalyptus (*Eucalyptus* spp.), cypress (*Cupressus* spp.), "marabú" (*Dichrostachys cinerea*), and rose apple ("pomarrosa," *Syzygium jambos*). Although these species are not dominant or extensive at present (as they have become in some other parks and ecological reserves in Cuba), it is not clear whether or not they will continue to behave as good citizens—that is, they may displace native vegetation over extensive areas in the future unless they are eliminated or actively managed. There are also many plantations of *Pinus cubensis* and *P. caribaea,* which are not native to the area. These species reproduce naturally in the area and easily hybridize with *P. maestrensis*, the Park's native species, thereby altering its genetic makeup.

03 **Introduced animals.** Predation by introduced animals, such as feral dogs (*Canis familiaris*) and cats (*Felis catus*), can affect bird and other faunal communities. At this time, these mammals' impact on native fauna is unknown. Reforestation may represent a threat to the Park's entirely endemic malacofauna because non-native mollusks can be introduced in the process.

Current status

La Bayamesa is a National Park, which is a Category II strictly protected area according to IUCN categorization.

REPORT AT A GLANCE

Principal recommendations for protection and management

01 **Reduce or eliminate deforestation or degradation of forested habitats and promote regeneration of large patches of rainforest and natural pine forest.** Protect undisturbed or relatively undisturbed native forests. Increase patrols and control within the Park to stop unregulated agriculture and unauthorized logging.

02 **Reduce or eradicate exotic species, focusing on the most damaging first.** Eliminate, or at least reduce, exotic plant populations in the Park and prevent the introduction of harmful animals.

03 **Control access to fragile habitats.** The cloud forest is especially vulnerable. Expert biologists should be consulted if new roads are built, or existing roads are rebuilt or widened, or when trails are built for tourists, so as to reduce subsequent erosion, disturbances, and habitat fragmentation.

04 **Consolidate park management, providing additional resources and training for personnel.** Elaborate the Park's Management Plan, using information from this and future inventories and other research, and strengthen human resources.

Why La Bayamesa National Park?

More than one thousand species of plants and an even larger number of animals find refuge in the rough and beautiful landscape of La Bayamesa National Park. Although the Park comprises only 0.2% of the area of Cuba, it is protected by its difficult access. Mostly covered by native forests in a good state of conservation, the Park encompasses the largest contiguous area above 1,200 m altitude in Cuba. Intact cloud forests mantle its tallest mountain peaks, which are named after heroes in the nation's struggle for independence.

Together with the adjacent Turquino National Park, this area is the principal nucleus of biodiversity in the Sierra Maestra and, unquestionably, one of the principal nuclei within all the Caribbean islands. Many species restricted to the Sierra Maestra, including amphibians, insects, mollusks, ferns, and spiders, are found in Parque Nacional La Bayamesa. Eleven species of birds endemic to Cuba are present, often in significant numbers (such as Cuban Trogon and Cuban Solitaire). The Park also shelters hugely important populations of North American migrant birds, especially Black-throated Blue Warbler, and populations of many globally threatened plants and animals.

These natural treasures of La Bayamesa deserve to be studied and appreciated in their full magnitude. But, it is one of the least studied national parks in Cuba, even though the information from such studies is crucial for the evaluation of conservation targets and for the development of effective management plans.

Conservation in the Park

CURRENT STATUS

La Bayamesa National Park is located in the central part of Sierra Maestra, approximately 36 km directly south of the city of Bayamo. It covers 241 km^2, of which 197 km^2 are located on the southern slope and only 44 km^2 on the northern slope. The highest point is Pico Bayamesa at 1,752 m. La Bayamesa National Park is a strictly protected area (Category II, IUCN). Together with Turquino National Park, which is adjacent, it forms the largest mountainous block above 1,200 m in Cuba. These two national parks harbor the greatest biological diversity in Sierra Maestra and contain some of the richest flora and fauna in Cuba. The fact that these protected areas are contiguous not only facilitates management actions but also provides a unique opportunity to safeguard important conservation targets.

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)

We identified the following conservation targets for the Park during the rapid inventory. Site managers and planners should continue research on these targets to refine our selections. Codes in parentheses refer to the criteria in the sidebar to the left. Detailed lists of conservation targets are provided at the beginning of each group's chapter in the Technical Report.

Physiographic Features	▪ Clean, uncontaminated rivers and streams, free of human-produced toxins and sediments that damage native amphibians, fish, and aquatic insects (C10)
Terrestrial Vegetation Types	▪ Montane rainforest and its successional stages, cloud forest, cloud scrub, natural pine forest, and gallery forest, all of which harbor thousands of endemic and native plant, invertebrate, and vertebrate species (C1, C4)
Nonvascular Plants	▪ Two endemic, threatened **liverwort** species (*Nowellia wrightii* and *Radula pocsii*) (C4, C5), 10 additional threatened species (C5), and 4 endemic species (C4) ▪ Twenty-two threatened **moss** species, including *Eurhynchium clinocarpum* and *Hookeriopsis luteo-rufescens*, which are categorized as globally Critically Endangered (C5)
Vascular Plants	▪ Forty-four species of **ferns** categorized as or listed as candidates for categorization as threatened; 10 of these species are found in Cuba only within the Park (for example, *Asplenium alatum* and *Blechnum gracile*) (C5) ▪ Twenty-five endemic or possibly endemic ferns, 3 of which are found only within the Park, 7 of which are endemic to the Sierra Maestra, and 12 to eastern Cuba (C4)

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	Vascular Plants (continued)	▪ One endemic **spermatophyte** (a seed-bearing plant) considered globally Endangered, *Lyonia elliptica* (Ericaceae); 5 species considered globally Vulnerable, *Begonia cubensis* (Begoniaceae), *Tabebuia hypoleuca* (Bignoniaceae), *Juniperus barbadensis* var. *lucayana* (Cupressaceae), *Licaria cubensis* (Lauraceae), and *Sideroxylon jubila* (Sapotaceae) (C4, except *Juniperus*, and C5); 1 subspecies categorized as Undetermined (C5); and 1 species restricted to small populations along the Peladero River and its tributary, the Nuevo Mundo, *Marathrum utile* (Podostemaceae) (C5)
	Mollusks	▪ Five species endemic to the Sierra Maestra Subregion and 6 endemic to the Eastern Region: *Helicina subglobulosa leoni*, *Troschelvindex arangianum turquinensis, Cysticopsis lessavillei*, *Obeliscus* (*Stenogyra*) *clavus flavus*, *Veronicella* sp. nov., *Alcadia* (*Idesa*) *spectabilis, Emoda p. pulcherrima, Zachrysia* (*Chrysias*) *bayamensis*, *Coryda lindoni*, *Cysticopsis pemphigodes,* and *Obeliscus (Pseudobalea) latus* (C4, C5)
	Arachnids	▪ Populations of 17 endemic **spider** species in the Park, especially *Argyrodes cubensis*, which is known from only two localities in the Eastern Region, and *Leucauge spiculosa, Modisimus pavidus*, and *Hibana turquinensis*, which are only known for a few localities within the Sierra Maestra (C4) ▪ The population of a **schizomid**, *Cubazomus* sp. nov. (Hubbardiidae), the second known species of this genus endemic to Sierra Maestra (C4)

Conservation Targets (continued)

	Insects	▪ Communities of **aquatic insects**, especially 26 endemic species, of which 3 are particularly important because they are Park endemics: *Hagenulus sextus* (Ephemeroptera), *Campsiophora mulata* (Trichoptera), and *Paltostoma palominoi* (Diptera) (C4) ▪ Four **butterfly** species endemic to Cuba (*Calisto sibylla, Anetia cubana*, *Greta cubana,* and *Parides gundlachianus*) (C4) ▪ Communities of **hymenopterans** (wasps, bees, and ants), especially groups of parasitic wasps that are more diverse and abundant here than in any other place in the country, including genera that in Cuba have only been found in this region (*Clistopyga, Eruga, Exenterus, Macrostomion, Protichneumon, Symplecis, Zatypota*) (C3, C4) ▪ Endemic ant species (*Camponotus gilviventris*, endemic to Cuban mountainous zones, and *Leptothorax bruneri*, a regional endemic) (C4)
	Amphibians and Reptiles	▪ Twelve species considered threatened (*Eleutherodactylus albipes, E. cubanus, E. glamyrus, E. gundlachi, E. intermedius, E. ionthus, E. jaumei, E. melacara, E. ricordii, E. turquinensis*, *Chamaeleolis chamaeleonides*, and *Epicrates angulifer*), which are also endemic to Cuba (C5, C4) ▪ Ten species whose ranges are restricted to the Sierra Maestra forests (*Eleutherodactylus albipes*, *E. cubanus*, *E. glamyrus*, *E. jaumei*, *E. melacara*, *E. turquinensis*, *Eleutherodactylus* sp. nov., *Anolis clivicola*, *A. altitudinalis*, and *Diploglossus garridoi*) (C4)

Conservation Targets (continued)

	Birds	▪ Four or five threatened species: Gundlach's Hawk (*Accipiter gundlachi*), Sharp-shinned Hawk (*A. striatus*), Gray-fronted Quail-Dove (*Geotrygon caniceps*), Stygian Owl (*Asio stygius*), and, if its presence is confirmed, Black-capped Petrel (*Pterodroma hasitata*) (C5) ▪ Eleven Cuban endemics (C4) ▪ Terrestrial migrant birds from North America, including Bicknell's Thrush (*Catharus bicknelli*) (C7)
	Mammals and Human Communities	We did not survey mammals or evaluate the human communities within and around the Park.

THREATS

DESTRUCTION AND ALTERATION OF NATIVE HABITATS

Terrestrial habitats

During the rapid inventory, we observed some areas (mostly in the western portion; Fig. 2) where forest cover had been eliminated sometime in the early twentieth century by settlements, logging, pasture, and cropland. Because of this, vegetation in many areas is regenerating via natural succession. However, in some areas along the Park's periphery, and in some lower elevation valleys, forest continues to be fragmented or degraded by human activities—despite formal protection of the Park. For example, habitat loss is extensive in the La Mula, Guayabo, La Plata, and La Bruja River Basins.

Many native species depend entirely on very specific microhabitats for survival. Deforestation not only affects the timber species that are cut out of the forests, but also different groups associated with these forests. For example, most liverworts living in the understory or on other plants need microhabitats of a certain age, and specific pH, shade, and humidity to grow and reproduce. Likewise, many mollusks, arachnids, insects, amphibians, and reptiles are also extremely sensitive to localized habitat loss or destruction.

Subtle fragmentation of fragile habitats is of particular concern. This fragmentation threatens flora and fauna because it creates habitat islands, which separate populations of the same species from each other. High-altitude habitats (those above 1,400 m, including cloud forest and cloud scrub) face the highest risk of degradation. Historic patterns of degradation of the Park's montane rainforests and mesophyll evergreen forests in lower altitudes have created isolated patches of some native plants and animals, which are now threatened with disappearance from the Park.

Roads and trails

There are very few roads within the Park, but the potential for new roads and trails is cause for concern. Increased vehicular traffic could alter the structure of the bird communities by introducing new species to the area, and it could change the structure and distribution of vegetation. Subsequent increased hunting pressure may also stress certain bird species.

New roads and trails, unless carefully planned and implemented, could also increase human presence in fragile, high-altitude habitats. High-altitude vegetation covers a small surface area in the Park and is vulnerable to excessive collection of plant material and human presence. Current projects designed to facilitate access to these areas represent an immediate threat.

Aquatic habitats

Fortunately, we did not detect any significant sources of contamination, such as dumping in rivers and creeks, which are typically the biggest threats to lotic ecosystems. As long as natural resource use remains as it is now, freshwater macroinvertebrate communities are not at risk.

We did see many ruts along the roads caused by fluvial erosion. Soil loss from erosion along these roads or any other construction area on steep slopes in the Park would have a negative local effect on some aquatic organisms.

EXOTIC, INVASIVE SPECIES

Plants

Another significant potential threat is the existence of exotic plants that displace native vegetation in some areas in the Park. For example, several intentionally planted species in the Park include eucalyptus (*Eucalyptus* spp.) and cypress (*Cupressus* spp.). Several other non-natives escaped cultivation and have invaded the forests, such as "marabú" (*Dichrostachys cinerea*, Fabaceae) and rose apple (*Syzygium jambos*, Myrtaceae). While these exotic species are not as pervasive or extensive as some in other parks or ecological reserves in Cuba, it is not clear whether or not they will behave as good citizens within La Bayamesa National Park in the future. That is, these species have the potential to displace large areas of native species if they are not eliminated or managed now, while they are still controllable.

Finally, there are several plantations of *Pinus cubensis* and *P. caribaea,* which are not native to the area. These species naturally reproduce in the Park and easily hybridize (especially the first) with native *P. maestrensis*, thereby altering its genetic makeup.

Animals

Predation by introduced species, such as feral dogs (*Canis familiaris*) and cats (*Felis catus*), could be affecting bird and herpetological fauna communities. The level of impact on native fauna is unknown.

A threat to the Park's entirely endemic malacofauna is deforestation and subsequent reforestation, which could introduce non-native mollusks.

OTHER POTENTIAL THREATS

Amphibian declines and extinctions have not been documented in Cuba, but the possibility exists, especially in high-altitude, forested areas (La Bayamesa, for example). Most species in decline in Latin America live above 500 m altitude (Lips et al. 2003). The lack of baseline studies or previous data in Cuba may be masking the magnitude of amphibian declines on the island.

West Nile virus is a potential threat, but we do not have sufficient information regarding its possible occurrence among resident and migrant species populations of birds.

RECOMMENDATIONS

Based on the Park's conservation targets and threats, we offer the following recommendations, including specific notes on protection and management, and additional scientific research (inventories, research, and monitoring). Collaboration among local communities, scientists, park managers, and local 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

01 **Reduce or eliminate deforestation and degradation of native habitats.**

- Protect native forests (rainforest, cloud forest, evergreen forests) and scrub.
- Increase vigilance and enforcement within the Park to eliminate unregulated agriculture and unauthorized logging, thereby protecting remnant stands of natural forest.

02 **Reduce or eradicate exotic species, focusing on the most harmful first.**

- Eliminate (or at least reduce) exotic plant populations (eucalyptus, cypress, *Dichrostachys*, rose apple, and others) from the Park.
- Prevent harmful animals from entering the forests (for example, feral dogs and cats, and non-endemic mollusks).

03 **Control access to fragile habitats.** Strictly limit (to small groups only) and control access to the cloud forest ecosystem (which is especially vulnerable), and strictly control excessive botanic and zoological collections. Restrict access (only permitting scientific research) to Pico Botella, Pico Maceo, and La Bayamesa's second peak, the natural pine forests at María Tomasa (Colón) and La Francia, as well as other places where endemic, rare, and/or threatened communities are concentrated.

04 **Carefully plan any new road or improvement project.**

- Consult biologists with expertise regarding vegetation, herpetology, birds, and aquatic environments if new roads are built, or existing roads are rebuilt or widened, or when trails are built for tourists, to help determine how best to reduce subsequent erosion, disturbances, and habitat fragmentation.
- Consider the indirect effects of new roads and increased access by humans; for example, the potential for increase in illegal logging or unauthorized collection of Park fauna.

05 **Maintain water quality, preventing sedimentation and contamination of aquatic habitats.** Implement erosion control along ruts and control water flow along roads and other areas where it causes damage.

RECOMMENDATIONS

Protection and management (continued)

06 **Promote regeneration of large rainforest and natural pine forest patches.**

- Reforest pasture areas within rainforests using passive and active processes and native species (appropriate to altitude) in the Park (especially areas in and around Pata de la Mesa).
- Prevent human-caused fires in the pine forests.

07 **Consolidate park management, providing additional resources and personnel training.**

- Elaborate the Park's Management Plan using information from this and future inventories and research to protect ecosystem integrity and indigenous species.
- Strengthen human resource capacities.
- Consider self-financing strategies for the Park's long-term maintenance and conservation.
- Develop "sustainable use" areas in La Bruja and in Marverde (disturbed and populated areas), that is, promote development that is compatible with the conservation of indigenous species and communities.

08 **Raise awareness of the Park's value and benefits.** Increase environmental education programs in nearby communities to establish conservation awareness.

Additional inventories

Gather more information on native species and their distribution in the Park. Here we present a sampling of the specific recommendations detailed in the Technical Report.

01 Continue biological inventories in other locations, during dry and rainy seasons.

02 Conduct additional, detailed inventories of the pteridoflora, which are lacking for many areas, especially La Sierrita (or "Maestrica") de los Libertadores.

03 Carry out more inventories of the area's entirely endemic mollusk community, which are needed to understand its composition.

04 Survey aquatic insects in different rivers and streams during the rainy and dry seasons to increase the total number of known species, and (most likely) find species new to Cuba and to science.

05 Devise an annual collection plan of hymenopterans in different areas in the Park. This will reveal the true magnitude of the Park's hymenopteran biodiversity and most likely will lead to finding many species new to Cuba and to science.

Additional inventories (continued)	**06** Conduct additional studies of the herpetofauna of the southeastern area of the Park (called "Maestrica de los Libertadores"), which is poorly known due to difficult access. **07** Monitor the presence and level of West Nile virus in populations of resident and migratory birds.
Research	**01 Investigate active and passive regeneration methods for disturbed and damaged forests.** ▪ Study the various successional stages, especially in the montane rainforest (Appendix 1), to understand and actively facilitate succession, if passive methods do not work. ▪ Study how to replace *Pinus cubensis* planted in the area. It is a major threat to *Pinus maestrensis* (because they can easily hybridize). Study how gradually to remove *Pinus caribaea* plantations from the Park, focusing first on regeneration around roads and other open areas. **02 Study the effects of introduced, exotic species on native biodiversity.** Determine which exotic species cause the most damage and then study their population biology in the Park. Using results from these studies, design management actions that address these threats. For example, understand and quantify the effects of feral dogs and cats on amphibians and reptiles in the Park to develop better control and eradication strategies. Also determine the effects of other feral or introduced animals on the survivorship of ground-nesting birds and on the health of understory vegetation. **03 Increase studies on the distribution, ecology, and phenology of threatened and endemic plant and animal species.** ▪ Research why ichneumon wasps are so abundant and diverse in the Park. ▪ Study the breeding biology and behavioral ecology of endemic birds in various sites. Factors driving high densities of some endemic species at sites we visited are unknown. **04 Study the ecological roles of migratory birds.** Carry out banding, point and transect counts, visual counts of daytime migrants, audio monitoring of nocturnal migrants, winter surveys of migrant populations, and winter survivorship studies. **05 Resolve the mysteries surrounding certain native bird species in the Park.** ▪ Observe Black-capped Petrel over the sea, close to the coast, and flying over

RECOMMENDATIONS

Research (continued)

inland territory at night to determine whether or not this species reproduces in the Sierra Maestra. Since nesting colonies for the area have not been confirmed, surveys of appropriate, potential nesting habitats are needed.

- Conduct additional studies to learn about the biology of Bicknell's Thrush. Such studies should include active "playback" techniques, area searches, and point and transect counts to determine the species distribution and abundance in the Park, especially near the highest peaks (over 1,400 m).
- Determine the requirements for secondary-cavity nesting species in the Park. Questions to consider include: What is the relationship between woodpecker abundance and other species that require secondary cavities for nesting? Is cavity availability a limiting factor for distribution and abundance of certain species in the Park? Is this why no Cuban Parrots (*Amazona leucocephala*) are found in the Park?

06 Complete vertebrate inventories and conduct population studies.

- Survey mammals in the Park while actively considering the possibility of finding the almiquí (*Solenodon cubanus*), whose last report for Sierra Maestra came from an area within the Park.
- Develop population studies of rare and threatened species, such as the frogs *Eleutherodactylus albipes*, *E. cubanus*, and *E. turquinensis*, which inhabit isolated areas or fragmented habitats.

Monitoring and surveillance

01 In general, site managers should give special attention to endemic species categorized as Critically Endangered, Endangered, and Vulnerable (see the list of Conservation Targets). Monitoring strategies for these species should be established, analyzing potential threats and estimating their distribution in the area. These actions will help to develop measures for maintaining their populations in the Park over the long term.

02 Exotic species identified as potential threats to native species should be monitored. For example, monitor cypress (*Cupressus*), "marabú" (*Dichrostachys cinerea*), and rose apple (*Syzygium jambos*) to determine if their populations are growing at an accelerated rate.

03 Aquatic insect communities have been used as water-quality indicators in various countries. The data collected during this inventory and presented in this report can serve as a baseline for monitoring water quality in the Park. Changes in water quality because of contamination or deteriorating ecosystems can be detected using these baseline data.