THE NATURAL HISTORY OF SOUTHERN HAITI

by
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Réserve de la Biosphère

MACAYA

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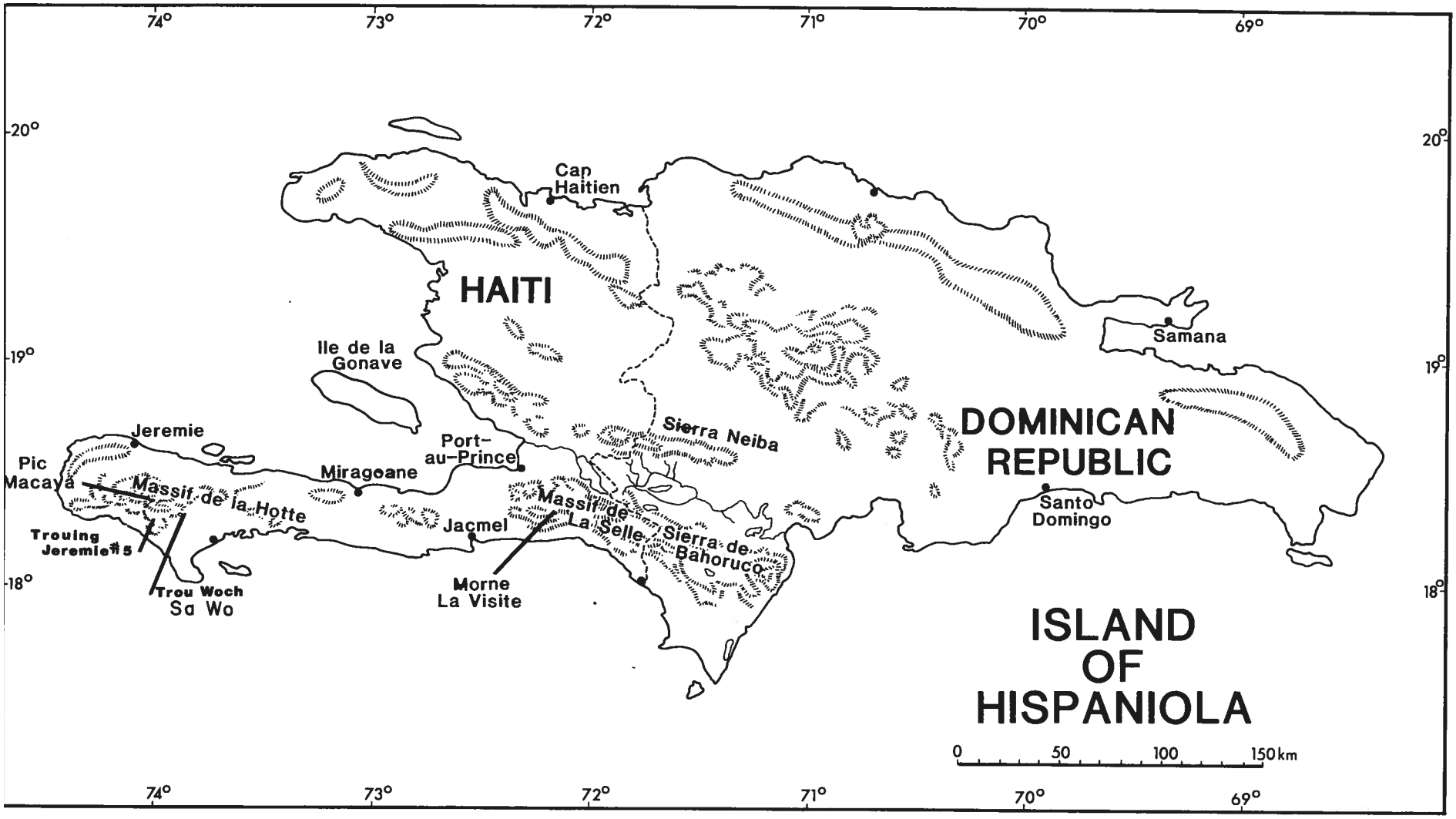
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Santo Domingo
ISLAND OF HISPANIOLA
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Dedication

This volume is dedicated to Michel Aubry, who lost his life while following his, and our, dream of a national park at Pic Macaya.

Acknowledgements

We would like to thank all of our co-workers of the University of Florida Macaya Biosphere Reserve Project who participated in various aspects of this project, and who contributed so much under very difficult conditions. Some of our colleagues who contributed valuable ideas and much-needed assistance were Paul Monaghan, Micki Swisher, Jenness McBride, Paul Paryski and John Hermanson. We acknowledge and appreciate the support of Edmond Magny and Louis Buteau of MARNDR and Albert Mangones of ISPAN. We also acknowledge with appreciation our associates at USAID, particularly Michelet Fontaine, Larry Harms, Catherine McIntyre, Kevin Mullally, and Charles-Emile Philoctete. We are very grateful to those many Haitians who assisted us as we did field work. And, we are grateful for the assistance of the following people in producing this volume: Florence Sergile for administration and editing, Beth Ramey for editing and layout, and Laurie Walz and Linda Chandler for artwork. Of course, none of the work would have been possible without the support of Missy Woods.

We would like to thank especially Michael Jenkins and the John and Catherine MacArthur Foundation. The MacArthur Foundation Grant to Charles Woods and the University of Florida is the single bright spot in an otherwise very difficult time in the history of conservation in Haiti. Without this grant, the Macaya Biosphere Reserve Project would have completely floundered. It is difficult to be optimistic about the conservation of natural resources in Haiti, and the preservation of the rare and endemic flora and fauna of the Pic Macaya area. However, with the help of the MacArthur Foundation, and the flexibility that this grant provides us, we are optimistic that some important species can be preserved.

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Résumé

Introduction

Ce document est un résumé des recherches effectuées sur la Réserve de la Biosphère de Macaya, destiné à informer les techniciens haitiens sur l'histoire naturelle d'Haiti en général et de la région de Macaya en particulier. L'essence de la documentation a été traduite en français, cependant le lecteur devra être assez indulgent de se référer au texte anglais et aux figures et tableaux pour de plus amples détails. Ce livre procure des informations sur l'écologie, la géologie, la paléontologie, la flore et la faune, un plan de rétablissement de populations animales et des recommandations. Connaître les ressources naturelles d'Haiti devient impératif dans la lourde tâche de conservation et de protection des sites naturels et des espèces endémiques.

Le monde entier connaît Haiti seulement comme un désastre écologique grâce aux mauvaises propagandes des média. En effet, la richesse de la flore et de la faune est mal connue puisque la documentation est éparpillée dans les quatre coins du monde et peu disponible en Haïti. Les chansons populaires, la peinture et les contes illustrent des animaux imaginaires (loup-garrou, sirène, cigouave) ou importés (zèbres, tigres, lions) et font rarement allusions à la faune locale (agouti, nez long ou caleçon rouge). Cependant, ils sont nombreux et les documents sur la nature haätienne sont aussi vieux que notre histoire.

Explorations

Le premier explorateur du Massif de la Hotte fut le naturaliste Louis-Claude Richard qui visita la zone vers 1787. Après plus d'un siècle le père Eugène Christ en 1908, et Erik Ekman en 1917 et 1924 firent d'importantes collectes de plantes. Beaucoup d'autres hommes de sciences firent des recherches dans la région, finalement depuis 1979, l'Université de Floride a entrepris de faire les inventaires biophysiques et de développer un programme de conservation sur le parc national du Pic Macaya en collaboration avec l'ISPAN et la direction des ressources naturelles du MARNDR.

La Réserve de la Biosphère de Macaya

En 1983, afin de protéger le caractère unique de l'ensemble des écosystèmes exceptionnels de cette zone, le gouvernement haïtien consenti de conférer à la région le statut de "parc national". Grâce à une aide financière accordée par l'Agence pour le Développement International (USAID), l'Université de Floride a pu entreprendre les études préliminaires permettant d'établir un plan de gestion pour la protection écologique du parc. L'objectif du projet visait à protéger et à réhabiliter les écosystèmes de la région du parc et ses environs tout en promouvant le développement à court et à long terme, avec la participation active des communautés paysannes de la région, en leur proposant des alternatives rémunératrices.

Le parc situé sur le massif de la Hotte, à environ 36 km de la ville des Cayes. On y accède difficilement, en deux heures, en jeep par la route de Ducis-le Prêtre-les Platons. Le centre du parc est dominé par le pic Formon (2.219 m) et le pic Macaya (2.347 m). Les chemins d'exploration sont ardus, cependant la nature est luxuriante et d'une beauté à couper le souffle.

Les programmes d'éducation environnementale deviennent impératifs dans la conservation de la flore et la faune native d'Haïti.

Géologie et Sols

La géologie de la région de Macaya est complexe et se situe dans le cré Elle est caractérisée par des roches calcaires, une formation karstique (conglomérat de roches volcaniques basaltiques, de turbidites calcaire: cherts, de grès siliceux et une faille importante qui sépare le morne de Fo de celui de Macaya. Cette faille du miocène traverse une bonne partie presqu'île du sud et le parc via la Grande Ravine. Les formations géologi régissent la composition des sols de la région qui varient entre des oxis des ultisols à pH légèrement acide ou neutre.

Flore

La flore du parc comporte plus de 500 espèces de plantes vasculaires 102 fougères (3 endémiques), 99 espèces de mousses et 49 es d'hépatiques, 1 conifère endémique, 141 orchidées (38 endémiques du r de la Hotte et 58 de l'île d'Haïti), 367 autres plantes à fleurs (55 endém du massif de la Hotte, 18 du Massif de la Hotte et de la Selle, 39 de l'île) espèce sur dix est endémique de Macaya, un bon nombre de ces espèce sensibles à la déforestation et risquent de disparaître malgré leur po sylvicole, médicinal et ornemental non encore exploité. Ces plante groupées dans la forêt de pins, des forêts de feuillus, des bosquets denses fragmentés, des jardins en jachère à l'intérieur des zones écologiq Holdridge.

Faune

La faune endémique originelle d'Haïti comprenait un nombre impor gros mammifères que chassaient les Guanahatabeys et les Tainos (500 ans A.C.). Ces animaux occupaient des niches écologiques qui furent er par les animaux domestiques introduits en 1492. Les boeufs et les devinrent rapidement sauvages, et constituèrent le gibier des boucanie mammifères de petite et moyenne taille étaient aussi chassés avant et p la période coloniale européenne jusqu'à l'extinction de presque to espèces. Les désastres écologiques se matérialisèrent vers 1900, et s conséquences de la distribution de petites parcelles de terres sous P du mode de partage des terres entres les héritiers, des systèmes de pro dans les montagnes et l'introduction d'espèces exotiques depuis l' coloniale.

La flore d'Haïti compte trois espèces endémiques sur dix.

La faune de la réserve de Macaya compte 11 espèces de papil endémique du massif de la Hotte), 57 mollusques (2 nouveaux ge nouvelles espèces, 23 endémiques), 18 d'amphibiens et 14 reptiles (ana cours), 65 espèces d'oiseaux dont 21 endémiques, 19 espèces de chauve et 2 espèces de mammifères terrestres endémiques.

La faune aviaire d'Haïti est riche et comporte 73 espèces d'oiseaux endémiques. Un grand nombre de migrateurs nichent uniquement forêts montagneuses d'Haïti comme le "Diablotin ou pétrel" (*Pte hasitata*). Le parc national Macaya compte 65 espèces dont le Caleço (*Temnotrogan roseigaster*), le kat Je Sid (*Phaenicopohilus poliocephal* Chit Kat Je (*Xenoligea montana*) et le colibri (*Tudus angustrirostr* analyses d'enquêtes confirment qu'onze espèces sont vulnérables à la dégradation de leur habitat et menacés d'extinction. La dis d'espèces entraine tout un déséquilibre qui affecte grandement les h court et à long terme. Des programmes de rétablissement et de cons sont urgents, ils seront difficiles mais pas impossibles.

Les mammifères terrestres endémiques du parc ne sont qu'au nombre de deux. Ce sont l'agouti ou zagouti (*Plagiodontia aedium*) et le nez long ou nen long (*Solenodon paradoxus*). L'agouti est un rongeur nocture qui vit dans des crevasses de formation karstique boisée ou se réfugie entre les racines de gros arbres particulièrement le bois tremblé (*Didymopanax tremulum*) dans les montagnes aux environs de 2.200 m d'altitude. Il se nourrit d'écorce de jeunes branches, de rameaux, de feuilles et de fruits de bois tremblé, d'avocat marron (*Persea anomala*), de lamandier (*Prunus* sp.). Cependant, il est considéré comme un fléau, puisqu'il s'attaque aux racines de malanga, d'igname, de patates, aux parties végétales des pois noirs, au maïs quand ces cultures sont établies près de ces sites naturels. Il boit très peu d'eau, donc l'obtient probablement de sa nouriture. Les agoutis sont de passables grimpeurs et utilisent leur queue semi-préhensile pour se mouvoir de branches en branches. Ils ont une vie assez longue, mais un taux de reproduction bas. Les femelles donnent naissance à un seul petit par portée après une gestation de plus de quatre mois. La couleuvre endormie (*Epicrates striatus*), les chiens et les chats "marrons" sont ces plus grands prédateurs. Il a toujours été un animal rare, et est encore vivant grâce à son comportement secret, cependant si sa niche écologique est détruite, il a de fortes chances de disparaître.

Le nez long est un insectivore sylvestre nocturne qui vit dans les crevasses des formations karstiques de la région de Catiche et Duchity, entre 500 et 1.000 m d'altitude . Il se nourrit d'escargots, de centipèdes, de scorpions, de petits vertébrés et d'oeufs d'anolis, grenouilles, oiseaux. Le taux de fécondité est faible. La femelle donne naissance à 2 petits par an. La gestation est de plus de 90 jours. La couleuvre endormie (*Epicrates striatus*), la chouette ou frisé (*Tyto alba*), les chiens et les chats "marrons", la mangouste sont ses prédateurs. Il est très vulnérable car mauvais grimpeur et pas aussi alerte que l'agouti. Il est très rare dans les limites du parc et disparaîtra dans les 10 ans à venir si de gros efforts de conservation ne sont pas entrepris.

La faune des fantômes du passé est abondante. Elle comptait 25 espèces, il y à 20.000 ans. Des fossils trouvés dans les dépressions (touings) documentent la présence de 5 insectivores, 13 rongeurs, 1 saï (singe), 4 aïs et 1 mégathérium (paresseux de l'ordre des édentés).

Résumé et Conclusion

L'Île d'Haïti comptait 25 espèces de mammifères terrestres de l'ordre des édentés, des primates, des rongeurs et des insectivores avant l'arrivée des indiens il y a 7000 ans, dont 23 ont disparus.

La disparition des gros herbivores avant 1492 est liée à la surexploitation de ces mammifères par 1,000,000 d'indiens.

Le mode de vie des indiens et la présence de leur chien muet a eu peu d'impact sur les animaux de taille moyenne et n'a pas affecté ceux de petites tailles.

L'impact le plus négatif sur la faune native a été l'introduction des espèces exotiques particulièrement du chien, du chat et de la mangouste.

La plupart des petits mammifères (rongeurs et insectivores de moins de 100 g) ont survécu jusqu'au début du siècle.

La disparition des petits mammifères en Haïti est liée à l'introduction des espèces et à la production agricole:

Les animaux endémiques jouent un grand rôle dans la dissemination et la reproduction naturelles des espèces végétales natives.

(a). Les taux de disparition ont augmenté après l'introduction de la mangouste en 1895 pour combattre les couleuvres dans les champs de cannes à sucre.

(b). La compétition entre rats et mammifères natifs joue un rôle important dans la disparition de ces derniers.

(c). La prédation des chiens et des chats devint plus sévère (tout comme les facteurs précédents suite à la fragmentation des forêts et l'expansion des jardins et habitations dans les coins les plus reculés, comme Macaya après la seconde guerre mondiale.

(d). La dernière des niches est une formation karstique rugueuse et pleine de crevasses qui permet aux petits mammifères de se faufiler à l'abri des prédateurs et serait l'ultime type de sol à cultiver. Cependant, le déboisement en vue d'exploiter du bois de feu et d'établir des jardins sur ce type d'habitat s'effectue maintenant dans les régions de Catiche et dans le maquis en bordure de la plaine de Formon et de Durand.

Introduction

Location of the Macaya Biosphere Reserve Study Area

This book is a summary of everything that is known about the natural history of the area of southwestern Haiti that is known as the Tiburon Peninsula. The book is designed to be used as a source book on natural history information. It will provide information on the species of plants and animals that occur in the area, as well as ecological data, and information on geology, paleontology and local soils. For some topics, there is an abundance of information, and we have provided summaries of life history information as well as detailed "Species Recovery Plans." For other species, we know much less. This book can help point out topics where much more knowledge is needed, and guide future biologists and administrators into those areas.

The purpose of writing this book is to bring together in one place as much information as possible on the natural history of Haiti. The average person working on natural resources in Haiti has an almost impossible job of gaining access to the kind of information presented here. Most studies have been published in journals that are unavailable in Haiti, or are in reports that are not available outside of Haiti. Some information has never been published. We hope that the book is complete enough to inspire people to work hard to conserve what is left of Haiti's magnificent natural patrimony. Without knowing what there is to conserve, or what has happend to some species that have already become extinct, there is little hope of developing wise conservation programs that will be able to save what remains of Haiti's natural patrimony. Since any future programs in Haiti will have to make difficult decisions and choices, we have tried to group species by habitats, and to concentrate on regions where conservation of native plants and animals are compatible with water and soil conservation.

This book concentrates on the "Macaya area." The specific regions of this area are discussed below, all of which are located on the Tiburon Peninsula. We are now planning a future book that will expand the present coverage to all of Haiti. That book, **The Natural History of Haiti**, will be available as part of the MacArthur Foundation Conservation Project now underway in Haiti.

The discussions in this book concentrate on the area of southwestern Haiti surrounding Pic Macaya. This area can be viewed as occupying the following main geographical regions.

1). **Pic Macaya** (the 2,347 meter high peak in the center of the region).

2). **Parc National Pic Macaya** (the official national park of the region that is discussed in detail in *Stewardship Plan for the National Parks and Natural Areas of Haiti* (Woods et. al., 1992).

3). **Macaya Biosphere Reserve** (the area of Parc National Pic Macaya and the surrounding buffer zone which generally includes all areas surrounding Pic Macaya at elevations above 1,000 meters, but dips to 500 meters in the Ravine du Sud).

4). **The Massif de la Hotte** (the mountainous area of southwestern Haiti west of the plateau of L'Asile, and extending all the way to the western tip of the Tiburon Peninsula).

The area designated as Parc National Pic Macaya is located on the Massif de la Hotte at the crest of the mountains where five major rivers originate: the Grande Ravine de Sud, the Port-a-Piment, the L'Acul, the Roseaux (via several smaller, but important rivers), and the Glace. The park and MBR are located at latitude 18 21' N and 74 01' W. The crest of the mountains divides the Departement du Sud (Arrondissement des Coteaux) in the south from the Departement de la Grande Anse (Arrondissement de Jeremie) in the north. The most characteristic feature of the park is Pic Macaya with an elevation of 2,347 meters. Pic Macaya is located 36 kilometers northwest of the city of Les Cayes and 195 kilometers west of Port-au-Prince.

The total recommended area for Parc National Pic Macaya is 7,500 hectares, including the Solenodon Wildlife Management Area west of Catiche and Duchity.

The "communique" in the Nouveau Monde (5 May 1981) mentioned the creation of "parcs naturels" in the Massif de la Selle and Massif de la Hotte but did not mention the specific location or boundaries of the park in the La Hotte region. The decree of 23 June 1983 creating the national park in the Massif de la Hotte designated the size of the park at Macaya to be 2,000 hectares. The communique signed by Dr. Roger Lafontant and Frantz Flambert on 15 January 1985 declared the Macaya area as a "zone protegee" but did not set the specific boundaries of the preserve. The size of the park was described as 2,000 hectares with a 10,000 hectare buffer zone in an internal document between the Ministere de l'-Agriculture, des Ressources Naturelles et du Developpement Rural (MARNDR) and the United States Agency for International Development (USAID) entitled "Fiche de Projet en Cours." Our original recommendation for the size of a national park around Pic Macaya was 3,000 hectares (Woods and Rosen, 1977). In correspondence between the Florida Museum of Natural History (FLMNH) and USAID, a preliminary boundary for Parc National Pic Macaya was recommended as comprising 5,500 ha. This proposal was accepted by ISPAN and MARNDR, and is being used by MARNDR. We believe that the size of the park should be expanded to 7,500 ha. The specific areas to be included and the justifications for doing so are discussed in volume three of this series (Woods et al., 1992).

The natural boundaries of Parc National Pic Macaya can be defined based on the results of the various inventory teams and the final reports of these investiga-

tions. Analyses of the inventories of the most significant geological, botanical, zoological and recreational features of the Pic Macaya region indicate that all of the following features should be included within the territorial limits of the Macaya Biosphere Reserve (MBR).

Pic Macaya (2,347 m)

Pic Formon (2,219 m)

Pic Le Ciel (2,170 m)

"Bwa Formon"

The karst hills between Morne Cavalier (1,570 m) and Sous Bois below Morne Cavalier and along rim of the Plain of Formon (karst hills) to 1,000 m.

"Gran Ravin" of the Riviere Ravine du Sud

The region from 1,919 meters in the saddle between Pic Macaya and Pic Formon eastward down the Gran Ravin to 500 meters elevation.

Ridge of Pic Macaya

Ridge of Formon

Plain of Mare Cochon 1,200-1,400 meters elevation north east of Macaya

All of these areas are part of a natural ecosystem that ranges in elevation from 500 to 2,347 meters. If Parc Macaya were to be enlarged to include all of these areas it would be a 5,000 hectare "block" of terrain that would contain Pic Formon and Pic Macaya at their watersheds. Parc Macaya would also include a 500 ha. peninsula of land that streaches southward from Pic Le Ciel and includes the forested karst hills around the western and southwestern boundaries of the plains of Formon and Deron that are rich in important sinkholes and have several small ponds. The park should also include 2,000 hectares north east of the ridge of Pic Macaya in the areas of Diquillon and Mare Cochon. All of this park of 7,500 hectares should be protected from environmental degradation of all kinds including all agriculture and deforestation. The flora and fauna of Parc Macaya contain more endemic species than any other known area of Hispaniola.

Access to Parc National Pic Macaya is difficult. The main access route is via the city of Les Cayes, where there are several hotels that would be suitable for tourist accomodations. Les Cayes is 196 kilometers by road west of Port-au-Prince and the journey takes less than four hours to drive on a paved all-weather highway. From Les Cayes the route is a gravel road to the town of Le Duc. Beyond Le Duc, the road becomes rough and crosses the Riviere l'Acul three times before passing through the town of Le Pretre. Beyond Le Pretre, the road is very rough and climbs the escarpment by a series of switch backs from the valley of the Riviere l'Acul up to the southwestern margin of the Plain of Formon at Les Platons. This is a picturesque area where there is a fortification (Citadelle Des Platons) and splendid views of the eastern Massif de la Hotte (ridges of Pic Formon). The trip from Les Cayes to Les Platons is 33 kilometers and takes about two hours to drive.

From Les Platons, there is a very rough jeep trail to the market town of Sous Bois. Beyond Sous Bois, the route passes through the extensive karst hills that are still forest covered and which are known locally as "Bwa Formon." The road

The famous ornithologist John James Audubon was born near the city of Les Cayes on April 26, 1785. His father was a French naval officer and planter.

finally passes out onto the flat, fertile Plain of Formon at "Portal Formon," a collection of houses and large fields in a region designated on the map (Edition 2-AMS, Sheet 5370-1, 1:50,000) as Nan Seille. Nobody in the region currently recognizes the name Nan Seille, and all use the name Formon or Portal Formon. The route from Les Platons is ten kilometers long. At "Portal Formon," the visitor looks northward to see Morne Cavalier and Pic Le Ciel to the west of the ridge of Formon orientated in an east-west direction.

The MBR project road extends westward across the plain of Formon and the Plain of Durand to the small cluster of houses at the MBR Project Headquarters overlooking the Plain of Durand adjacent to the rich forest of "Bwa Durand".

From "Portal Formon" or the MBR Project Headquarters, two trails can be used to pass into the interior of the national park and MBR. The first trail passes directly northward and ascends the ridge of Formon via a series of gardens known as "Kay Ogile" until it passes over the top of the Massif de la Hotte at 1,850 meters elevation. The trail then descends into the "Gran Ravin" to a settlement of gardens known as "Deglacis." The area at "Deglacis" is 1,030 meters in elevation, and is located beside the Riviere Ravine du Sud in the bottom of the "Gran Ravin".

The second trail passes northeast across the upper Plain of Formon and through a karst zone to the Plain of Deron. On the Plain of Deron is a region of sinkholes, ponds and streams. The karst hills south of the Plain of Deron are known as "Bwa Deron." All of this area should be in the park. The trail then ascends a ridge east of Morne Cavalier to the crest of the mountain at 2,000 meters elevation. At this point, three routes are possible: a) a newly-cut trail that follows the ridge to the east to intersect the first trail at 1,800 meters elevation; b) the old trail which passes northward and descends into the upper "Gran Ravin" where it eventually joins the dry streambed of the Riviere Ravine du Sud at 1,550 meters elevation; c) a newly-cut trail that cuts off to the west of the trail and ascends the ridge of Formon. The trail to the west passes across one peak (called by local woodsmen "Le Ciel"). The top of Pic Le Ciel is somewhat cleared, and a magnificent view of Pic Macaya is possible from there by climbing a low pine tree in the clearing. This area serves as an excellent camp site. The trail continues on from this 2,170 meter peak across a narrow ridge to 2,219 meter Pic Formon which is covered with broadleaved forest capped with a few towering pines. The trail then descends northward along the ridge that connects Pic Formon with Pic Macaya. This connecting ridge is known locally as "Palencont." After passing over a small well forested peak at 1,919 meters in the center of the ridge which we designate as "Tete Ravine," the trail steeply ascends the south ridge (shoulder) of Pic Macaya. This trail passes near rocky ledges in places and is quite dangerous and steep. The trail eventually levels off at the shoulder below the summit (2,200 meters) before steeply climbing to the summit. A camp has been cleared near the summit of Macaya at 2,335 meters. The summit is 50 meters west of the camp site at 2347 meters, and is marked by chunks of cement (probably part of the old benchmark) wedged into the stump of a fallen pine.

There is a campsite on the top of Pic Macaya at 2,335 meters elevation in the magnificent pine forest. Many of the rare species of birds discussed in Chapter IV can be seen in the surrounding vegetation. Black-capped Petrels nest on nearby cliffs during winter months.

This is the only practical route to take into the park, although it is possible to hike into the park from the east via the towns of Duchity or Beaumont. However, the route crosses steep ravines, and the trail to the summit of Pic Macaya has not been cleared. It is currently possible to travel only as far as "Sapoti," a clearing at 1,216 meters two kilometers north of Pic Macaya. The northern route, therefore, is not suitable as the primary access to the national park even though this is the historical route of access to Macaya that was followed by Alexander Wetmore and and P. J. Darlington (see chapter II on the History of the Macaya Area). This could change in the next few years as a new road is completed from the town of Duchity towards the north side of Pic Macaya. A road also has been completed from Port-a-Piment to the western side of Pic Macaya. This road makes it possible

to reach the Riviere Trois Sources. From there a trail follows the river to its source near the saddle between Pic Macaya and Pic Formon. Another trial ascends the west side of Pic Macaya to just below the summit. These trails and the habitats of the region are described in great detail in Chapter II.

Terminology used in Natural History of Haiti

Many organizations, individuals and terms are used in this book. We are providing a list of the major terms used. When a name for an institution or organization is used for the first time in the text it is spelled out completely, but thereafter usually the acronym is used.

COSAR Cooperative de Saint Andre de Rendel

DMRE Departement des Mines et des Ressources Energetiques

FLMNH Florida Museum of Natural History

GOH Government of Haiti

ISPAN Institut de Sauvegarde du Patrimoine National

IUCN International Union for the Conservation of Nature and Natural Resources

MBRP Macaya Biosphere Reserve Project of the University of Florida

MBR Macaya Biosphere Reserve

MARNDR Ministere de l'Agriculture, des Ressources Naturelles et du Developpement Rural; sometimes known as Damien.

SPE Service de Protection de l'Environmentf

Parcs Haiti Parcs Nationaux Naturels d'Haiti

SAHPE Societe Audubon d'Haiti pour la Protection de l'-Environnement

USAID Unites States Agency for International Development

UNEP United Nations Environment Program

UNESCO United Nations Educational, Scientific and Cultural Organizations

WBP World Bank Project

WCS World Conservation Strategy

WWF World Wildlife Fund

The following words are used in the text of this report without definition. We provide a brief definition of each below.

Biotic diversity

The desired condition of having the greatest number of compatible species associations in a natural area. The goal of our stewardship plan is to increase species diversity in the parks, not just to increase the numbers of a few selected species.

Conservation

The practices and/or customs of man that permit the perpetuation and sustained yield of renewable resources and the prevention of waste of non-renewable resources.

Edaphic factor

A condition or characteristics of the soil (physical, chemical or biological) which influences organisms.

Endangered species

Species in danger of extinction and whose survival is unlikely if the causal factors continue operating.

Endemic species

A species confined to the island of Hispaniola, or to a region of Hispaniola when so designated.

Migratory species

Species that regularly move beyond their regularly occupied geographic location, and in the sense of this study, species that seasonally depart Hispaniola.

Preservation

The practice of totally protecting a species or habitat from any exploitation.

Solenodon paradoxus

This "living fossil" is one of the most endangered species in Haiti.

Rare Species

Species with small populations, usually localized within restricted geographical areas or habitats, that are at risk.

Resident Species

Species that do not migrate.

Restoration

The act of putting the ecosystems or a specific unit of the ecosystem (local habitat) back into prior (more natural) conditions. The activity is one element of a stewardship plan.

Stewardship

The act of working with all aspects of a natural ecosystem so as to promote and protect its natural integrity. The word has been chosen to contrast to "term management," which we believe implies an active state of manipulation and "tinkering." Stewardship in its ideal sense can be passive and allow the ecosystem to recover and maintain itself without extensive manipulation. Some restoration activities are part of the process of stewardship.

Threatened Species

Species likely to become endangered in the near future it the causal factors continue operating.

Names in Haitian Creole

Whenever possible the names for regions and conditions have been designated in Haitian Creole. The standard spelling and usage follows Valdman (1981). We have done our best to check the designations and authenticity of all Creole names with local authorities on a particular region or subject.

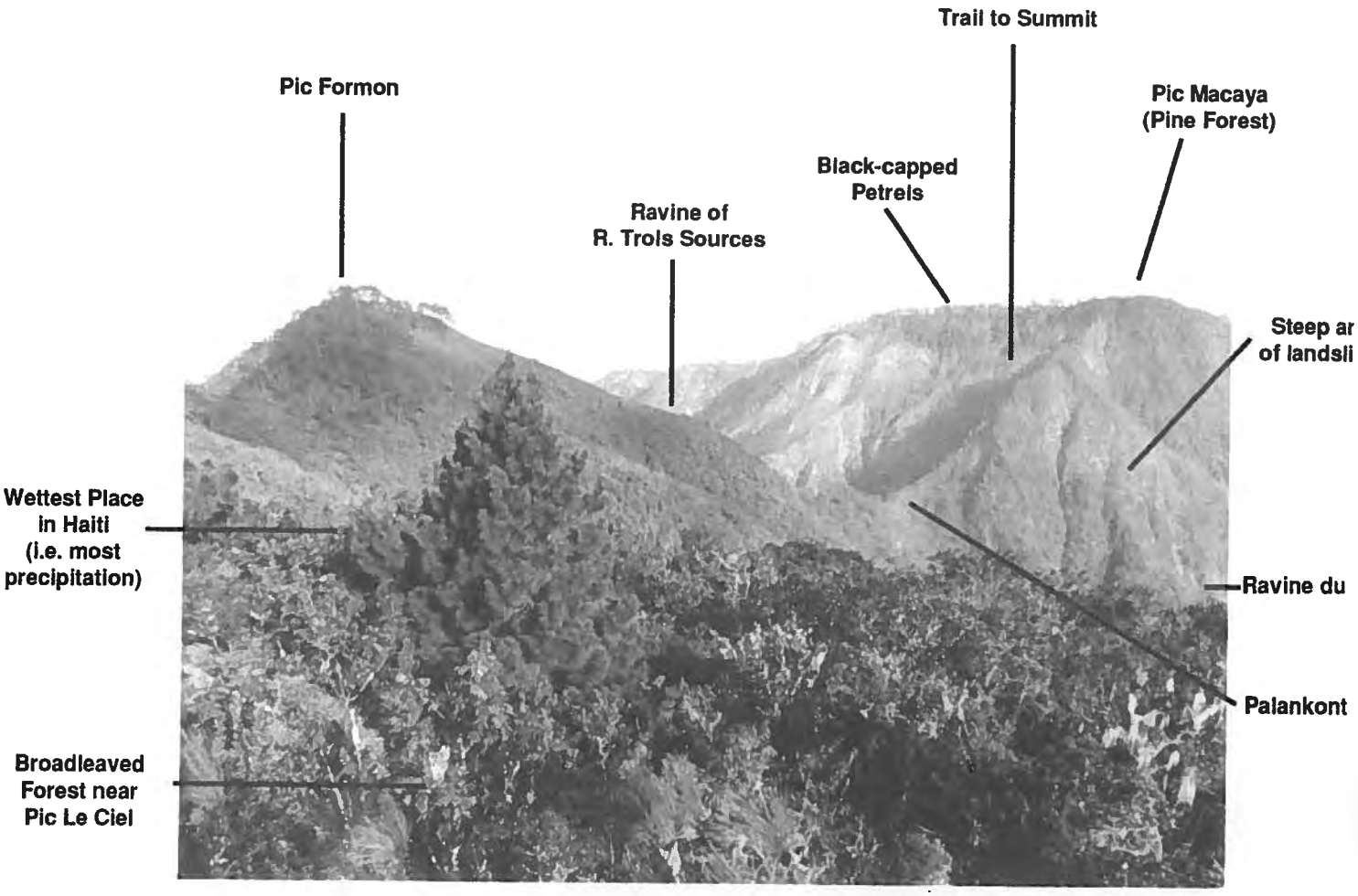
The Literature of Natural History in Haiti

There is a very sparse literature on the natural history of the Macaya area. The literature of natural history of Haiti is reviewed by Woods and Sergile in *Haiti, A Research Handbook* by Robert Lawless (1990). This book is available in most libraries. Another really fine review of the early literature related to the natural history of Haiti can be found in the volumes by David Wetherbee. Two of these volumes, *Zoological Exploration of Haiti for Endemic Species* (1985) and *Contributions to the Early History of Botany in Hispaniola and Puerto Rico* (1985) are useful summaries. The bibliography at the end of this volume lists other publications on Hispaniola by David Wetherbee. These volumes are not generally available because they were privately published in very limited numbers via xerox. A complete set of David Wetherbee's publications is available at the FLMNH, and several other major museums and libraries including the Museum of Comparative Zoology at Harvard University.

The first early description of the flora and fauna of the countryside surrounding Pic Macaya is in the work of Moreau de Saint-Mery (1797). These three volumes provide comprehensive descriptions of life in Haiti in the late 18th Century, including discussions of encounters with some animals such as the Haitian Hutia or "Zagouti." The best early accounts of the natural history of Macaya are the published works of Erik Ekman. His two papers "Botanizing in Haiti" (1926) and "Botanical Excursion in La Hotte, Haiti" (1928) are classic descriptions of the early part of this century in the Macaya region. Ekman was such a famous personality of the time that he figures largely in the Haitian classic *The Magic Island* by Seabrook (1929). Other fine descriptions of the Macaya area are found in the book by Alexander Wetmore and Bradshaw Swales (1931) *The Birds of Haiti and the Dominican Republic*, and its supplemental small publication by Wetmore and Frederick Lincoln (1933) "Additional Notes on the Birds of Haiti and the Dominican Republic." The introductions to these volumes include valuable historical summaries and itineraries of their travels in the Macaya region, and include photographs of the habitat and area. Philip Darlington's (1935) account of climbing Pic Macaya is also one of the best early descriptions of the area and its natural history.

There are many books about the history and culture of Haiti, but very few on the natural history of Haiti. One of the best early accounts is by Moreau de Saint-Méry.

There are few good modern treatments of the flora and fauna of Macaya. Walter Judd's (1987) "Floristic Study of Morne la Visite and Pic Macaya National Parks, Haiti" includes fine descriptions of the botany of the park and surrounding buffer zone (now the MBR), as well as valuable photographs. And the series of reports on the USAID/FLMNH Biogeophysical Surveys are important summaries of ecological conditions in the area as of 1986 (see Franz and Cordier, Gali and Schwartz, Judd, MacFadden, Thompson, Woods, Woods and Harris, and Woods and Ottenwalder). The groups that are best documented from the Macaya area are the reptiles and amphibians. References on these two groups, as well as other publications on all aspects of natural resources in Haiti can be found in the review by Woods and Sergile (1990), and in the fourth volume of this series (The Natural Resource Data Base). All available references on the flora and fauna of Haiti are listed in the FLMNH data base, which is also available on computer disks at the FLMNH on the library bibliographic system Procite. The compilation of the Haitian Natural Resource Data Base was part of the USAID/MBR project. As part of completion of the USAID\UFMBR project we will make this program and system available in Haiti.



Interior View of Parc National Pic Macaya
1986

CHAPTER I

The Natural History of Haiti; Is there one?

Introduction

We all have come to know much about Haiti in the last few decades (i.e., 1957 on), and of course during the last few months it has been constantly in the news. It all paints a pretty grim picture. And the recent cascade of books and major magazine pieces on Haiti fall into the same pattern. A review of the literature over the past decade indicates many books on the politics and political history of Haiti, but almost nothing on the natural resources of the country, or about its rich natural patrimony. A review of just a few of the more recent of these books and magazine articles is presented below.

The natural history of Haiti as discussed in most books dwells on the fantastic and mysterious rather than the factual.

Edward Barns. 1992. Exodus from Haiti. April 1992 issue of Life Magazine. The article includes the following message.

> "It was once a paradise where wild grapefruit swelled so full of juice that they split at the touch, and a fisherman could land a catch as large as the canoe he gouged from a log. For almost two centuries after the slave revolt that brought independence from the French, the isolated village of Petit-Trou-de-Nippes avoided the bloody conflicts that raged in Port-au-Prince, Haiti's capital city 73 miles away. But with the overthrow of dictator Baby Doc Duvalier in 1986, all of Haiti was swept into a political and economic maelstrom. Even in Petit-Trou paradise was lost."

"The trees were cut to make charcoal to sell for cash. Without the trees, rains washed away the soil, and silt emptied into the once clear Caribbean, killing fish and leaving fields barren. On market day women tried to sell a few pieces of fruit or a couple of dried fish. Families could afford only three meals a week; there was no money. Hospital beds were empty; there was no medicine. The broken church bell lay on the front steps; there was no faith that a better day was coming."

Kenneth Roth. 1992. Haiti Deserted. A magazine article in the journal, The Nation.

Ian Katz. 1992. Bananas Republic, Haiti's Deadly Struggle with Itself. A magazine article in GQ.

Ian Thomson. 1992. Bonjour Blanc. A scathing book about all that does not work, and can't be fixed in Haiti.

Herbert Gold 1991. *The Best Nightmare on Earth.*

Mark Danner. 11 August 1991. New York Times book review of Gold's book (really a review of Haiti).

Amy Wilentz. 1989. *The Rainy Season*. A long and thoughtful book with a few comments on the destruction of natural resources.

Richard Holwill. 7 August 1989. "Insight" review of Wilentz's book (review entitled "A Place That Gets Under Your Skin," and also a review of conditions in Haiti).

David Gates. 1989. Review (in Newsweek) entitled "Years of Living Dangerously: A report from the hellhole of the hemisphere." It, too, is more a review of Haiti than a simple review of Amy Wilentz's book.

T. D. Allman. 1989. After Baby Doc. A magazine article in Vanity Fair Magazine.

When we first started working in Haiti, the message on the license plates of the cars proudly proclaimed, "Haiti Perle des Antilles." Few people inside or outside of Haiti feel that way about the country today.

Elizabeth Abbott. 1988. *Haiti, The Duvaliers and their Legacy.*

Bob Shacochis. 1988. An Island Between Seasons, the task of reimaging Haiti. A magazine article in the February issue of Harpers Magazine.

Mark Danner. 1989. Beyond the Mountains. A serialized set of three articles in the New Yorker Magazine on Haiti (Nov. 27, Dec. 4, Dec. 11, 1989).

Charles Cobb. 1987. Haiti: Against All Odds. An unflattering article in Natural History Magazine.

James Ferguson. 1987. *Pappa Doc, Baby Doc, Haiti and the Duvaliers.*

Wade Davis. 1985. *The Serpent and the Rainbow.* A book than inspired a popular (but awful) movie of the same title.

Of the few articles appearing in the last few years that address environmental conditions in Haiti, or focus on the natural resources of the country, the following are representative.

Mark Kurlansky. 1988. Haiti's Environment Teeters on the Edge. An article in the March-April issue of the magazine International Wildlife, suggesting that deforestation has plunged Haiti perilously close to ecological collapse.

Richard Pellek and Peter Talbot. 1988. Misperceptions of deforestation in Haiti: Problems of available data and methodology. An article in the journal Ambio.

and

Bernard Diederich and J. F. O. McAllister. 1992. Bad to Worse. An article in the February 10th issue of Time Magazine suggesting that the political and economic crises are increasing the rate of deforestation and habitat destruction in Haiti, with potentially disastrous consequences for the future of the country. (See sidebar.)

These articles and books portray such a depressing picture of Haiti that many people who know and love Haiti are shellshocked. Charles Woods was sitting at the Jacmelien Hotel in Jacmel in December of 1990, discussing Haiti. When the conversation turned to some of the new books that have been written about Haiti, he mentioned that he was working on a book. The people at the table were stunned and their mannerisms turn cold and abrupt. "Oh no, not another book on Haiti," one person replied. It was only when he mentioned that his book was on the natural history of Haiti (*Pearle of the Antilles, the Natural History of Haiti*) that the conversation lightened up and turned friendly again. For his colleagues at the table, every new book or magazine article about Haiti is somehow dreaded. For those interested in tourism or economic development, such articles are viewed as new nails in Haiti's coffin.

Can Haiti ever recover from the avalanche of bad news, bad times, and bad self esteem? All of these publications, and many more dating all the way back to Seabrook's 1929 book *The Magic Island*, and Richard Loederer's famous book *Voodoo Fire in Haiti*, paint Haiti out to be the same:

Exotic;

Different from every place else in the Caribbean;

Crawling with people;

Steeped in history, but without any "natural history";

Full of people with no sense of how to govern themselves;

Lacking all institutions;

and the most widespread impression of all,

Haiti is an environmental disaster area.

The extent to which this attitude of gloom and doom is widely accepted is vividly demonstrated in a conversation we had with an administrator from an international funding agency. We were describing the importance and uniqueness of the Pic Macaya area, and were saying that it appears that a new, living species of *Solenodon* many still survive in the area. This species of living fossil would be endemic to the Macaya area. We were stressing the importance of this living fossil, and explaining why southwestern Haiti has so many endemic species found nowhere else in the country. One explanation that we mentioned was that southwest Haiti was a separate island for much of its history, and only came to be attached to the rest of Haiti in the last few million years (perhaps nine million years ago). This explains the large number of endemic plants and animals found in the Pic Macaya area, and nowhere else in the world. The administrator's comment was:

"The environment has taken such a brutal beating that Haiti may already have mortgaged its future. To make up for the dearth of propane gas and kerosene, peasants have slashed away at trees, even mangoes, windbreaks and the mahoganies that shade the coffee crop. Thus, even in the unlikely event that Haitians settle their political differences soon, they will be living in the unrelieved glare of the current crisis for a long time to come."

Time Magazine,
10 February 1992

"**It was it's misfortune to get attached to Haiti**," referring to the newly discovered species of *Solenodon*.

That comment says everything to us, because:

1). **IT IS TRUE.** Imagine the difference if the Tiburon Peninsula (including Les Cayes, the birthplace of Audubon) had remained an independent island, or if it had become attached to Jamaica or Cuba instead). For example, 88% of all known land mammals in Haiti are now extinct (only three still survive), while in Cuba, only 76% of the same kinds of mammals have become extinct (at least nine still survive).

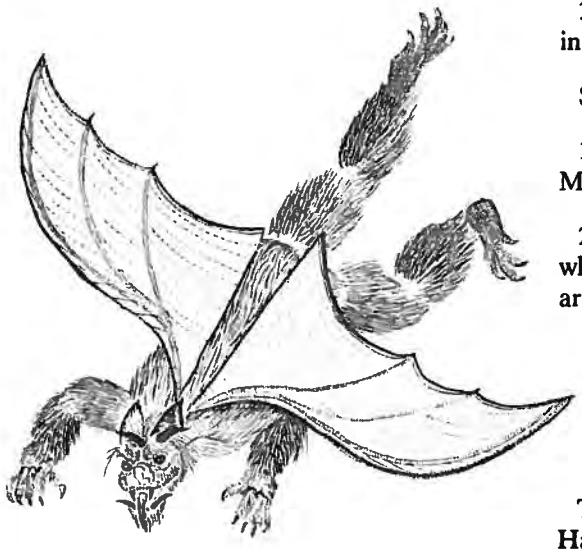
2). **IT SUMMARIZES PERFECTLY THE PERCEPTION**, even at the level of policy makers and international grant administrators, that Haiti is a lost cause (at least ecologically--which we means totally).

3). At the same time, **IT IS TOTALLY FALSE**, as we hope that this volume will indicate.

So the purpose of this volume, is to try to come to grips with these contrasts by:

1). Describing what is unique and special about Haiti, and especially the Pic Macaya area.

2). Concluding with our thoughts on the future of conservation in Haiti, and what can be done (if anything) to replace the perception of an ecological disaster area with the reality of wise management of fragile renewable natural resources.



The Loup-garou is one "beast" of the Haitian hills that is only in the imagination.

What is Special about Haiti?

The closest published account of something special about the natural history of Haiti among the articles and books listed above is Amy Wilentz's melancholy book, which has a chapter entitled "The Beast of the Haitian Hills." But this is a tale of destruction and despair, not of endemics. The beast turns out to be, in Wilentz's view, a "Cigouave," a beast that lives in a cave, and is "half man, half ferocious, night-prowling devil-dog." (Walentz, 1989:202).

Walentz took her ideas from a famous little 1946 book by Philippe Thoby-Marcelin and Pierre Marcelin entitled *La Bete de Musseau* (translated into English as *The Beast of the Haitian Hills* in 1951 by Peter Rhodes). Walentz's analysis epitomizes what is wrong with the body of knowledge about Haiti:

It is wrong;

It is sensational;

It is destructive and ends disastrously;

It is based on misinterpreted facts.

The beast of the Haitian hills is described by Wilentz, and indeed implied by the Marcelin brothers, to be a Cigouave. In fact it is not. What they are describing is a much better-known mythical, and indeed ferocious, beast that is well known in the Haitian countryside as the "loup-garou" (= werewolf). The two get confused and mixed together in both books.

In reality, the Cigouave, known in the Dominican Republic as a "Ciguapa" is a very different creature that may indeed be based on reality. It is a man-like (or more accurately, woman-like) creature that in mythology is supposed to be an Indian maiden who has long flowing hair over her front, and walks backwards to protect her modesty and hide her body from view.

The creature in the myth of the Cigouave is not the flame-red, ferocious loup-garou, which is the werewolf of legends. It is the last echo of stories told by Indians of animals seen by their ancestors when they first arrived on Hispaniola (somewhere between two and six thousand years ago, that date is hotly debated). The beasts were sloths; large, lumbering, hairy, ground sloths.

These mammals were found all though South America, where the group appears to have originated, and then spread to North America across open water before the land bridge connecting North and South America formed. They are good over-water dispersers, and they got to Cuba, Hispaniola, and Puerto Rico 10-30 million years. In Hispaniola they became very diverse, and radiated into at least six different species.

So did other mammals that got there, as did a variety of birds, reptiles, amphibians, fishes, and orchids. These adaptive radiations, many of which produced species that are found only in the Pic Macaya area, are all discussed in a 1989 book entitled *The Biogeography of the West Indies* (Woods, 1989).

The story of the endemic plants and animals of the West Indies is a fabulous story. One of the most interesting things to come out of the story is that "Haiti" is the most taxonomically diverse island of the West Indies. The most diverse part of the island is the area of Haiti itself. And the most taxonomically diverse part in all of Haiti is the Tiburon Peninsula, especially the area immediately surrounding Pic Macaya.

The stories of a few of these groups will be told in some detail in this volume. The stories are being presented to give planners in the areas of conservation and the management of natural resources data and information to use in the development of wise land use policies. We hope that the information can also be used to educate people in Haiti as to how important the natural patrimony of their country really is. However, a brief overview of some of this information is presented here to help answer the question posed above: is there a natural history of Haiti?

The West Indian manatee is one of the most endangered mammals of Haiti. It should be protected by the creation of a new national park at the delta of the Riviere Artibonite around the Baie de la Tortue and Baie de Grand Pierre.

Mammals

There are 26 known species of "terrestrial" mammals in Haiti, all of which are native only to the island of Hispaniola. This number excludes marine mammals such as the manatee (Lamatin), the monk seal (probably now extinct anyhow), and porpoises and whales. It also excludes the volant mammals (i.e., bats), of which there are 16 known extant species (we are describing a few new ones based on fossils collected in the Macaya area). Of these 26 known terrestrial mammals, all but three are now extinct. These facts can be viewed two ways. 1) Why have 88% of Haiti's terrestrial mammals become extinct? or perhaps more to the point, 2) What has allowed 12% of Haiti's terrestrial mammals to survive (i.e., what is the 12% solution)? These answers to these questions are discussed in detail in Chapter V.

What were the mammals of Haiti?

Taxon	# Species	% Total	# Surviving	% Lost
RODENTS	12	46	1	92
INSECTIVORES	6	23	2	67
SLOTHS	6	23	0	100
PRIMATES	2	8	0	100
Total	26	100	3	88

What did these creatures look like?

The Native Rodents

The 12 known rodents of Haiti ranged from the size of a pig (*Quemisia* with an estimated body weight of 15 kg) to that of a rat (*Brotomys* with an estimated body weight of 300 gr). These were all closely related to one another, and possibly the result of an adaptive radiation from a single invader to Hispaniola 20 to 30 million years ago. At most there may have been two invasions. The rodents all appear to have "dispersed" to Hispaniola over the sea, probably via a raft of vegetation that floated out to sea from the mouth of a large river system south and east of Hispaniola on the mainland of South America. These rafts could have been swept along by the prevailing ocean currents towards the main island (Proto-Hispaniola, which looked quite different from present-day Hispaniola), or a series of smaller islands that might have served as "stepping stones" towards Proto-Hispaniola.

At least one genus and species of native rodent was endemic to only the Pic Macaya area of Haiti.

The endemic rodents of Haiti ranged in body size from 300 grams to 15 kilograms.

La Hotte "Zagouti"

This small mammal was about the same size as the present day "Zagouti." It probably became extinct within the past 500 years, although it may have survived into more recent times. It was a forest-dwelling rodent. No other species of rodent in the Greater Antilles has such a restricted distribution. The La Hotte Zagouti was truly an animal of the Macaya area. This rodent is one of the most important mammals of the West Indies, even though it is now extinct. It appears to be a missing link between several of the subfamilies of West Indian rodents.

The "Island Shrews"

The "island shrews" are small mammals with long snouts. They resembled shrews from North America in size and body shape, but they are members of a very special and ancient group of insectivores. There were three species in Haiti, and all are now extinct. They ranged in size from a small shrew (20 grams), to a small rat (100 grams). Live examples of these creatures have never been captured anywhere in the Greater Antilles, although we have interviewed people who may

have seen them alive. These modern-day relicts of an ancient group probably became extinct in Haiti sometime in the present century (after 1930) based on evidence from decomposed, but recent-looking owl pellets collected in the mountains of the Massif la Selle and the nearby Cordillera Central of the Dominican Republic. In Haitian Creole there is no local common name for these small mammals, and they are almost unknown in the county.

The "Living Fossils," or Solenodons

These are similar in shape to island shrews, but are larger. They are called "Solenodons," and there are three known species in Haiti. They are very primitive, and probably are closely related to a long-extinct family of insectivores from North America. The local name in Haiti for this species is usually the same as for the native rodent, the "Zagouti." However, some people in the countryside where Solenodons are especially common, such as the area around Parc National Pic Macaya, will call the animals by the name "Nez Long." The common name we have selected for the new species of Solenodon that is endemic only to the Macaya area is:

Nez Long Macaya

This new species, which is presently being described, is the second mammal species known to be endemic only to the Macaya area. The Nez Long Macaya and the La Hotte Hutia are remarkable indications of how important the Macaya area is. No place else in the West Indies has so many endemic mammals restricted to such a limited geographical area.

The Giant Sloths of Haiti

These large, lumbering sloth-like mammals are related to the large ground sloths of North America. During the last several million years of Haitian history, these mammals became quite diverse. Some were small and tree-sloth like. Some were large and heavy-bodied (bear-sized). This group also appears to have at least one species that is found only in the Pic Macaya area, but we are still working on the fossil remains of what might turn out to be the La Hotte Ground Sloth. These fossils were collected in deep sinkholes on the Plain of Formon at the edge of Parc National Pic Macaya.

The first Amerindians that arrived on Haiti found many giant mammals living in the open savannas or toward old growth forests. These species evolved in the absence of carnovires and were easily hunted.

The Haitian Monkey

There was at least one species of native monkey living in Haiti. So far we have only found the fossil remains of these monkeys from two places in Haiti. Some fossils of monkeys have been collected along the high, well-forested ridge of La Visite/La Selle at about 2,000 meters where the forest is (and probably was) mostly pines. Because monkeys are rare there, which is in the area of Parc National La Visite, we believe that they were never very common in the pine forests of Haiti. Monkey fossils have also been collected from around the base of Pic Macaya/Pic Formon at about 1,000 meters elevation where there was a dense broadleaved forest. Such broadleaved forests were probably the prime habitat of the Haitian Monkey.

Overview of Mammal History in Haiti

The original endemic terrestrial mammal fauna of Haiti was composed of an unusually large number of very large mammals, which follows the predictions of Island Biology theory. Between 7,000 and 5,00 years ago, Paleoindians (Guanahatabeys) and Taino Indians killed off almost all large mammals of Haiti by overhunting. These large mammals (megamammals) occupied ecological niches that were filled about 500 years ago (1492) by introduced domestic mammals such as cattle, goats, sheep, and pigs. These domestic animals quickly became feral, and were used for food by colonists and the early buccanneers. The presence of these feral domestic mammals, especially wild pigs and cattle, took hunting pressure off of the remaining large mammal (a rodent), and the small and medium-sized mammals of Haiti. Small and medium-sized mammals were more or less stable in status during the colonial period and the early years of the Haitian Republic.

"Ecological chaos" began about 100 years ago (1900). As a consequence of the land reforms of Petion in the early 19th Century which broke large land holdings into small farms, habitat destruction reached critical levels as the average size of farms became smaller and smaller. Ecological chaos was also caused by the introduction of the mongoose, which was introduced into Haiti to control snakes in sugar cane fields. Rats increased in numbers to finally saturate most habitats, and have recently spread to remote districts as a consequence of continuing fragmentation of the natural forest. Cats and dogs became significant predators on the remaining small mammals because of the spread of humans into remote areas as a further consequence of land fragmentation, and of population increase. All of the above events and phenomena resulted in the loss of all endemic small terrestrial mammals of Haiti, with the replacement of the natural mammalian community with rats and mice everywhere. The few surviving native mammals of Haiti all live in the area of the ancient "South Island" (the Tiburon Peninsula) which became attached to the rest of the country several million years ago. This ancient island was once a low, coral island like many islands of the Bahamas are today. As a result, southern Haiti has an abundance of rock crevices and highly karstic habitats. These habitats provide places for the Zagouti and Nez Long to hide from predators and people, and are areas where the forest cover has been less disturbed for gardens and villages.

The last 100 years are characterized by "ecological chaos" which led to the second great wave of extinction of native species.

Birds

A complete list of the resident bird species of Haiti is presented in Chapter IV. In spite of Haiti being a small country, there are strong regional differences in the Haiti's avifauna. For example, there are fewer resident bird species in the Macaya area of western Haiti because of the absence of five endemics that do not occur west of the Jacmel-Fauche depression ("Bond's line," named after the famous American ornithologist James Bond). These "missing" species include the Black-crowned Palm Tanager, Ground Warbler, Hispaniolan Parakeet, Palm Crow and La Selle Thrush. The pattern of isolation observed in birds of Parc Macaya may be the result of ecological conditions rather than the geographical remoteness of the area. Indeed, Pic Macaya in the Massif de la Hotte is not very far from the Massif de la Selle, since the mesic broadleaved forest of Morne D'Enfer is only 175 kilometers from a similar forest on the ridge of Pic Macaya. But the Black-crowned Palm Tanager, Ground Warbler and La Selle Thrush, all three of which are closely associated with mesic broadleaved forest, remain isolated in the Massif de la Selle east of Bond's line.

The White-winged Crossbill and Antillean Siskin, on the other hand, have showed up in the Macaya region for the first time during the course of this study, indicating that these species have greater powers of dispersal. These birds are associated with open areas and mature pines. The expansion of their range into Parc National Pic Macaya may be the result of increased destruction of the mesic forest in the Macaya region. These habitat changes have been documented by Cohen (1984). The loss of the mesic forest in upland areas is often followed by rapid regeneration of pines, making the area more suitable for species such as the crossbill and siskin. Large flocks of crossbills were present from 1982 through the last of our bird surveys in November, 1989.

The dispersal of "Haitian" species onto the Tiburon Peninsula is not complete, however, since Hispaniolan Parakeets and Palm Crows, two other species that do well in the open pine habitats of La Visite have not yet spread to Macaya. Should these two species spread into the Macaya region, it would be a further indication that Macaya has been isolated by its abundant rainfall and rich, dense mesic forest. Therefore, the appearance of crossbills and siskins in the Macaya area, which at first thought would seem to be a good sign since the species are important Antillean endemics, might instead be a consequence of the destruction of the rich mesic broadleaved forest that covered the region until the last two decades (Cohen, 1984).

The list of resident birds of Haiti is swelled by the addition of migrant species that arrive in late September and stay until April. This brings the total number of species found in the Macaya region to 65; two less species than found in Parc National La Visite. During the winter census period on La Visite, an average of 242 birds were seen per day. Some mixed flocks of north American migrants (mostly Yellow-rumped Warblers, Palm Warblers and Cape May Warblers) number over 300 individual birds. Haiti, and especially the montane forests of the national parks at Pic Macaya and Morne la Visite, therefore are important refuges for many species of migratory song birds.

The presence of breeding Black-capped Petrels on the south face of Pic Macaya is also an important new observation. The small colony of petrels on Macaya was discovered for the first time in January, 1984, and surveyed in detail in January, 1985, and January, 1989. An additional colony may exist on the northwest face of Pic Formon. The only other known breeding colonies of Black-capped Petrels in Hispaniola are in the area of Parc National La Visite, and just across the border from Haiti in the Dominican Republic. The presence of Black-capped Petrels in Parc Macaya adds special significance to the park since the species has been eliminated from most islands in the Antilles. The birds are nesting in burrows at about 2,200 meters elevation at the transition zone between wet broadleaved forest and scrubby secondary growth.

The discovery of the breeding colony of Black-capped Petrels on Pic Macaya is one of the most important biological discoveries of the Macaya Biosphere Reserve Project.

Amphibians

Amphibians have sensitive skin, and usually breed in or near water, or in very mesic situations, such as in patches of sphagnum moss or in the small basins formed by leaves of bromeliads (epiphytes). As a consequence, many species are restricted to areas of higher rainfall, or to well-forested (and frequently high elevation) areas. There are many endemic species in Haiti. Some of the species endemic to the Macaya area are listed below.

One example is the genus *Eleutherodactylus*. These are small frogs.

Eleutherodactylus wetmorei	Haiti
Eleutherodactylus semipalmatus	So. Haiti
Eleutherodactylus ventrilineatus	Macaya
Eleutherodactylus thorectes	Macaya
Eleutherodactylus sciagraphus	Macaya
Eleutherodactylus parapelates	Macaya
Eleutherodactylus lamprotes	Macaya
Eleutherodactylus glandulifer	Macaya
Eleutherodactylus eunaster	Macaya
Eleutherodactylus counouspeus	SW Haiti
Eleutherodactylus chlorophenax	La Hotte
Eleutherodactylus brevirostris	La Hotte
Eleutherodactylus bakeri	La Hotte
Eleutherodactylus apostates	La Hotte
Eleutherodactylus amadeus	Macaya
Eleutherodactylus corona	Macaya
Eleutherodactylus dolomedes	Macaya

There are 126 know species of *Eleutherodactylus* in West Indies. Of these, 54 are known to occur in Hispaniola. So, 43% of species of the genus are endemic to Hispaniola.

There are 15 species of *Eleutherodactylus* that are endemic to the Macaya area. So, 12% of all *Eleutherodactylus* are endemic to the la Hotte area of SW Haiti. That is an amazing indication of the importance of Macaya. Twenty-five percent of Hispaniolan species of *Eleutherodactylus* are endemic only to the la Hotte area of southwest Haiti.

The Orchids

One of the most remarkable examples of the abundant natural history of Haiti is illustrated by the abundance of orchids, especially in the area of the national park at Pic Macaya. The information on this group has been documented by Donald Dod, who has worked in Hispaniola for many years, and collected orchids in southwestern Haiti in 1982, 1983, 1984, 1990, and 1992 as part of the UF MBR project. Few other groups of plants or animals point out more clearly how interesting the natural history of Haiti is, and how important the special the high mountain areas of the country are. Unlike most animals, which have some ability to move from one place to another as habitats are disrupted, orchids live very sedentary lives. They are usually found growing on mature trees in old growth forests. Since there are more old growth forests in the Pic Macaya area than most

other regions of Haiti, we expected that there would be an abundance of orchids in the region. What Donald Dod found, however, far exceeded all of our expectations.

There are at least 133 species in 42 genera of orchids in the forests in and around Parc National Pic Macaya. Of these, at least 29 are endemic to the Massif de la Hotte (often to the park area itself) and over 58 are endemic to Hispaniola. The most important habitats for orchids are the mesic broadleaved forests of the karst hills along the edge of the Plain of Formon between 950-1,150 meters elevation, and the few remaining patches of old-growth forest east of Pic Macaya. Many of the orchids are small and inconspicuous, and some grow high on the branches of mature forest trees. Sadly, some of the best collecting sites Donald Dod found were at locations where the forests were being cut down.

The diversity of orchids in Parc National Pic Macaya is truly phenomenal. The presence of over 133 species of 42 genera in an area of less than ten square kilometers is extraordinary, especially when it is realized that Hispaniola has 337 orchids recorded for the entire island. This means that almost 40% of all the orchids of the island occur in Parc Macaya. Almost all of these occur in the broadleaved forests surrounding the high peaks. These forests are often growing on small hills or exposed blocks of hard limestone (karst), and in regions that have been considered unsuitable in the past for agriculture. It may have been the rugged limestone topography that protected these forests, and led to the great diversity of orchids. Similar old-growth forests on the high ridges of Pic Macaya and Pic Formon have many fewer orchid species growing in them, possibly because they have occasionally been destroyed by the forest fires that sweep across the mountain ridges.

The Pic Macaya Project

The University of Florida has been working with USAID, ISPAN and MARNDR to promote the conservation of the natural resources of Haiti for over 15 years. This work has resulted in a number of scientific publications and reports documenting the unique natural patrimony of Haiti, and has pointed out the special nature of the Massif de la Hotte. One result of this work has been the creation of the national park located in the Massif de la Hotte. Parc National Pic Macaya is part of the official list of National Parks of Haiti.

The Government of Haiti (GOH) in the past has taken a legislative role to protect some of the unique aspects of its natural history. The law of 17 August 1955 regulated cutting, transporting and selling wood, protected the environment and created "Zones sous protection" and "Zones reservees." In 1962, even stricter legislation was passed concerning the protection of forest resources and activities in forest reserves. In 1971, a law was passed regulating hunting and protecting nine categories of birds in accordance with the recommendations of the "Convention pour la Protection de la Nature et la Preservation de la Faune Sauvage dans l'hemisphere occidentale," which Haiti ratified.

Haiti has also been active in the area of setting aside protected areas. The decree of 1968 created "Parcs Nationaux" and "Sites Naturels" under the joint administration of MARNDR and the Office National du Tourisme. The sites that were selected for protection were "Sources Puantes," "Sources Chaudes," "Sources Cerisier et Plaisance," "Fort Mercredi," "Fort Jacques," "Fort Alexandre," "la Citadelle," and "lac de Peligre." The concept of protected lands was expanded in 1981 to include natural lands, and the first "Parc Naturel" was created in Haiti in the Massif de la Selle between Morne La Visite and Morne Kadeneau. The official creation of "Parcs Nationaux Naturels" was by decree in June, 1983. This

The number of endemic orchids living in the Pic Macaya area is truly phenomenal. They probably occur there because of the abundant rainfall and few remaining old growth forests. Most areas of Haiti where orchids once occured are now totally destroyed.

decree continued the protection of the eight sites discussed above by declaring them to be "Parcs Nationaux Naturels." In addition, "Parcs Nationaux Naturels" were created at "Morne La Visite du Massif de la Selle" (2,000 hectares) which is now known as Parc National La Visite and "Morne Macaya du Massif de la Hotte" (2,000 hectares), now called Parc National Pic Macaya. The goals of the Parcs Nationaux Naturels program in Haiti are as follows.

1. The protection of natural ecological conditions and processes. The two most important consequences of these actions are:

A) the preservation of watersheds, thereby improving the quality of life for all inhabitants of Haiti in areas adjacent to or under the influence of national parks;

B) the preservation of natural species diversity, and therefore the national natural patrimony.

2. The promotion of the national natural patrimony. The two most important consequences of this activity are:

A) the education of the citizens of Haiti about the unique features of their country that make Haiti special;

B) the increased possibility that wise decisions of long-range importance can be made concerning the utilization and development of the natural resources of Haiti.

3. The development of a recreation and tourism program that will take advantage of the unique physical location and beauty of the parks as well as special features of the flora, fauna or geology. We believe that it is possible for the citizens of Haiti to benefit from the parks at both the local and national levels without damaging the quality of the parks if a careful management plan is developed and implemented.

Parc National Pic Macaya was established in 1983. However, about ten years later there are still no official well-trained park guards, and the boundaries are still a matter of dispute.

Parc National Pic Macaya has been very successful in protecting the fragile habitats within the core area of the Massif de la Hotte (areas on Pic Macaya and Pic Formon above 1,600 meters elevation). Two important problems remain to be resolved. One is to find an appropriate organization in Haiti with a GOH mandate and sufficient funding level to take charge of the administration and supervision of the park. The equally important problem that must be addressed is the complex role of the local communities in the La Hotte region on the natural ecosystem. As the ecologically fragile areas within the park have become protected, the ecosystem surrounding the park has come under increased pressure from people living in the region who are no longer able to exploit the parklands. We did not anticipate the extent to which this would happen. It is now clear that an integrated plan for the region must be developed that goes far beyond the concept of a "Buffer Zone" as originally proposed in the Stewardship Plan developed by the University of Florida.

So, is there a viable natural history in Haiti?

The groups of plants and animals discussed in this chapter only touch on the scope and uniqueness of the flora and fauna of Haiti. These patterns are discussed in much greater detail in the following chapters of this book, in the *Stewardship Plan for the National Parks and Natural Areas of Haiti* (Woods, Sergile and Ottenwalder, 1992), and in the *Final Report: Macaya Biosphere Project* (Woods, Sergile and Paryski, 1992). We hope that two things are very clear from

the above discussion, however. The first is that Haiti is not an ecological disaster area. The flora and fauna of the country are among the most unique found in all of the West Indies. And in certain regions of the country, significant parts of Haiti's natural patrimony are still present. The second important point is that Haiti does have legislation available to protect its natural resources, and it already has existing national parks strategically located that can preserve the country's unique natural history and renewable natural resources. In these ways, Haiti is far ahead of some of its Antillean neighbors.

The most important point of all is that now is a critical time in the history of conservation in Haiti. The country is suffering economically, and the pressure on the environment has never been greater. If the existing programs to protect Haiti's soil, water and forest resources are continued, then there is a future for many of the unique plants and animals that are found in these areas (and frequently no place else in the world). If educational programs designed to increase the appreciation of how important forest cover is to the economy and environment are successful, then local farmers will continue to be able to farm their lands with sufficient soil and water to be "sustainable." And if all of us who are interested in the future of Haiti will focus on protecting and preserving Haiti's natural resources, then perhaps there is a future. The environment and natural history of Haiti are at a crossroads. One route leads to a sustainable future that includes enough water and soil to support future generations of Haitians, and enough habitat to protect the plants and animals that make Haiti's natural history so special. The other route leads to complete deforestation, massive soil erosion, progressive desertification, and a non-sustainable future. The decision as to which future Haiti will have will depend on what decisions are made in the next few months and years. But for the moment, the answer to the question posed in this chapter is yes, Haiti does have a splendid natural history. And no, it is not too late to save that natural history for the pleasure and well-being of future generations of Haitians.

Haiti is one of the most important areas for endemic species in the West Indies and once had more higher-level biological diversity than any other country in the Antilles.

SUMMARY OF NATURAL HISTORY OF HAITI

Forest Cover:	1923- 60%
	1974- 7%
	1982- 3%
Ideal Habitat Use:	55% Forest
	17% Grazing
	28% Arable (Source MARNDR)
Rainfall:	300mm-over 5000mm
Topography:	Below sea level to 2674 m (La Selle)
	Pic Macaya 2347 m
	Pic Formon 2219 m
Plants:	5,000 species
% Endemic	36%
Birds:	75 Residents
21 Endemic	28%
Mammals:	28 Terrestrial (plus 19 bats)
% Endemic	100% (of Terrestrial)
# Endemic Macaya	1 Genus & species
# Extinct	26 of 28
% Extinct	93% (of Terrestrial)
# Introduced	5 (non-domestic)
National Parks:	2 Natural, 1 Historic
Wildlife Laws:	107 (1826-1985)

BASIC INFORMATION ON HAITI

Land Area:	27,700 km^2
Population:	5,053,792 (1982)
	6,500,000 (2006 estimate)
Density:	200 km^2 (Total)
	700 km^2 (Arable Land)
Rate of Growth:	2%
Distribution:	1804: 80% Rural; 20% Urban
	1985: 80% Rural; 20% Urban
Literacy:	20-25%
Rural to Urban	10%
Per Capita Income:	$320 (1983 Rural and Urban)
	$150 Rural
Total Area Farmed:	1,300,000 ha (47% of land area of Haiti)
Farm Size:	71% 1.3 ha (with 3 or more plots)
Slope Factor:	63% of land 20% slope; 29% 10%
Erosion Factor:	6,000 lost to erosion each year
Erosion Problem:	33% of land severely eroded

MACAYA BIOSPHERE RESERVE

Core Area:	Parc National Pic Macaya
Established:	April 1983 by Presidental Decree
Area:	5500 hectares (Park)
Main Features:	Pic Macaya (2347 meters)
	Pic Formon (2250 m)
Rivers:	Riviere Grande Ravine du Sud
	Riviere l'Acul
	Riviere Port-a-Piment
	Riviere des Roseaux
	Riviere Glace

Biogeophysical Survey (USAID)	1983-1986
Biosphere Reserve Project (USAID)	1987-1990

Area of MBR (January 1989)
Zones of MBR (January 1989)
- Core Zone
- Multiple Use Zone
- Agriforestry Zone
- Forestry Zone
- Agricultural Zone

CHAPTER II

HISTORY OF THE MACAYA AREA

Brief History of Investigations in La Hotte Region

The Massif de la Hotte in southwestern Haiti between Les Cayes and Jeremie has long been considered one of the most remote and biologically significant regions of Haiti, if not all of Hispaniola. The first explorer to visit La Hotte was Louis-Claude Richard, a French naturalist and botanist who traveled the fringes of La Hotte in 1787 (Donald Dod, pers. comm.). The next explorer to work there was Father Eugene Christ, a French Catholic priest who collected plants for Professor Ignacio Urban of the Berlin Museum of Natural History and Botanical Garden. Father Christ explored the eastern ridges of the Formon range west of Camp Perrin in 1908. He must have passed this information on to the famous Swedish botanist Erik Ekman, who also collected plants for Professor Urban. Ekman first came to Haiti in 1917, and immediately attempted to climb La Hotte from the Camp Perrin side of the ridge of Formon. He described "dark green mountain masses dominated by a double-topped, pine-clad peak" (Ekman 1926:486). However, the vegetation was so dense that Ekman was not able to climb above 1,100 meters elevation along the ridge of Formon. Ekman left Haiti to continue his work in Cuba, and did not return again until 1924.

Dr. Erik Ekman returning from collecting plants in the Pic Macaya area.

Other explorers who attempted to climb La Hotte during these early years were Rollo Beck and Dr. William L. Abbott. Both of these well-known naturalists made their way into the interior of La Hotte from Port-a-Piment. The dense forests of La Hotte began just outside the city, however, and while Beck and Abbott got into the pine forest, they did not penetrate far into Macaya.

Ekman returned to Haiti to stay in 1924, and became one of the most important and talked about residents of Haiti of the period (1924-1928). Many stories of Ekman's exploits were to be heard, and even today it is possible to find people in Port-au-Prince who remember him. He is mentioned in a major way in W.B. Seabrook's book *The Magic Island* (1929). In December of 1925, Ekman again tried to climb La Hotte from the Camp Perrin side without success. In December, 1926, he returned to La Hotte, and journeyed to Formon via Les Platons. His description of the town of Formon, which is the center of our work today, was as follows;

> The place itself is so poor that it scarcely deserves a name, only one house fit to live in and the rest nothing but ajoupas.... The poor people are not owners of the soil they till, in most cases nothing but squatters, even if they sometimes recognize the lawful owners.... Every white man is at first suspected to be some kind of 'arpenteur', whose object is to deprive them of what they consider their property (Ekman 1928:204).

Ekman also noted that

> the forest begins immediately above Formon, the soil is rocky, the going trecherous. Both machetes were in steady use. Shrubs and small trees had to be felled, and the ensnaring vines of *Arthrostylidiun multispicatum* and *Smilax* to be cut and cleared away" (1928:205).

Photo of Dr. Henry Barker while climbing in the Pic Macaya area with Erik Ekman.

This is a description that contrasts greatly with the area today, where most of the Plain of Formon and adjacent slopes of Morne Formon are deforested, and almost 1,000 permanent residents live on or near the Plain of Formon (one of our "Target Areas"). It took Ekman and his colleague Henry Barker three days of cutting trails to get to a place that we can walk today in a little less than two hours. Ekman and Barker struggled on to Pic Formon, which they climbed on January 2, 1928. They were the first people ever to get to the highest peaks of La Hotte. The weather was so awful that they never even saw Pic Macaya, but they left behind a valuable description of the natural habitat of the ridges of Formon. One of their most important observations was that the Riviere l'Acul was deep and clear when they crossed it, in spite of over one month without any rainfall in the area. This is clearly the natural state of the watershed that our plans for a biosphere reserve hope to recreate.

Erik Ekman made one last trip into La Hotte in September of 1928. He became the first naturalist ever to climb Pic Macaya when he collected plants on the top of the mountain on September 13, 1928. His description of his findings, and of the natural conditions of the area are contained in his field notes, a copy of which is on file at the Florida Museum of Natural History (the originals are in Stockholm).

After the first ascent of Pic Formon 62 years ago, and of Pic Macaya two years later, scientists became very interested in the unique flora and fauna of La Hotte. In April of 1931, the American ornithologist Alexander Wetmore planned a visit to Macaya to collect birds. As part of his preparation he flew over the Macaya area in a small plane on April 3, 1931. It is worth quoting his published observations of the natural beauty that he saw from the plane that day.

> Beyond Camp Perrin we turned directly toward La Hotte, crossing above a wonderful stand of dense rain forest that covered the eastern and southeastern slopes of the mountain, beginning apparently at about 1,000 meters altitude or higher. Obviously the section was one of heavy rainfall. To the north of the moun-

tain were rolling ridges with considerable human habitation. Crossing over Desbarriere, Trevelyan (the pilot) turned directly toward the north face of the mountain, flying above the deep intervening valley. The northern slope of the Pic de Macaya was covered with pine forest of large size, without sign of trails or human habitation. A deep valley separated Pic du Formon from Macaya, the tree growth there being dense and principally rain forest. La Grande Colline, the third peak in the mountain complex, lower in elevation than the other two, was covered principally with pine. Traveling first at a few hundred feet elevation to get the lay of the land, we later descended so that the airplane traversed the deep intervening valleys and crossed the highest points of all three peaks only a few feet above the trees. On the northwest point of Macaya, the highest of the three, was a small clearing made by Engineur Dejour the year previous. We crossed and recrossed over slopes whose wild beauty is difficult to describe, looking down into the dark, wet depths of jungle, where there was no indication that man had ever set foot, and which the imagination peopled with any manner of strange and unusual birds. Both Macaya and Formon are along ridges with little plateau area at the top, extending east and west with steep pitches on the eastern faces.

We left the mountain finally from the south face of Formon. From Port a Piment a valley with many habitations leads up to a rolling cultivated plateau, apparently the region designated on maps as Les Platons, which offers easy access to the base of Formon and the rain forest on the southwest face of the mountain. (Wetmore and Lincoln 1933:2-3)

Alexander Wetmore went on to journey to the top of Pic Macaya via the same route that Ekman took in 1928, and climbed the northwest side of the mountain in the vicinity of the present-day settlement of Sivette (one of our local communities in the Trois Sources Target Area). Wetmore climbed to the summit of Pic Macaya on the 17th and 20th of April, 1933. Some of his observations of the area are quoted below:

At 1,275 m at the edge of the rain forest we dug out a level space and pitched our tent. Below us the mountain descended steeply into a deep valley with slopes cultivated in bananas, sweet-potatoes, coffee--grown without shade because of the almost continuously clouded sky--and other crops. Across rose the steep pitches of La Grande Colline, called locally Changelange, and ahead we had a glimpse of the forested slopes of Pic du Formon, the third of the peaks of La Hotte. La Grande Colline had an extensive stand of pine, while rain covered Formon. (Wetmore and Lincoln, 1933:6)

Alexander Wetmore climbed Pic Macaya in 1931.

This is a good description of the view from 1,300 meters on the west slope of Pic Macaya near what we call today the settlement of Sivette. Wetmore mentioned in his journal entry for April 15, 1931, that his camp was on the northwest slope of Macaya.

Above our camp on Macaya, rain forest extended to 1,800 meters elevation, where it was replaced by a stand of tremendous pines 4 to 6 feet in diameter, their lower limbs cloaked in moss and epiphytes, and the ground beneath covered with dense growths of dripping bracken. (1933:6)

Macaya still is as it was in Wetmore's time in this region. From Caye Godet, they followed a narrow ridge to the summit of the mountain.

> The peak extended in a general east west direction, with a very narrow plateau at the summit. To 1,950 meters elevation the ascent was very steep and difficult, but beyond was a more gently sloping shoulder leading to the narrow plateau mentioned at 2,120 meters, rising slightly higher toward the west. Limestone was exposed at the altitude last mentioned. This upper portion of the trail had been opened by Haitian engineers of the Travaux Publique, but at the time of our visit signs of their passage had been almost obliterated. Since the summit had at some time been swept by fire, in some years there must be a reduction in precipitation. (1933:6)

After Wetmore, Pic Macaya was visited by the American entomologist P.J. Darlington of the Harvard University Museum of Comparative Zoology. Professor Darlington traveled along the same route as Alexander Wetmore to the north side of Pic Macaya, but climbed directly up the mountain from the settlement of Les Anglais on the Riviere de la Guinaudee. He described several new species from the mountain, including a new snake, and commented on the unique features of the La Hotte area. He also described the natural forests in the area:

Photo of touring car along the mountain roads of Haiti in the early 1930s. (Courtesy of Henry Barker.)

> Between Bonnet Carre (located between Aquin and L'Asile) and the eastern-most rainforest (at about 2,000 ft.) on La Hotte there are 20 miles or more of low, dry ridges. The high ranges of the central part of the La Hotte Massif (Pic de Macaya, Pic du Formon, and Pic de la Gde. Colline on the map), and apparently also most of the lower ranges to the west almost to the coast, are very heavily forested. On La Hotte itself is a completely unbroken tract, without even trails, probably 8 or 10 miles across the narrowest way. The forest is of two kinds: fine pine with unusually thick undergrowth and with thick moss and pine needles on the ground, and lower, denser, very wet cloud forest, without pine, fringed with cutting climbing bamboo and other atrocious plants. (1935:173)

It is interesting to note that both Wetmore and Darlington traveled along the route of the "new" road that was being built between Les Cayes and Jeremie. The road was not yet constructed between Poste Avance and Durand (near Beaumont). Both Wetmore and Darlington commented on the difficulty of traveling along the route from Camp Perrin to Jeremie at that time. Alexander Wetmore, S.W. Parish, and Frederick Lincoln followed the route of the road to Tombe Chevel and on to Geffrard (at the crest of the hill at 740 meters) where on April 7, 1931 they found that:

> A slide had blocked the trail a short distance ahead, making necessary a detour through a dense rain forest over steep trails, deep in mud, where our animals slipped and plunged and we were at times compelled to descend and walk for our own safety. In places mudholes that we could not avoid were belly-deep on our mules. The rain forest extended to Donte, the route leading through the edge of the great expanse of forest that we had seen from the air. (1933:3)

The first big University of Florida expedition to the top of Pic Macaya was in 1984.

Darlington described this same route on October 8, 1934, as being "along the narrow, new road, impassable for cars in rainy weather, which crosses the foothills toward Jeremie, then west by vile foot trails, and finally north to Desbarriere (about 4,000 ft.), on a spur which curves down first north, and then west from the

northern slope of La Hotte itself." (1935:169)

From these observations it is clear that in 1934, the original forest extended from Macaya/Formon east as far as Catiche, and that access to the interior regions surrounding La Hotte was difficult. The completion of the Les Cayes to Jeremie road in about 1935 accelerated the rate of deforestation in the Macaya region. The extent of this deforestation is clear from the comparisons of the forest cover of La Hotte described above with the condition of the area today, just fifty years later. The rapid increase in the rate of deforestation of the La Hotte area has also been documented by Warren B. Cohen in a report to USAID/Haiti in which forest cover observable in aerial photographs was digitized and analyzed (Cohen, 1984).

The acceleration in the rate of deforestation in the La Hotte region is also the result of tremendous population growth in the past fifty years. The population of Haiti in 1934 was 2,550,000. In 1950, the population was 3.1 million, in 1971, 4 million, in 1982, 5.054 million, and today it is approaching 6 million.

Darlington concluded with this poignant observation:

> It is in the La Hotte region, of all Haiti, that there is to-day the best chance of finding novel forms of life, and it is undoubtedly there that natural conditions will persist longest." (1935:173)

Few scientists worked in the Macaya area after Darlington's journey. Preston Webster of the Harvard University Museum of Comparative Zoology visited the area in the 1960s to collect reptiles.

In 1973, Charles Woods and his students began a series of expeditions into the La Hotte region to document the unique biology of the endemic species occurring there. After several attempts to get into the central region of La Hotte, Charles Woods flew over the area in a small plane on December 18 and 30, 1974, to plot a route to the interior. This was followed by an expedition into Pic Macaya in May, 1975, following Darlington's original route through Les Anglais and up the north side of the mountain. In January, 1977, Richard Rosen, Margaret Langworthy, and James Bicket, all graduate students of Charles Woods, traveled from Catiche to the east shoulder of Pic Macaya, down into the Ravine du Sud, up the ridge of Formon, and down over the Plain of Formon to Cavalier and on to Port-a-Piment. This remarkable journey marked the first time that both Macaya and Formon had been traversed, although only the lower slopes were climbed (up to an elevation of 1,875 meters).

With the results of these expeditions, it became abundantly clear that the natural resources of La Hotte were being severely exploited, and that a major conservation effort was need to protect the environment of the Macaya region. A report was prepared for the Ministere de l'Agriculture (MARNDR) in 1977 by Charles Woods and Richard Rosen which recommended the establishment of a series of national parks in Haiti, with a specific plan for a national park at Pic Macaya (Woods and Rosen, March, 1977). In 1982, with assistance from the International Foundation for the Conservation of Birds and with technical support from the Institut de Sauvegarde du Patrimoine National (ISPAN), expeditions from the Florida Museum of Natural History and University of Florida were planned to document the extent of deforestation of the interior of La Hotte, and to look for rare endemic species. Formon was climbed in December, 1982, and in January, 1983. A big expedition from the Florida Museum of Natural History/University of Florida, with the assistance of USAID/Haiti, climbed Pic Formon and Pic Macaya in January, 1984, and documented the presence of nesting Black-capped Petrels on the south face of Pic Macaya. These expeditions were part of the Biogeophysical Inventories of the National Parks of Haiti, funded through

CHRONOLOGY

1) **L. C. Richards**, 1787
2) **E. Christ**,
   1908 (east side of Formon Range)
3) **E. L. Ekman**,
   1917 (Formon east)
   1925 (Formon east)
   1926 (Formon south to Pic Formon)
   1928 (Pic Macaya from the north)
4) **R. Beck**,
   1917 (Formon southwest)
5) **W. L. Abbott**, 1917
6) **A. Wetmore**,
   1931 (Macaya north and west to Pic Macaya)
7) **P. J. Darlington**,
   1934 (Macaya north to Pic Macaya)
8) **P. Webster** et al., 1963
9) **Jean Sprumont**,
   Up Ravine du Sud to Formon Ridge
10) **C. A. Woods** (and associates),
    1975 (Macaya north)
    1982-83 (Formon south)
    1984 (Formon south to Pic Macaya from south)
    1985 (Formon south to Pic Formon, Pic Macaya & Ravine du Sud)
    1985 (Formon south and Pic Macaya)
    1988 (Macaya west)
    1988 (Ravine Trois Sources west)
    1989 (Formon south and Pic Macaya)
11) **R. C. Rosen**,
    1977 (Formon northeast to southwest)
12) **Paul Paryski & David Windate**,
    1981 (Formon, Pic Cavalier, Le Ciel)
13) **P. Mertens** et al.,
    1984 (Macaya southwest)
14) **B. Hedges & R. Thomas**, 1986
15) **D. Skean**, 1986

USAID/Haiti and coordinated by Charles Woods of the University of Florida. Similar expeditions to collect data for the biogeophysical inventory were conducted to Pic Formon and Pic Macaya in August, 1984, May and November, 1985, and January-February, 1989. The results of these expeditions and investigations are summarized in the series of reports to USAID/Haiti on file in Haiti at the USAID Mission and at the Florida Museum of Natural History of the University of Florida (Contract number 521-0169-C-00-3083-00).

SPECIFIC INFORMATION ON EXPEDITIONS

Louis Claude Marie Richard

French Naturalist 1754-1821

Worked in Haiti in 1786-1787

According to Donald Dod, Richard was the first biologist to visit Macaya in 1787.

Father Eugene Christ

French Catholic Priest and Explorer 1872-

Worked in Haiti 1897-

Worked for Professor Urban and collected plants. In 1908, he collected at Camp Perrin, Morne Vandefeld, Morne Quinille, and apparently in the Riviere L'Acul region. Therefore, while he did not get into the Massif de La Hotte proper, he was one of the early explorers of the region.

Erik Leonard Ekman

Swedish Botanist 1883-1931

Worked in Haiti 1917, 1924-1928

Represented Stockholm Museum of Natural History, and collected plants for Professor Ignacio Urban of the Berlin Museum and Botanical Garden.

May, 1917 (Up the east ridge of Massif Formon)

Ekman appears to be the first scientist to attempt to climb to the top of "La Hotte". His route was via Camp Perrin and "La Civette" near Camp Perrin.

> But north of Les Cayes towered dark green mountain masses dominated by a double-topped, pine-clad peak. (1926:486)

Ekman went to Jardins Coutard on the north slope of Morne Vandervelde. He got to 1,100 meters, where pines and palms began. He gave up just below the ridge above Mare Blanche.

The same year (May, 1917), he also tried to climb to La Hotte from Port-a-Piment. With three peasants, he climbed up to the ridge of Formon (he did not write it as Formond) at 1,600 meters, having to "cut the way along the ridge through the everlasting thickets of climbing bamboo, the *Arthrostylidium haitiense.*" (1926:487). There were huge fallen pine trees, many of which had fallen down in the hurricane of 1915. He had to turn back because of an open revolt by his three peasant guides, who had not taken enough to eat.

He returned to Cuba in 1917 in frustration.

Ekman returned to Haiti in July, 1924.

December 1925 (Up the easts ridge of Massif Formon)
Ekman, accompanied by Dr. H.D. Barker and Mr. W.R. Barbour, attempted to climb La Hotte from Camp Perrin.

He climbed to 1,750 meters on the ridge of Formon, but weather drove him back.

> We had, however, from a vantage point of about 1,750 m above sea level, been able to ascertain that there were at least two high tops. The one to the north apparently the higher, and the easiest route up would be over Les Platons, a small mountain settlement between branches of the Acul river. (1928a:201).

December 1926 (Up Pic Formon)
Ekman and H.D. Barker returned to the La Hotte region. They drove to Le Duc, and continued on foot beyond.

> We passed the Acul river, quite broad and deep despite a month-long drought. (1928:202).

They commented on how dry the mountains were, and that there was no water in the bromiliads, so it was extraordinarily dry, which is significant in what it says about the watershed at that time (i.e., the river was still flowing deep and clear).

25 December 1926 they were at Les Platons

26 December 1926 they traveled to Formon via the same trail as our present-day route. They noted that forest cover, ferns, and epiphytes

> of all kinds are very abundant.... The place itself is so poor that it scarcely deserves a name, only one house fit to live in and the rest nothing but "ajoupas".... The poor people are not owners of the soil they till, in most cases nothing but squatters, even if they sometimes recognize the lawful owners.... Every white man is at first suspected to be some kind of "arpenteur", whose object is to deprive them of what they consider their property." (1928:204).

> The mountain top which was our goal loomed high above us, its eastern slope apparently bare, elsewhere covered with pines.... The forest begins immediately above Formon, the soil is rocky, the going trecherous. Both machetes were in steady use. Shrubs and small trees had to be felled, and the ensnaring vines of

Erik Ekman first visited Haiti in 1917, but went back to Cuba in disgust.

> *Arthrostylidium multispicatum* and *Smilax* to be cut and cleared away. (1928:205)

> The vegetation of these lower slopes of Morne Formon offers little of interest beyond that of the forest near Formon itself. (1928:206)

This comment is further justification for the importance of saving the Rak bwa along the south side of the Plain of Formon, which Ekman notes is of significance.

> A winding ridge seemed to offer the best route up, and towards this we labored the rest of the day. (1928:205)

After 24 hours (two working days until 2:00 P.M. of second day) of cutting, they reached a crest at 1,500 meters.

> Between us and the steep slopes of Morne Formon, as we had now resolved to call the southern of the twin peaks of La Hotte, was a narrow and deep gorge of the headwaters of the Acul river. (1928:207)

This ravine must be what we now call the Ravine Casse Cou, and on the maps is called the Ravine Dalest. They were forced to turn west at this point, and to head towards Morne Cavalier and Pic Le Ciel.

> The ridge is covered by a dense thicket of spiny, tough shrubs, woven together by a *Smilax* even meaner than the *Arthrostylidium*. (1928:207)

It was hard work for them to get through this thicket. There were quite a few new plant species here. Water was not available in this region, and so Ekman and Barker each made trips back to Formon to collect water. Ekman commented on "...the waterless, windswept ridges of Formon." (1928:208)

Ekman and Barker spent three days cutting trails with machetes to get to this point, which was about a three-hour hike by cleared trail. "Barker had during my absence reached the pines, at about 1,520 m, and made good progress along the ridge, in the partly open pine-forest.... We could see no evidence here for fire ever having destroyed the vegetation, as so often is the case in other pine forests in Cuba and in Haiti. The ground is covered by a very thick, soft carpet of moulding pine-needles, so that few plants grow on it." (1928:209).

Erik Ekman and Henry Barker tried to climb Pic Macaya from the south (via Formon) in 1928, but gave up because the forest was impenetrable. They made it as far as Pic Formon.

This area must be the ridge of Pic Formon below Pic Le Ciel.

Ekman provides a good description of the habitat and plants (1928:209).

Ekman and Barker continued on until the top of the ridge where the shoulder of Pic Le Ciel joins the ridge of Formon where "some enormous pines grew, nearly two meters in diameter, and tall in proportion, while other recently fallen obstructed the path, causing us many laborsome detours." (1928:210) The entire next day they cut through a dense thicket of ferns and cutting bamboo.

> It is sometimes possible to crawl out on top of these thickets and crush them down with the weight of the body. But more often the machete has to be relied upon as the only means of progress, and the path thus cut may resemble a canyon or even a tunnel. (1928:210).

So, after five (5) days of cutting through dense vegetation they arrived at 1,750 meters. Their location was at the base of the ridge going up to Pic Le Ciel. Today that is in view of Formon from Madam Robert's house, and is now a 4-5 hour hike.

Day 6 (**31 December 1926**) they climbed to 2,000 meters along an open steep slope. They found numerous pines, some of which were growing close together, and signs of fire (carbonized stumps). They concluded that fire was part of the natural ecosystem along the ridge of Pic Formon.

Day 7 (**January 1, 1927**) they reached the top of what they called Morne Formon at 2,225 meters). Current maps indicate the elevation of Pic Formon to be 2,219 meters. As we know from his reading on the top of Pic Formon (see below), Ekman's altimeter was reading 81 meters too high. So this location was really about 2,144 meters, which is near Pic Le Ciel above Morne Cavalier.

> Close to the top, deciduous forest with *Arthrostylidium*-thickets again sets in. Our progress was slowed up, partly due to a new obstacle, prickly *Rubus domingensis*, not seen before in La Hotte. (1928:211)

This is a good description of a fire-disturbed area, and resembles the top of Pic Macaya today. It is not a good description of the top of Pic Formon, but rather resembles what we currently call Pic Le Ciel, which has an elevation of 2,170 meters. Further evidence that Ekman was not on Pic Formon, but rather Pic Le Ciel comes from the following quote:

> Between us and that top (Pic Macaya) was the very deep and narrow gorge of La Ravine, and the opposite slope seemed nearly vertical. Of course, there is a connection somewhere, but much farther to the west than we had believed. (1928:214)

Barker climbed a tall pine tree to gain a view of the area; wanting to get to the highest point of La Hotte, they traveled on.

> Consequently, next morning (2 January 1928) we began cutting our way in a northwesterly direction. We came soon into a low saddle, c. 2,150 m, where I had the pleasure of finding a number of rare and maybe unknown ferns. Still further ahead we came upon a partly open pine ridge, dived down into another saddle, and finally arrived at the highest point of the ridge northwest of Morne Formon, or maybe more correct, at the highest peak of Morne Formon itself. This top is the one that on the sea chart No. 948 of the Eagle Expedition is marked as being 7525 f. (2,290 m) high. My barometer showed 2,300 m. (1928:216)

Ekman and Barker viewed Pic Macaya from a pine tree on the ridge of Formon. The weather was awful and the forest too dense to press through to get there.

The weather was awful. Nothing could be seen, and so they retreated back to their camp on Pic Le Ciel just before darkness fell. This is a perfect description of the trip between Pic Le Ciel and Pic Formon. The real height of Pic Formon is 2,219, so Ekman's altimeter was 81 meters off.

Because of the awful weather, and in order to save his collection of plants, Ekman and Barker returned to Formon the following day.

> The path which had taken us a week to open required less than a day on the return. (1928a:218)

September 1928 (Up Pic Macaya from the northwest)

In book 7, page 30 of his "Catalogue of Hispaniolan Plants" Ekman wrote "Grand excursion Western La Hotte", with the next entry being June 24, 1928. The locations of the following entries range all over southwestern Haiti. On September 12, 1928, under the heading "The final ascent of Morne La Hotte" is the following account.

> I went over Fond-Cochon, Alnette, Nan-Potates, and Laurent to Godet, the last inhabited place. Roads were terrible, as usual in this part of Haiti. The old lady in Godet, Eximene Jean-Pierre, gave me her two boys, aged 12 and 14 years resp., to help on the ascent. We had good luck, the weather proved favorable, and the woods rather easy to get through. Already the first afternoon we reached the pine region. A fire had destroyed the underbrush recently, and we made good progress towards the top, which was reached at noon, Sept. 13, at an altitude of 2,410 m. The two boys proved to be the best helpers I ever had in Haiti. Their names are worth noting: Pi-Diew-Vle Jean-Pierre, and Laurice Jean-Pierre. On the return we passed another night in the pine forest. Old Eximene, fearing that we had run out of food, came up to the pines, 2,000 m, bringing boiled "caraibes". (Ekman, unpublished catalog for 1928:78)
>
> The top itself is a narrow ridge, running east and west, all overgrown with pines. It proved quite difficult to find the really highest point. I blazed an enormous pine to commemorate my ascent. (1928:80)
>
> Besides the plants already listed (10646-10656) the following occurred on the top: Pinus occid (common); Garrya (common); Rapanea guianensis (common), Weinmannia; Fuchsia Pringsheimii; Lobelia assurgens, Lobelia rotundifolia; Peratanthe Ekmanii; Mikania cyanosma; Peperomia nibbasellifolia; Dendrophthora n. 7541 (should have been collected); Alsophila guadripinnata; Dryopteris paleacea, Dirudis, D. physematoides, plagiogyria semicordata; Blechnum Underwoodianum; Histiopteris incisa; Polypodium moniliformes; P. lasiopus, P. angustifolium var. amphistemon. Thus not a very interesting flora, as rarely is the case in high pine-lands. (Unpublished catalog for 1928:81)

Erik Ekman finally climbed Pic Macaya in 1928.

On September 14, he descended the mountain from Godet to Laurent at 750 meters at Riviere des Roseaux. He then traveled on towards Nan-Potates c. 1,100 meters. He stayed for several days at Nan-Patates (1,000 meters) "to dry my plants from Morne La Hotte, and to explore the interesting forests here." (*Ibid*:84) On to Fond-Cochon, Conserve (800 meters), Alnette, Bras Sec, Grande Vincent.

Rollo Beck

American Ornithologist

Worked in Haiti 11 June-19 July 1917

Represented American Museum of Natural History

June 1917 (Up Formon-Grande Colline side of La Hotte)

June 18 he proceeded inland up a steep slope where he found coffee growing to 1,200 meters, and at noon reached the last available water above the highest native hut. Beyond there were no trails and progress was impeded by trees blown down by a recent hurricane. On the following day he laboriously cut a trail to the top of a large ridge running toward the highest peak in the vicinity and continued along this to two pines. On returning to his camp at noon he found that his men had deserted him. On June 21 he moved to another site, the following day cutting a trail up to the pines. June 24 he climbed again to the summit of the ridge near the base of the peak, returning on June 26 to Port-a-Piment. On July 1 he returned again to the interior, and on July 4 cut another trail along the ridges towards the peak. On July 6 he returned to Port-a-Piment, and the following day to Les Cayes." (Wetmore and Swales, 1931:19)

Dr. William L. Abbott

American Naturalist and Explorer

Represented the Smithsonian Institution

2 March-12 March 1917

Worked in the region of Port-a-Piment

There are indications that he worked in the La Hotte area.

Alexander Wetmore

American Ornithologist

Represented the Smithsonian Institution

Worked in Haiti 27 March-3 June, 1927; 22 March-27 May, 1931.

3 April 1931 (Air reconnaissance of "La Hotte Mountain Range")

Beyond Camp Perrin we turned directly toward La Hotte, crossing above a wonderful stand of dense rain forest that covered the eastern and southeastern slopes of the mountain, beginning apparently at about 1,000 meters altitude or higher. Obviously the section was one of heavy rainfall. To the north of the moun-

Dr. Abbott collected many important biological specimens in Haiti and the Dominican Republic.

tain were rolling ridges with considerable human habitation. Crossing over Desbarriere, Trevelyan (the pilot) turned directly toward the north face of the mountain, flying above the deep intervening valley. The northern slope of the Pic de Macaya was covered with pine forest of large size, without sign of trails or human habitation. A deep valley separated Pic du Formon from Macaya, the tree growth there being dense and principally rain forest. La Grande Colline, the third peak in the mountain complex, lower in elevation than the other two, was covered principally with pine. Traveling first at a few hundred feet elevation to get the lay of the land, we later descended so that the airplane traversed the deep intervening valleys and crossed the highest points of all three peaks only a few feet above the trees. On the northwest point of Macaya, the highest of the three, was a small clearing made by Engineur Dejour the year previous. We crossed and recrossed over slopes whose wild beauty is difficult to describe, looking down into the dark, wet depths of jungle, where there was no indication that man had ever set foot, and which the imagination peopled with any manner of strange and unusual birds. Both Macaya and Formon are along ridges with little plateau area at the top, extending east and west with steep pitches on the eastern faces.

We left the mountain finally from the south face of Formon. From Port-a-Piment a valley with many habitations leads up to a rolling cultivated plateau, apparently the region designated on maps as Les Platons, which offers easy access to the base of Formon and the rain forest on the southwest face of the mountain. (Wetmore and Lincoln 1933:2-3)

April 1931 (Up west ridge of Pic Macaya)

Wetmore seems to have obtained information on the route to Pic Macaya from Erik Ekman, since his destination was the same region of the mountain, and specifically the house at Caye Godet, which both Ekman and Wetmore refer to as the last and highest human habitation on La Hotte.

They (Wetmore, S.W. Parish, and Frederick C. Lincoln of the U.S.National Museum) traveled by vehicles to Les Cayes, Camp Perrin and on to Poste Avanc) (450 meters) on April 6, 1931. They traveled on from there by pack animals beginning at 2:00 P.M. They followed the route of the road to Tombe Chevel and on to Geffrard (at the crest of the hill at 740 meters).

Alexander Wetmore in 1931 followed the same route to the tip of Pic Macaya as did Erik Ekman in 1928.

The next morning (7 April) they continued on.

> A slide had blocked the trail a short distance ahead, making necessary a detour through a dense rain forest over steep trails, deep in mud, where our animals slipped and plunged and we were at times compelled to descend and walk for our own safety. In places mudholes that we could not avoid were belly-deep on our mules. (1933:3)

This is in the region of Catiche, where we have had similar experiences with deep mud. The area is now all cut over, but in 1933:

> The rain forest extended to Donte, the route leading through the edge of the great expanse of forest that we had seen from the air. (1933:3)

So, in 1933, the original forest extended from Macaya/Formon east as far as Catiche.

They continued on to the Riviere Glace, the town of Les Glaces (a settlement of 30-40 houses), and finally on to Durand (620 meters) where they met the road under construction once again. They spent April 8 in Durand. At 1:15 P.M., April 9, they left Durand and turned west towards Macaya via Bois Pin Lacondis (Lacadonie on the present day map) where they encountered an open stand of pines ("in contrast to the dense jungle growths that we had crossed previously." [1933:4]) They spent that night at 925 meters at a settlement they called Bois Lacombe. The following morning at 11:00 A.M. they departed, and crossed the Riviere des Roseaux three times (680 meters) and up to a ridge at 900 meters, where "occasional ridges were grown with pine, but this was not abundant." (1933:5) At 3:15 P.M. they came to the settlement of Desbarriere on a narrow ridge at 985 meters overlooking Pic Macaya. They spent the night here, and on April 11, continued on to the summit of a hill at 1,090 meters, and on to Amiel before descending to the "Riviere Anglais" (565 meters). They called this settlement La Cour Z'Anglais. This river would be the upper part of the main branch of the Riviere des Roseaux about 1.5 kilometers downstream of the junction of the Riviere de la Guinaudee and the Riviere Trois Sources, based on his reported elevation. However, Les Anglais is a small settlement along the Riviere de la Guinaudee where we camped between May 21-23, 1975. We believe that this was the location of Wetmore. Further evidence for this comes from a man we met in Les Anglais named Jean Journal. He claims that his father "guided" a man to the top of Macaya about 40 years ago. His father was named Celonal Journal, and he lived in Les Anglais at that time. Our altimeter read 576 meters. Wetmore's journal for Wednesday April 22, 1931, reports that "Celona Journal" had taken care of his pack animals that he was forced to leave behind because of the steep trails beyond "La Cour Z'Anglais." This bit of evidence confirms that Wetmore passed through Desbarriere and down the steep incline to Les Anglais.

On April 12, they continued on in the rain (it had been raining for several days) via foot. The mules could go no farther, so porters carried all of their equipment from this point on. His description of traveling on April 13 in the rain is "with difficulty over narrow trails that led up and down through coffee plantations, little fields, and tracts of forest over a series of ridges whose slopes in places were almost precipitous." (1933:6) While Wetmore is vague as to his exact route in this area, we believe that his group was travelling along the basin of the Riviere Trois Sources in the direction of the settlement of La Hotte, and up over the rolling north west flank of Pic Macaya towards the present-day settlement of Sivette. They spent a cold night sitting over a little fire in a small caye, probably near the settlement of La Hotte at 970 meters elevation.

In 1975, we found the son of the man who worked with Alexander Wetmore in 1931. He remembered his father's stories about the expedition.

On April 13, they climbed on up Macaya, and reached their goal in the morning when they arrived at "the little group of three huts called Caye Godet, the last human habitation on the higher slopes of the Pic de Macaya." (1933:6) The settlement was named after Madam Godet, who wore shoes and seemed to have some recognition in the region.

> At 1,275 m at the edge of the rain forest we dug out a level space and pitched our tent. Below us the mountain descended steeply into a deep valley with slopes cultivated in bananas, sweet-potatoes, coffee--grown without shade because of the almost continuously clouded sky--and other crops. Across rose the steep pitches of La Grande Colline, called locally Changelange, and ahead we had a glimpse of the forested slopes of Pic du Formon, the third of the peaks of La Hotte. La Grande Colline had an extensive stand of pine, while rain covered Formon.

This is a good description of the view from 1,300 meters on the west slope of Pic Macaya near what we call today the settlement of Sivette. Wetmore mentioned in his journal entry for April 15, 1931, that his camp was on the northwest slope of Macaya.

> Above our camp on Macaya, rain forest extended to 1,800 meters elevation, where it was replaced by a stand of tremendous pines 4 to 6 feet in diameter, their lower limbs cloaked in moss and epiphytes, and the ground beneath covered with dense growths of dripping bracken. (1933:6)

Macaya still is as it was in Wetmore's time in this region.

From Caye Godet they followed a narrow ridge to the summit of the mountain.

> The peak extended in a general east west direction, with a very narrow plateau at the summit. To 1,950 meters elevation the ascent was very steep and difficult, but beyond was a more gently sloping shoulder leading to the narrow plateau mentioned at 2,120 meters, rising slightly higher toward the west. Limestone was exposed at the altitude last mentioned. This upper portion of the trail had been opened by Haitian engineers of the Travaux Publique, but at the time of our visit signs of their passage had been almost obliterated. Since the summit had at some time been swept by fire, in some years there must be a reduction in precipitation. (1933:6)

It is not clear if Wetmore climbed Macaya along the west ridge, or went up via a steeper shoulder just north of the west ridge.

Rain fell daily, and it was often misty.

> Because of the dense growth collecting and observation were difficult, and the whole mountain was less interesting than the high ridge of La Selle, visited by Wetmore in 1927. (1933:6)

Wetmore climbed to the summit of Macaya on 17 April and 20 April, 1933.

They departed from their camp on Macaya on 22 April. They reached Post Avance on April 25, and Camp Perrin on April 26.

P.J. Darlington, Jr.

It rains almost every day on Pic Macaya.

American Entomologist and Biogeographer

Represented Harvard Museum of Comparative Zoology

Worked in Haiti from 30 August-22 November in 1934

October, 1934 (Up north face of Pic Macaya)

Darlington began his journey to the "Massif de la Hotte" from Camp Perrin on October 8. The trip was a 16 day journey on foot. The route was first

> along the narrow, new road, impassable for cars in rainy weather, which crosses the foothills toward Jeremie, then west by vile foot trails, and finally north to Desbarriere (about 4,000

ft.), on a spur which curves down first north, and then west from the northern slope of La Hotte itself. (1935:169)

Desbarriere is a ridge directly north of the main ridge of Pic Macaya. Darlington followed the Desbarriere ridge back towards Pic Macaya to "a prominent rock marked with a rude natural cross," which he called "Roche Croix" at c. 5,000 feet. He could not go any further because "the ground was covered with trecherous limestone formations hidden under deep moss and bracken." (1935:169)

Darlington then returned to Desbarriere down the steep slope to the "Tardieu" along the "turbulent Riviere Tardieu" (now called the Riviere de la Guinaudee, a tributary of the Riviere des Roseaux). From this spot at the base of Desbarriere, Darlington stated that "I ascended the main peak (Pic de Macaya on the map, but called merely 'La Hotte' locally." (1935:170) It took four days to go up and down the mountain from this point. Darlington did not describe his route. However, we have stood at this same point on the Riviere de la Guinaudee, and the most logical route to the top of Macaya is straight up along a shoulder of the mountain via a footpath to the collection of cayes at "Sapoti". This is the route Charles Woods took to Pic Macaya from the same location on the river in 1975. We believe that this is the route of Darlington.

Darlington did not describe the forest cover of the top of the mountain other than to say that "surveyors had been up two or three years before, cutting a temporary trail from the other side, and had felled an acre or two of the big pines on the highest point to make room for surveying targets..." (1935:170). This temporary route must have followed Alexander Wetmore's route of 1931 along the west ridge of Macaya. (See Wetmore's description of activity by surveyors.)

Darlington described the region of the Massif de la Hotte, which includes the three tall peaks "Pic du Formon" (once again without d), "Pic de Macaya", and Pic de la Grande Colline.

> Between Bonnet Carre (located between Aquin and L'Asile) and the eastern-most rainforest (at about 2,000 ft.) on La Hotte there are 20 miles or more of low, dry ridges. The high ranges of the central part of the La Hotte Massif (Pic de Macaya, Pic du Formon, and Pic de la Gde. Colline on the map), and apparently also most of the lower ranges to the west almost to the coast, are very heavily forested. On La Hotte itself is a completely unbroken tract, without even trails, probably 8 or 10 miles across the narrowest way. The forest is of two kinds: fine pine with unusually thick undergrowth and with thick moss and pine needles on the ground, and lower, denser, very wet cloud forest, without pine, fringed with cutting climbing bamboo and other atrocious plants. (1935:173)

The population of Haiti in 1934 was 2,550,000.

Darlington concluded with this poignant observation:

> It is in the La Hotte region, of all Haiti, that there is to-day the best chance of finding novel forms of life, and it is undoubtedly there that natural conditions will persist longest. (1935:173)

When Darlington climbed Pic Macaya in 1934 he noted that surveyors had cleared a large area on top of the mountain for surveying targets. The area where these big pines were cut has still not regenerated its towering pines even though it was 60 years ago. Today, it is still a scrubby, ruinate area.

Leslie Rensselaer Holdridge

American Ecologist

Did his Doctoral Dissertation on the pine forests of Haiti.

Worked in Haiti 1939-1946

February 1941
He got "to near the peak" of Pic Macaya on 9 February 1941 (Judd 1987:6). See also, Jimenez (1988) for a discussion of Holdridge.

Charles A. Woods

American Professor

Represented the University of Vermont (1972-1979) and the University of Florida (1979-present).

Worked in Haiti 1972-present.

18 December 1974
Flew over Pic Macaya and western Haiti. It was rainy and cloudy, so the visibility poor. Many inhabitants and much cutting of the forest were observed. Houses existed on the mountains right up to the cloud levels.

30 December 1974
Flew all around south west Haiti.

Macaya was cut over on the east face. There was a thick stand of pines all along to top ridge of Pic Macaya. Dense rain forest covered the northeast face of the mountains. The Plain east of Pic Macaya towards Duchity and Catiche was thickly settled. The dense forest along the banks of the Riviere Glace stood out in contrast with the chopped-up inhabited region surrounding it. The west ridge of Macaya was forested in large pines. The basin of the Riviere des Roseaux was deforested and thickly settled in the Larrieux and Annette areas. Pic de la Grande Colline was mostly deforested, with some forest remaining on the east and northeast shoulders. The north face of Pic Macaya was very steep, but also well-forested. Southwest of Pic Macaya the area was very inhabited and cut-over.

The famous ecologist Leslie Holdridge did his Ph.D. dissertation on the pine forests of Haiti.

January, 1977
Flew over Desbarriere and around Macaya, and took numerous photographs. There were some signs of deforestation on the south west flank of Pic Macaya. The north west face of Macaya was in excellent shape. The basin in between Pic Macaya and Pic Formon (ravine of Riviere Trois Sources) was well-forested with broadleaf forest on the Formon side and pine forest on the Macaya side. The upper ridge of Macaya was well-forested in pines. The pines were widely spaced in places where white karst was exposed on the ridge of Macaya. The Plain of Formon side was very cut-over, and appeared dry. The area east of Formon towards Catiche looked good from the air, with nice pockets of forest, Catiche. Excellent forest cover was observed on the east and north flanks of Pic Macaya. The forest cover of Morne Grande Colline was cut off the east and south faces of the mountain towards Macaya, but there was good forest cover on the north west flank of Colline, and on the mountains just west.

May, 1975 (Up north face of Pic Macaya)

Charles Woods, Richard Rosen, Betsy Howland, Bill Howland, and David Barrington of the University of Vermont traveled by Landrover to Les Cayes, Catiche, Duchity, Beaumont, and then via foot to Laconde, Desbarriere (962 meters), Les Angles (576 meters), across the river and up to Lorbordlo (787 meters; the name means "other side of the water"), and finally to Sapoti (1,136 meters) on a ridge on the north face of Macaya.

The route from Beaumont to Desbarriere was rugged. Most of the forest has been cut, but there was much coffee. Many peasants were carrying sacks of coffee along the trail back towards Beaumont. Along the side of the trail were coffee buyers with scales hanging from tree limbs. There were some pines, many burned and chopped, in the vicinity of Desbarriere, especially on ridge overlooking Macaya. Below Desbarriere there was a settlement called Les Anglais. The area was all in gardens. Up the valley of the Riviere de la Guinaudee there were two settlements: Tardieu and Chevrit. The area was very disturbed. They climbed up to "Sapoti," above Les Anglais and there were gardens all the way up. A settlement was carved out of the face of the mountain half-way up, called Lotbordlo (787 meters). Sapoti was a cluster of four houses, with gardens and sheep. A saddle just above the little plateau lead on to a trail up the north side of the mountain. The forest began just above the saddle. There was a spring there, and the highest garden seen was at 1,303 meters. The forest was composed of "Bwa Tremble" and "Bois Sang." The pine forest began about 1,545 meters and extended up to 1,700 meters. Above 1,700 meters, the pines mixed with thick underbrush, and became nearly impassible at 1,850 meters.

December 1982-January 1983

Charles Woods, Kevin Jordan, Mara McDonald, Jose Ottenwalder, of the University of Florida, and Donald Dod of the Jardin Botanico of the Dominican Republic climbed the south side of the ridge of Formon.

They hiked up the steep face of the Formon ridge to a campsite on shoulder of Formon at 1,650 meters. The trail from Formon to "Deglacis" passed this spot, which was called "Kay Ogil" (Caye Ogil). They climbed the trail above Kay Ogil, along a ridge until it entered a big pine forest on the top. The trail over the crest of the Formon ridge is at 1,880 meters. Vegetation on the top of the mountain was dense. At 1,740 meters on the north side, the vegetation became disturbed, and it was possible to look out to the Plaine Martin (NE) and to Pic Macaya (NW). They cut a trail westward along the ridge of Formon from 1,880 meters towards Pic Formon through second-growth scrubby vegetation and climbing bamboo. Almost no big pines are found in this area, but there were some large Bwa Tromble. Along the ridge of Formon there was evidence of old gardens and fires. Peasants were seen on the trail with sacks of beans on their heads, some coming from the ravine going to Formon, and others coming from Formon, and going to Camp Perrin.

Westward, beyond 1,880 meters, the vegetation became more natural with *Persea*, tree ferns, and fallen trees. It was very rough-going on foot because of the thickets of climbing bamboo and fallen trees.

At their campsite at "Kay Ogil," more peasants were seen going over the main trail towards Deglacis, where they said they were getting beans. They passed at the rate of about one group each hour (each group = 5 people, usually boys or young men). Big trees were being cut in the area of the camp. There were three sawmills (scieries) in forest around them, and one right at Kay Ogil. They often heard the crash of big pines being cut down each day. The woodcutters were working on the upper flanks of the basin. The edges were covered with a dense elfin forest, with some towering pines. The floor of the basin was deforested, with an ajoupa and some gardens. Three scieries were on the steep sides of the basin,

Charles Woods first climbed Pic Macaya in 1975.

and they could see skid trails where the big logs were slid down. Deforestation was going on at a rapid pace, and they saw ten trees during the course of the days journey that had been recently cut down.

January, 1984

This was the largest expedition to La Hotte. It was sponsored by USAID as part of the Biogeophysical Survey, and also by grants to Charles Woods by the National Science Foundation, the International Foundation for the Conservation of Birds, and Earthwatch.

Expedition members were Charles Woods, Dan Cordier, Tia Cordier, Ada Fowler (all of the NSF grant field crew); one Earthwatch volunteer (Ray Cleeland); Paul Paryski of ISPAN; Brent Mitchell of the Peace Corps (volunteer); Dick Franz, Bruce MacFadden, Mara Mcdonald, Fred Thompson, Walter Judd, and Scott Yocum of the University of Florida; Bryan Woods and Jeff Franz (as young volunteers); and Donald Dod of the Jardin Botanico of the Dominican Republic. The expedition included 18 people in all, with 3 vehicles plus two motorcycles.

The expedition traveled by vehicle from Camp Perrin to Les Platons. From Les Platons it proceded by foot (with 43 porters) to Formon where it settled near Madam Robert's house. It filled the field north of her house with tents, and used an ajoupa there as a cook house.

On **January 24**, we sent Brent Mitchell and three porters off to continue to extend the trail we began on the previous expedition. By **January 25**, eight people were up at the Kay Ogil camp on Formon, and ten people were working out of the Formon base camp at Madam Robert's. Each day Brent Mitchell continued to cut trail along the ridge of Formon with a crew of cutters from our base camp. The cutters were sent up early each morning with notes and food for Brent. The expedition was also working in the karst hills of Bwa Formon. This area was full of endemic plants. Dod found new orchids each day. Hispanolian hutias (*Plagiodontia*) were present, as were nesting parrots. The forest was being cut down for gardens at an alarming rate. There were new gardens all over, and each day we found new clearings, and fires. Whole hillsides were being cut and burned.

Paul Paryski and Bryan Woods reported hearing Black-capped Petrels on Pic Macaya for the first time on January 31, 1984. This was the first time Petrels had been reported in the Massif de la Hotte.

By **January 31**, the trail was finally pushed into the clearing at Le Ciel (the sky). Trail continued beyond and into a saddle where there was a wet elfin forest. This is the spot where Barker and Ekman got to in their climb of Pic Formon on January 2, 1928 (56 years ago). Paul Paryski and Bryan Woods were in the upper Ravine du Sud where Paryski heard Black-Capped Petrels on Macaya for the first time.

On **February 3**, Charles Woods, Dan Cordier, Reginald Ambroise, and two trail cutters climbed the Formon/Durand trail to the crest of the ridge of Formon and down into the upper Ravine du Sud in a driving rainstorm. The night was spent in an ajoupa at 1,650 meters on the north east shoulder of the mountain below Pic Le Ciel. Petrels were heard vocalizing after dark. Brent Mitchell continued cutting the trail over the top of Pic Formon and down the north shoulder of the saddle connecting Pic Formon and Pic Macaya.

On **February 4**, Charles Woods and his crew climbed down into the upper Ravine du Sud to an ajoupa at 1,500 meters. The area was extremely disturbed, with gardens, sheep, goats. No peasants were seen. They then began to climb up the head of the ravine towards the saddle, where they arrived at 1530 hrs., after a 7.5 hour hike. The saddle is 1,900 meters. The vegetation on the east face of the saddle was very disburbed "rage", with old gardens, some second growth, and patches of forest (unlike the west face, which was still in original forest). Camp was made at 1,900 meters in the saddle at a site we named "Amba Macaya".

Mitchell completed the Pic Formon trail to just south of their camp, and was less than 100 meters away on the far side of Tete 1919.

On **February 5**, the trail cutters began working up the steep shoulder of Macaya in the early morning, and Woods and Cordier broke camp in a misty rain at 1100 hr. The climb up Macaya was through good vegetation all the way, but the sides of the ridge were badly eroded and too steep to hold tall trees, especially to the east. Fires seemed to be common on the east side of the ridge, and also in a band above a caye (later determined to be at "Tombe Crier") on the west side of the ridge. Wet forest was present at 2,000 meters. Big pines began at 2,100 meters, where there was a magnificent stand of pines, tree ferns, ferns, and rak bwa. At 1500 hrs., they were on the lower shoulder of Macaya in dense pines and a wet forest. The trail cutters were exhausted and frightened. They quit. Woods and Cordier took machetes and continued on along a narrow open ridge that was very disturbed by fire. There were small pines and scrub forest. White-winged Crossbills were in the pines and feeding in the weeds. At 1700 hrs., they got to the top of Pic Macaya at 2,335 meters elevation. Huge pines with many fallen giant trees were on the ground. The ground was covered with pine needles and pockets of wet sphagnum moss. They found a small flat area in the middle of the plateau--about 200 feet from where the shoulder ridge joins the top of the peak (they later found the benchmark 50 feet east of this small clearing). The camp was hidden behind huge fallen pines, and had a narrow winding entrance. Cool mist blew through the trees, with darkness falling soon after their arrival. They heard Petrels at night, which seemed to be nesting in burrows on the steep face of the south slope of Macaya just west of where the ridge from the saddle joins the peak. This was the first project camp on the top of Pic Macaya.

On **February 6**, Woods, et al., worked the top of Macaya. Mitchell, A. Fowler, W. Judd and D. Franz joined the group in mid-morning, having climbed up via Brent Mitchell's trail which connected to their trail at the saddle. Paul Paryski joined the group at 1430 hr. having hiked all the way from the base camp at Formon via the Woods/Cordier route, up through the Ravine du Sud. A group of eight plus porters and cutters spent the night of February 6 on Macaya. Petrels were very abundant between 1930-2215 hrs. off the south face of Pic Macaya.

The entire group descended Macaya on February 8. They left the peak at 0845, and were down to the saddle by 0945, Pic Formon by 1100, Pic Le Ciel by 1145, base camp at 1345; five hours hike down from Pic Macaya. By dark, all groups were off the mountain and out of the ravine, and 15 biologists were back in the base camp. The expedition left Formon on Feburary 9, with 50 porters for the hike to Les Platons.

On February 5, 1984, Charles Woods and Dan Cordier set up the Macaya Biosphere Reserve campsite on the top of Pic Macaya and located the crumbly bench mark at the top of the mountain.

January, 1985

This expedition included Charles Woods and Bruce MacFadden of the Florida Museum of Natural History; Lawrence Harris of the Department of Wildlife of the University of Florida; Donny May of the University of Florida; Gaston George of the Ministere des Mines et du Ressources Energetiques; Florence Sergile of the Ministere de l'Agriculture (MARNDR); William Oliver of Jersey Wildlife Preservation Trust, and a group from the University of Vermont Field Naturalist Program (Nancy Bazilchuk, Chris Fastie, Anne Heise, John Kasmer, Tamara Naumann, Rose Paul, David Publicover, Carol Savonen, Sandy Whidden, and Koren Zimmerman). Also part of the expedition were Paul Paryski of ISPAN, and Reginald Ambroise of Camp Perrin.

Funding was via Jersey Wildlife Preservation Trust, the International Foundation for the Conservation of Birds, and USAID/Haiti as part of the Biogeophysical survey of the national parks of Haiti.

The area around Plain of Formon looked much changed in one year. All of the small limestone hummocks around the Despagne land had been cut. There seemed to be much additional deforestation on the south face of the Formon Ridge. Madam Robert had built a new caye in the field to the west of the house. There were new gardens all around the house.

The group with 21 porters climbed to Pic Le Ciel on January 22.

Treeline was at 1,840 meters. Five new clearings of .5 hectares each were observed near treeline along the trail. Some big pines had recently been cut, and a scierie was beside the trail near the treeline.

On **January 24**, the entire group started a long trek with porters up across Pic Formon, down the ridge to the saddle, up the ridge of Macaya to the upper 2,220 meters shoulder and on to camp on top of Macaya.

On **January 25**, they worked on top of Pic Macaya. Solitaires were singing at 0530. There was deep pine duff, huge old pines, and some regeneration of young pines in open spots. A small mammal trap line was set all along the ridge.

On **January 26**, they hiked all along the ridge to the west end of the upper Macaya plateau at 2,307 meters. They had to cross two deep swales to get to the western point, which was an area of exposed limestone. There were signs of fire, and numerous burned stumps on the western tete. The swales were filled with rak bwa (holly, myrtle, ferns) and towering pines, some over five feet in diameter. There was no pine regeneration in this area, suggesting that there had not been recent fires.

On **January 27**, an owl was heard during the night--maybe Stygian Owl. We departed down the mountain into the Ravine du Sud. As we departed the top of the mountain with our porters, they broke out into a song Bye bye Macaya Bye bye Macaya, etc. (We later had them do it again for us down at Madam Robert's house, and have it on tape). There was much deforestation in the upper ravine, and no water in river most of the way (it was underground). Some areas had 6-10 foot pines regenerating. It was a devastated area in comparison with the upper Ravine Trois Source on the west side. Many rocks here had come down in landslides from the shoulders of Macaya and Formon above. We arrived at the camp at the base of lower Formon/Deglacis trail at 1700 hr. There was a basin near the camp with a 50-foot waterfall where Collard Swifts were nesting. Gardens existed on shoulders above the waterfall. This must be Deglacis.

In January, 1985, a big expedition from the University of Florida, the University of Vermont and the Jersey Wildlife Preservation Trust surveyed endangered species in Parc National Pic Macaya and searched for "lost" mammals in the most remote areas of the park.

On **January 29**, most members of the expedition hiked out of Ravine du Sud. The trail up the ridge toward Formon was very steep. There was much deforestation, soil erosion, and ruined habitat. The group passed a number of ajoupas and cayes.

At Kaye Ogil, there was more deforestation than the previous year. The campsite area was much more open, with a huge garden. A pile of new pine logs was at the campsite, and an operational scierie was at the edge of the forest. There was much more deforestation in the ravine just east of Kay Ogil. The rate of deforestation in the area was accelerating.

On **January 30**, we left Formon, but left a small group behind to continue sstudying the flora and fauna of Macaya for another week.

November, 1985

Charles Woods, John Hermansonm, and Reginald Ambroise climbed Pic Macaya.

On **November 3**, they hiked up Formon/Durand trail and on to Pic Le Ciel. Forest began at 1,780 meters. Trail was open to this point. Beyond the campsite at Pic Le Ciel, the trail was very rough and overgrown. The climb over Pic Formon and down into the saddle was in hard rain, and the trail wet, steep, dangerous.

On **November 5**, they worked in saddle in morning, and climbed up to Pic Macaya at mid-day. It was a one-hour climb to knoll at 2,200 meters, and another 30 minutes to the top of Pic Macaya (so a steep 1.5 hr. climb from the saddle to the peak). They worked along the ridge. All their marking tape from the previous year was faded and tattered, so it was difficult to find their way along the ridge, and the ridge trail was overgrown.

February, 1988

Charles Woods, Paul Paryski, Catherine McIntyre, and Charles Emile Philoctete climbed up the west ridge of Pic Macaya.

This trip was via Port-a-Piment to Rendel, and then via foot to Gran Plen, and Sivette mat (1,445 meters on the west ridge of Pic Macaya). They departed Sivette at 0745 on 28 February. At 1,650-1,700 meters, there was Bwa Tromble Rak Bwa. At 1,720 meters, there was an old abandoned home site with only flat ground left and plantains growing in second-growth Rak Bwa. At 1,780 meters, the original elfin forest began with three layers;

upper = Pines, Bwa Tromble, Bois Sang;
middle = Tree Ferns and *Persea*;
lower = ferns and bird of paradise plants.

At 1,875 meters, there was a clearing with small pines, large old stumps, signs of fires. At 2,100 meters, they encountered new pines about 12 feet tall, tall brackens, rough karst topography, and a semi-flat ridge. At 2,140 meters, there was grass, bracken, small pines, exposed rocks. At 2,160 meters, they found a small saddle with many 6-12" pines. At 2,200 meters, there were huge pines (five feet in diameter) along the ridge. There were also many small 12" pines, and the area is quite open.

This group made it to just below the steep last cliff of the ridge of the summit of Pic Macaya.

December, 1988

Charles, Paul Paryski, and Roy Voss traveled by vehicle from Port-a-Piment to the end of the road beyond Rendel, and then on to the west shoulder of Pic Formon at Gran Plen where COSAR coffee cooperative headquarters is located. They were part of the Sondeo team of the University of Florida (also including Marilyn Swisher, John Lichte, Paul Monaghan, Suz Mathieu, and Michel Aubry).

On Monday December 5th, they traveled by foot eastward up the Ravine of the Riviere Trois Sources. The route is through very disturbed country in the district of Graine Mouton. The steep slopes of Pic Formon and Pic Macaya rise on either side of the river. Beans were planted in cleared fields up to about 1,500 meters elevation. At the east end of the ravine was a small mountain called Morne Bois Pin. The trail climbed up and over this pine-covered hill, which marks the end of COSAR-owned land. The gardens on the Formon side opposite the hill are on very steep terrain of Pic Formon, and were eroding badly. Gardens extended up to 1,600 meters and were filled with beans, potats, and grazing sheep (c. 24). It was an ecological disaster.

Beyond the hill, the landscape became much more natural, but there were three permanent houses. One was near the river not far beyond the mountain. Coffee was growing there, and a very bad landslide descended from a garden on the steep

In 1988, a Macaya Biosphere Reserve team climbed Pic Macaya from the west, the old route of Ekman (1928) and Wetmore (1931). The trail was almost completely abandoned and difficult to follow, but signs of abandoned houses and gardens showed the area was previously more inhabited.

slope of Formon. About .5 km beyond this place, there was another house on the Macaya side of the river. This area is called "Tombe Crea" (Tomber Crier), which should mean "fall down and cry," but the local peasants insisted meant "rain that falls like tears" (for all the rain). Gardens were on the steep slope of Macaya, up to about 1,400 meters. Neither of these permanent houses was inhabited with family groups, and may have been "super-ajoupas" or semi-abandoned permanent settlements. Both were primitive, but had cooking cayes, and each had fires going in the cook house. Beyond this, the trail clings to the Macaya side. Only one garden was observed on the Formon side. Most of the forest on the Formon side was original, dense rain forest dominated by Bwa Tromble and huge pines, with an understory of tree ferns and *Persea*. It looked nearly impenetrable. The Macaya side was drier, with pines, grass, and bracken ferns extending down to the river where there were no gardens.

The last caye in the ravine was perched up on the Macaya side at 1,475 meters elevation, just below the huge burn on the south west face of Macaya (B.C. Petrel side). The compound was called "Twompe" (La Tromp), and was inhabbited by an old man named Pierre-Edmond Paul and his family. The man had been here about 40 years, and said he came here via Beaumont, Desbarriere, La Hotte, and the ravine. He did not rent the land; "God gave it to me" he said. He had gardens of beans on the steepest slopes (over 60°) on the Macaya mountainside above the river. Some of these gardens had recently been washed away (probably as a result of the hurricane). A new garden had just been cleared, and the soil slid out from under our feet as we walked, and tumbled into the ravine below as we made our way across the garden. It was a terrible ecological disaster in the making.

Beyond this last garden, the forest became completely natural for one kilometer to the saddle connecting Macaya with Formon, which we could see just above us. The habitat was impenetrable. Water flowed in the river, and a 200-foot waterfall tumbled into the ravine from the steep slope of the saddle. There were huge pines on the Macaya side, and Bwa Tromble and pines on Formon. We ate lunch on an extremely steep slope at the base of a five-foot diameter giant pine at 1,560 meters elevation overlooking the ravine and waterfall. A rock dropped from where we ate, descended for 7.5 seconds before hitting the bottom of the ravine below. This wet, steep head of the ravine of the Riviere Trois Sources was still in a completely natural state from the spot where we ate lunch east for a distance of one kilomeeter to the saddle and then up to the crest of both Pic Macaya and Pic Formon. Such was not the case on the east side of the saddle.

In December, 1988, the Macaya Biosphere Reserve Project conducted a Sondeo on the western side of the National Park and showed that the area was being envrionmentally devastated.

The presence of the local peasant (Pierre-Edmond Paul) clearly was the reason for the fires that have swept up the south west face of Macaya, although he denied knowing anything about the fires.

Pierre-Edmond Paul remembered Paul Mertans and his friends as they descend off of Macaya several years ago. They came down through his garden. He kept pointing up above his garden saying there was a big route to Macaya there, but that Macaya was far away. He did not know of the Zagouti or of the Black-capped Petrel, even though both are nearby.

There was a huge washout next to the peasants' house, where massive amounts of water came down off the burned face of Pic Macaya during Hurricane Gilbert. The washout included giant boulders, and had big pines that had broken in lengths and smashed. Some rocks were 6' up in trees.

January-February 1989

Between January 28 and February 5, 1989, a team headed by Charles Woods spent nine days in the region of Pic Macaya conducting a Sondeo as part of the UFMBR project. The members of this team were (in alphabetical order):

Jenness McBride (UFMBRP), Paul Paryski (UFMBRP), Charles Emile Philoctete (USAID), Denique Philoctete (UFMBRP), Felix Saint Pierre (MARNDR), Roy Voss (UFMBRP), Charles A. Woods (UFMBRP), and Ellen S. Woods (Volunteer).

The team assembled at Formon on January 28, 1989, at the MBR field headquarters on the Plain of Formon adjacent to the house of Madam Robert (Tila Despagne). The weather was too rainy to climb on January 29, and so the team worked in the Plain of Formon region. On January 30, the team departed Formon (957 meters) and hiked west to the Plain of Durand (1,200 meters) and then up the west trail over the ridge Morne Formon (2,000 meters) and down into the most western end of the Ravine du Sud (1,400 meters). The journey took eight hours because of rain and very slippery trail. Camp was made in an open rocky "galet" in a region known by the guides as "Pa Lan Kont". On January 31, the team hiked up the east wall of the saddle connecting Pic Formon with Pic Macaya to the camp ground in the saddle at 1,870 meters ("Fraz" according to the guides, sometimes called "Amba Macaya" by biologists working with the UFMBR project), and then north up the shoulder of Pic Macaya to the top of the mountain at 2,347 meters. The name "Fraz" was applied to the resting place in the saddle by several people, especially Redicule Beljean (who knows the area well). We are not sure of the meaning of the local name, which may come from the French word Phrase (a sentence), or more likely from an alternative to the Creole word for "chitchat." The journey from Pa Lan Kont to the summit of Pic Macaya took seven hours. The trail along the way had to be cleared by guides with machettes because there had been so much regeneration of vegetation since our last visit to the top of Macaya in 1986. The Sondeo team split into two sections, with McBride, Paryski, C.E. Philoctete, and D. Philoctete camping at "Fraz" in the saddle; and F. Saint-Pierre, R. Voss, C. Woods, and E. Woods camping at the summit of Pic Macaya. All members of the team visited the top of Pic Macaya. Data on the status of the forest, flora, and fauna were gathered for two days along the transect from the saddle to Pic Macaya.

On February 2, C.E. Philoctete, D. Philoctete, and F. Saint-Pierre began the journey back to Formon, while Paryski, McBride, Voss, C. Woods, and E. Woods journeyed down the Ravine du Sud via Pa Lan Kont to Deglacis. The journey from Pic Macaya to Formon took ten hours, while the journey to Deglacis took five hours. The route to Deglacis is along a poorly defined trail to Pa Lan Kont. It then follows the riverbed of the Riviere de la Ravine du Sud, which is difficult to traverse. Much of the water in the river is flowing underground, and it is necessary to climb around slowly and sometimes over huge boulders. Occasional springs enter the river from the steep walls of the ravine, and two major streams join the ravine. The team spent the night of February 2 at the place where the trail to Formon via "Kay Ogil" joins the ravine, and near where a waterfall enters the ravine from the Macaya side. The region was referred to by the guides as the beginning of Deglacis. They stated that the Deglacis region continued on downstream for another three hours walk. The area above the ravine to the north and west of our camp, which is on a high shoulder of Macaya where the slope is not too steep to plant, is called "Kay Ropano" by the guides in reference to the house with a tall roof that Ropano Despagne built there. The team interviewed inhabitants of Deglacis the evening of February 2, and the morning of February 3. The team then hiked out of the Ravine via "Kay Ogil" to the headquarters at Formon on February 3. The journey took seven hours. McBride and Paryski departed for Camp Perrin on February 3. Voss, C. Woods, and E. Woods worked in the Plain of Formon and Rak Bwa Formon on February 4 and 5, before departing for Camp Perrin on February 5.

In 1989, the Macaya Biosphere Reserve team conducted a Sondeo in the Ravine du Sud and top of Pic Macaya.

Richard Rosen

American Biologist

Represented University of Florida and Charles Woods

January 1977

Richard Rosen, Margaret Langworthy, James Bicket, and Andy Wagler traveled by foot from Catiche to Tombe Cheval down into a branch of the Ravine Du Sud, up again and west along a ridge of Pic Macaya to 1,460 meters where there were many big gardens of beans, malanga, mazumbelle, yams, potats, but few people, and back down into the main Ravine du Sud at 855 meters, where they made camp at a small settlement (Deglacis). From there they followed the very steep main trail up to 1,788 meters on the ridge of Formon, which they noted was covered with huge pines and dense forest beginning at about 1,515 meters. They came down the south side of the ridge of Formon via the trail through Caye Ogil to the town of Formon where they slept in the Catholic church (855 meters) on the night of 4 January 1977. They then traveled across the Plain of Durand, down the steep trail of Morne Cavalier, and along the Riviere Port-a-Piment to Grande Plain. On the morning of 6 January, they met Charles Woods in Port Salute Airport. An amazing journey. The porters frequently said that this route was impossible, and that the only way to go from Catiche to Pic Macaya and Pic Formon was via Desbarriere. They kept trying to talk Rosen et al. into the Desbarriere route.

Conclusions

The history of exploration in the Pic Macaya area is closely linked to the creation of Parc National Pic Macaya.

These expeditions clearly document the changes that have occurred in the natural habitat of the region.

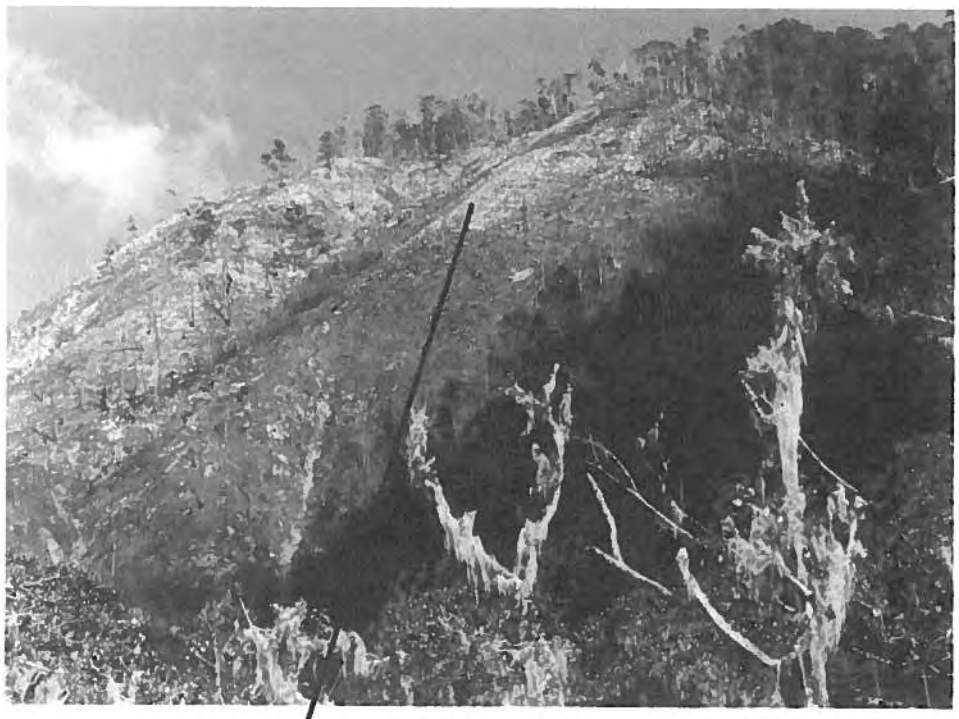
This chapter documents that a number of expeditions have climbed Pic Macaya and worked in the area of the Macaya Biosphere Reserve during the last 75 years. But, as the quotations from Erik Ekman clearly document, the earliest expeditions to Macaya in the first three decades of this century encountered a nearly impenetrable wilderness. These observations have been confirmed by Charles Woods, who interviewed both Dr. Henry Barker, who journeyed to the top of Pic Formon with Erik Ekman in 1926, and Dr. Philip Darlington, who climbed up the north face of Pic Macaya in 1934. Both scientists remembered their journeys to the Macaya area vividly, and both reported a nearly pristine environment of tall trees and well-forested mountain slopes. These conversations are preserved on tape, and are in the archives of the Florida Museum of Natural History.

Other individuals and small groups worked in the Macaya area, and some even climbed to the top of Pic Macaya. We have attempted to document some of them in the chronology list of this chapter. Paul Paryski, for example, made several climbs into the area during the early years that he was associated with ISPAN. The accounts discussed in detail in this chapter, however, have concentrated on expeditions which left behind field notes or journals that could be referred to for specific information and original observations. Many quotes from these journals are included in this chapter in order to document the changes that have occurred in the Macaya area during the past century. It is clear that many changes have taken place. The environment encountered by Ekman, Barker, Darlington, and Wetmore is nearly gone. The changes were occurring slowly, and indeed some were well underway by the time these great explorers and naturalists worked in the area. The changes accelerated following the completion of the Cayes to Jeremie road in the 1930s. But the most radical changes began in the late 1940s and early 1950s, when peasant farmers began to colonize the remote corners of the region, such as Deglacis in the upper Ravine du Sud and Trombe of the upper

Riviere Trois Sources. These early colonists could still be found in the region, and we interviewed several of the first people into the region during the course of our work on the MBR project reported here. The impacts of these pioneer efforts, such as burning the steep hillside for gardens, and cutting the gigantic ancient pines for planks, were visible everywhere by the time our expeditions into the area began in 1975. And on our most recent trip into the Formon/Macaya area in April of 1992, we observed an even faster rate of deforestation and habitat destruction. The loss of forest cover in some regions was so total that without the original observations reported in this chapter it would be nearly impossible to know that the area was ever forested or supported a rich flora and fauna. It is a sad story that is being made even sadder by the recent political events in Haiti, and the effects of the OAS embargo, which have led to widespread chaos and environmental destruction. It is as if the memory of the presence and importance of the natural patrimony of Haiti has vanished. It is to hold onto this memory that this chapter is presented as part of the final reports of the USAID Macaya Biosphere Reserve Project.

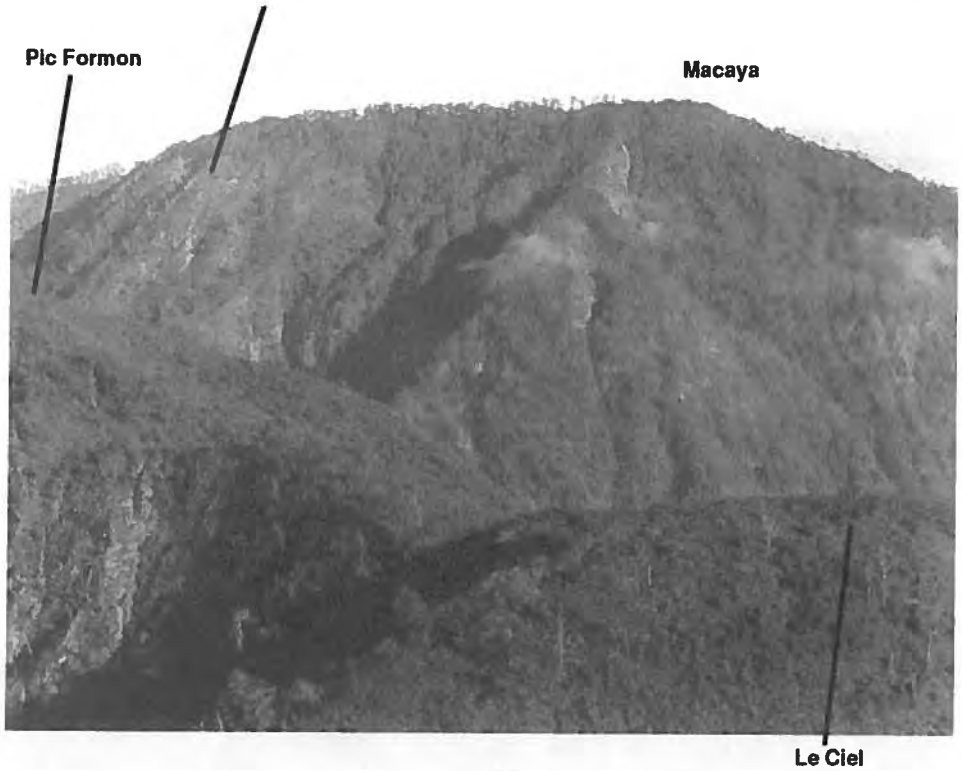
These observations on the history of the Macaya area clearly document how important the USAID/UF MBR project has been. Without the radical interventions associated with this project, and the sense of history and documentation of the natural ecosystem of the area provided by naturalists from the University of Florida, it is our opinion that the Macaya/Formon area would have been almost completely deforested by 1992. This was the prediction of Warren Cohen in his analysis of patterns of deforestation in Haiti. If this had been true, the historical accounts presented here would be sad and melancholy echoes of an important ecosystem lost forever, instead of guidelines for an ongoing stewardship plan that can save the watersheds of southwestern Haiti as well as preserve a measure of the biological diversity of the country. It is not too late. But the changes in the ecosystem of Macaya documented here point out how vulnerable the area is, and how rapid the rate of habitat destruction can be once it gets underway.

University of Florida Macaya Biosphere Reserve crew at Formon



1986

View of an extensive area of burned habitat on the southwest shoulder of Pic Macaya taken in 1986. Black-capped Petrels breed on the southern cliffs.



1977

Central core of Parc National Pic Macaya taken from a small airplane in 1977. Note the differences in vegetative cover between 1977 and 1986.

CHAPTER III

Summary of Biogeophysical Information on the Macaya Area

Introduction

This chapter summarizes all of the reports of the biogeophysical inventories of the University of Florida Biogeophysical Inventory (Franz and Cordier, 1986; Gali and Schwartz, 1986; Judd, 1986; MacFadden, 1986; Thompson, 1986; Woods, 1986; Woods and Ottenwalder, 1986). An attempt has been made to review the most important features of Parc Macaya and the surrounding area of the Macaya Biosphere Reserve, and to provide a synthesis of the information necessary for planning as well as understanding the significance of Parc Macaya. Each original report stands on its own and should be consulted for detailed information concerning Parc Macaya. Some of the reports have been expanded upon in later publications. A more complete analysis of the botanical features of the Macaya and La Viste regions was published by Judd (1987), and Judd and Skean (1987), based on their original field work and additional data collected in the early years of the MBR project. A more complete review of the birds of the region has been done by Woods (1987), and birds are further discussed in a separate chapter in this book (Chapter IV, Birds of the Macaya Area). The mammals of the region are discussed in more detail by Woods (1989a, 1989b, 1989e), and by Woods, Ottenwalder and Oliver (1986). Mammals, because of their importance in the Haitian ecosystem and extreme vulnerability to habitat destruction, are also discussed in greater detail in Chapter V of this volume (Mammals of the Macaya Area). This chapter is designed to give individuals who are interested in flora and fauna of Haiti a quick overview of the major features of the area. It is as up-to-date as we can make it. We hope it clearly documents how important the Macaya region is as one of the last pockets of biological diversity in Haiti.

The Geology of Parc National Pic Macaya

The interpretation of the structural geology of Parc Macaya is complicated by the extensive weathering of the outcrops and the dense vegetation cover of most sections of the park. There are numerous faults, some trending east-west along the Grande Ravine du Sud and others north-south in the Macaya Formation.

One of the most significant geological features of Parc Macaya is the extensive karst topography that occurs along the areas of low relief east and south of Morne Cavalier. Karst is also exposed along the ridges between 1,800-2,000 meters east of Pic Formon and along the ridge between Pic Formon and Pic Macaya. Most exposures of karst in the park are associated with the "karst hills" that cover the edge of the Plain of Formon, which are really cones of karst. Low areas are frequently doline collapses or sinkholes. Steep-sided solution pipes and sinkholes are often encountered on the Plain of Formon and Plain of Durand. Even though the area receives abundant rainfall, most water quickly enters the subsurface hydrologic cycle via the extensive joint system and larger-scale solution features (flowing into caves).

The main body of the park is composed of two tall peaks, Pic Formon and Pic Macaya. They are separated by an active east-west trending fault system that forms the "Gran Ravin," and the Ravine du Sud east of the ridge connecting Pic Formon and Pic Macaya indicates active vertical uplift in the region. The upper surfaces of both mountains are covered with deep rich soils that support a dense forest. These soils are highly oxidized, reddish laterites. There is a thick layer of humus formed by decomposing vegetation.

The long fault that originated in the Miocene passes through much of the Southern Peninsula and crosses Parc Macaya via the "Gran Ravin." The evidence of active vertical tectonics in the region is found in the steep slopes of the ravine, the numerous talus deposits that flow out onto the bottom of the ravine and flat areas on the slopes above, and the frequent occurrence of massive landslides.

The rocks of the park are from two formations. Most rocks are limestones of the Macaya Formation. These massive limestones are characterized by numerous veins of calcite. Most rocks are fine-grained and light grey in color. Occasionally, greyish-brown or even darker rocks are encountered. This rock formation is very old, probably originating in the late Cretaceous 70 to 80 million years ago. During this time, the western portion of what is now the Southern Peninsula, and the Parc National Pic Macaya was a back-arc basin that may have been detached from northern Haiti and located hundreds of kilometers to the west of its present position.

Hispaniola was separated into at least two islands in the past, one being the "South Island," the present-day southern peninsula of Haiti. It joined the rest of Haiti about nine million years ago.

The second formation found in the park is the "Demisseau Formation." This is the same formation that is found in Parc National La Visite north of the La Selle Escarpment. It is a deep-water deposit consisting of basaltic volcanics (lava flowing under the ocean surface), turbidites, limestones, cherts and siliceous sandstones. Rocks derived from this formation are exposed at 1,150 meters in the stream basin of the Grande Ravine du Sud. Other outcrops of basalt can be observed at 1,400-1,600 meters elevation along the southern slope of the ridge of Formon. Most workers believe that the Demisseau Formation underlies the Macaya Formation, and is therefore older.

Both the Macaya and Demisseau formations were formed in the deep ocean in the ancient Caribbean Sea. This sea became shallow in the area of what is now the peninsula of Haiti in the early Tertiary. During the middle Tertiary (Miocene), a major tectonic left-lateral fault developed. Since this time there have been continued lateral and vertical tectonic events that have shaped the land as we see it today. The late Tertiary and Quaternary (last nine million years) have been

characterized by the formation of karst landforms and lateritic soils. If Hispaniola was separated into two islands, as some geologists believe, then the Southern Peninsula would have joined the rest of Haiti about nine million years ago.

Karst topography predominates east and south of Morne Cavalier and between 1,800 and 2,000 meters elevations east of Pic Formon and along the ridge between Pic Formon and Pic Macaya. Exposure of karst is associated with the karst hills covering the edge of the plain of Formon and the plain of Durand, the "rak bwa." Solution pipes and sinkholes are common on the plain of Formon and on the plain of Durand as well. Exposured blocks of limestone stand like monuments on the surface.

The limestone varies in hardness and fracturing, and may not be able to be treated as a single formation. Water penetration through cracks and fissures and consequent runoff will be associated with these differences. Below the limestone lies a complex that was formed under the sea in the late Cretatian period.

Basalt exists as pillow lavas, dikes and other thin strata intruded into the basement rock. This basement rock is composed of deep-water marine limestone, shale and other sedimentary rocks veined with calcite.

When weathered, these rocks are highly erodible. The most notable feature caused by this erosion in the park area can be seen in the undercutting of the rock under the limestone of the Demisseau formation, causing the great cliffs of the massif. Differences in topography are reflections of the predominate underlying material. Those areas underlain with limestone are usually rounded on the ridges and in the ravines. Soils and rock are usually more stable on these materials. On the other hand, where the sedimentary/basaltic rock is found, ridges are sharp, and "V-shaped" ravines are common, as the material is highly erodible.

Based on the predominant geological formations in the area, three general types of topography can be defined. These correspond to some degree to current land use patterns and are also an important element in developing a land use plan for the future.

(1) The first type consists of very steep, upper slopes. Such lands are in some cases utilized today for agriculture, particularly in the Trois Sources area. They are not, however, generally appropriate for agricultural land use. It is recommended that long-term planning move toward a system in which use of these lands is restricted to conservation purposes and/or very limited use of natural resources (e.g., selective exploitation of native vegetation).

The steep slopes of the upper Ravine du Sud are geologically active and characterized by frequent landslides.

(2) The second type consists of moderately sloping to steep hillsides, and corresponds in large part to the karst outcroppings, known locally as rak bwa. While some farmers are presently almost entirely dependent on these areas for agricultural production, most farmers who utilize the rak bwa also have access to more productive lands at lower elevations and/or with lower slopes. These rak bwa lands are highly variable. In some cases they are appropriate for limited agricultural use (particularly agroforestry), but in other cases extreme degradation has already occurred, limiting their utility in the future. In the latter case, rehabilitation is critical--that is, systems must be devised which can improve the quality of these lands.

(3) Finally, much of the area consists of formations which are quite appropriate for intensive, sustained agricultural production. These lands include the nearly level plains (such as Durand) and gently sloping hillsides. Most of these lands are in agricultural production today and should continue to be utilized for agriculture in the future. Conservation agricultural practices should be

developed which can assist farmers in making the most productive use of such lands.

The forces that shaped geological conditions in Haiti are still at work in the region of the Macaya Biosphere Reserve. One of the best places in all Hispaniola to stand and appreciate the forces of geological events in action is in the upper Grande Ravine du Sud at 1,600 meters elevation.

The Soils of the Macaya Region

In the central portion of the Plain of Formon, the soils are deep oxisols formed on predominantly limestone parent rock. These soils are dark red and deep, with moderate fertility levels. Soil pH is nearly neutral. Lower down the slope, the soil changes to a brown ultisol formed on the non-limestone rock. Because slopes are not severe, the soils are relatively deep and somewhat fertile, with nitrogen and phosphorus being the most commonly deficient nutrients. The pH of these soils is slightly acid.

On the slopes of the upper area of Durand, the soils are relatively deep and coarse-textured ultisols that may be formed on the colluvium and alluvium that has washed downslope from underneath the Demmissaeu formation. Some explosive volcanics of a later geologic era may have also contributed to the parent material of these soils. The soils are less weathered and the coarse texture leaves them draughty and dryer than surrounding souls.

Toward Kay Tilus and the ridge of Formon, the steep slopes have been cleared, exposing the ultisols. Severe erosion is in process, but farming continues in spite of landslide and landslip on nearly all of the deforested slopes.

On areas of rak bwa, a large portion of the soil surface is covered by limestone rock formations and strewn rocks, but the soils are nonetheless deep and fertile oxisols. Production is severely limited by the portion of the soil surface not covered with rock.

Across the escarpment toward Cavalier, the soils are predominantly brown ultisols. On the upper slopes below the market of Sous Bois, the soils are relatively recently cleared and hence moderately deep. Because of the nature of the soil, however, they are subject to erosion and may rapidly degrade. Because of the limestone on the rak bwa above them, they retain a neutral pH. Lower on the valley floor, the ultisols have been cultivated much longer, and even with less slopes, are eroded moderately.

The soils of the Formon region are extremely variable and form a mosaic of intermixed soil types.

To the west of the Park in the areas near the COSAR area, the soils follow the same pattern of ultisol formation. Cleared land is showing signs of erosion and in some areas the plinthite subsoil is at the surface. High up the Port-a-Piment river clearing and fire during the last ten years has caused a severe avalanche hazard that should be addressed immediately.

The three predominant soil types described above coincide to some degree with the major topographical features of the region. However, it must be stressed that soils in the entire region are extremely variable and form a mosaic of intermixed soil types in some areas which will require extremely careful attention when agricultural land use is suggested.

In general, the oxisols occupy the nearly flat plains and very lowest slopes in the region. They are much more prevalent in the Formon area than in the Trois Sources area. While they do offer problems of fertility, their structure is excellent and they are highly resistant to erosion, in addition to occupying the least erodible sites. Intensive agricultural production on these soils should be possible.

Deep ultisols occupy many of the intermediate slopes, including large portions of the rak bwa area. These soils are much more susceptible to erosion than the oxisols and must be treated with great care. In many cases, current land use will not be sustainable on these soils, especially when it occurs on steep slopes. These soils should, over the long term, receive the greatest attention regarding appropriate agricultural and/or non-agricultural land use practices. These soils have also been highly degraded in many areas and will require rehabilitation if they are to prove productive in the future.

The upper slopes are occupied in many cases by thinner ultisols, even more susceptible to erosion than those occupying the lower slopes and rak bwa. These soils are very prevalent in the Trois Sources zone, and contribute to the very severe erosion problems that are so visible in that area. In the vast majority of cases, prolonged agricultural production will not be possible on these soils. It should be noted that the upper slopes show extreme variability in soil type and that generalization is difficult. Further study of these soils is critical, particularly in areas of intensive utilization.

Floristic Features of the Macaya Area

The vegetation of Parc National Pic Macaya in the Massif de la Hotte consists of an extremely diverse, moist broadleaved forest growing on and around areas of exposed limestone at the lower elevations of the park and extending upward to about 1,250 meters elevation. Above 1,250 meters, a complex mosaic of habitats exists, ranging from moist, dense cloud forest to occasional open, savanna-like pine forest (best developed above 1,600 meters). Human-caused disturbance is extensive below 1,600 meters.

Judd (1986:7-10) divides the vegetation in the Macaya region into two major types. The first is an extremely diverse wet forest on limestone. This is equivalent to Holdridge's (Sedwitz and Canet, 1972) "foret tres humide de Montagne de basse altitude," and ranges upward to about 1,250 meters elevation. The second forest type described by Judd is a complex mosaic of pine and cloud forest formations. Local edaphic factors such as soil, exposure, local precipitation amounts, wind patterns as well as historic factors (i.e. fire, cutting, hurricanes), influence what type of forest will grow in a particular locality. Because it is difficult to speak of the park in specific terms within the general forest types mentioned above, we have subdivided the forest types with several sub-units.

The lower "wet forest on limestone" is subdivided into four types of habitat.

1) Mature broadleaved forest (Creole name "Rak Bwa Woch"). This is a typical forest of the karst hills on the edge of the Plain of Formon. The species composition is described by Judd (1986:9-10).

2) Fragmented broadleaved forest (Creole name "Bwa Raje Woch). This is a small patch of the preceding forest type, or one that has been dramatically altered by selective cutting.

3) Abandoned gardens or areas of early succession (Creole name "Raje"). Grassy areas on the Plain of Formon or in the foothills below 1,300 meters.

4) Gardens (Creole name "Jadin"). Gardens planted in cleared areas within the "Rak Bwa Woch" or on the Plain of Formon.

The endemic pine of Hispaniola is *Pinus occidentalis*.

The Hispanolian White-winged Crossbill is totally dependent on this pine for its food of mature pine seeds.

The complex of forest types above 1,300 meters elevation have been subdivided into the following units.

1) Pine forest (Creole name "Bwa pen"). This forest type is described by Judd (1986:7). It is similar to the pine forest in La Visite except it is much moister and has many more broadleaved plants in the understory.

2) Successional pine forest (Creole name "Bwa pen Raje"). Young stands of *Pinus occidentalis* with blackberries (*Rubus* spp.) and braken ferns.

3) Mature hardwood forest or "cloud forest" (Creole name "Rak Bwa"). This forest has few or no overstory pines, and usually has large and conspicuous individual *Didymopanax tremulum* trees (called "Bwa Tramble"). The understory is a diverse array of small trees and shrubs such as *Garrya fadyenii, Myrsine coriacea, Brunellia comocladiifolia* and the important wild avocado *Persea anomala*. The climbing bamboo *Arthrostylidium haitiense* ("liane a scie") grows up in sunny spots and makes many areas of this habitat almost impenetrable.

4) Fragmented hardwood forest (Creole name "Bwa Raje"). Small patches of "Rak Bwa," or hillsides where the typical "Rak Bwa" has been modified by fire or wind damage so that only a few species are present. In these disturbed zones, the climbing bamboo often grows up and over all of the fallen vegetation.

5) Abandoned gardens or areas of early succession (Creole name "Raje").

6) Gardens (Creole name "Jadin").

The above designations in conjunction with the discussion and species lists available in Judd (1986) allow us to understand the fine-grain distribution of vegetation types and associated flora found in various regions of the park. A further indication of the importance of Parc Macaya is demonstrated by examining the ecological map of Haiti prepared by L.R. Holdridge for the Organization of American States (Sedwitz and Canet, 1972). The map shows five vegetation formations occurring within the boundaries of the park and associated buffer zone. These formations are determined on the basis of elevation, precipitation, evaporation, and climate. The five formations are described below. The French name for the formation is given as presented on the map by Holdridge (Sedwitz and Canet, 1972). The English name is taken from Holdridge (1947:138) in the work on the pine forests of Haiti in which he developed his now-famous system for classifying vegetation types. The presence of five vegetation formations in one small region is an indication of the ecological importance of Parc National Pic Macaya. Some of these formations are associated with abundant rainfall, further pointing out the significance of the park in water conservation (see plate 6 in Atlas d'Haiti, Lasserre et al., 1985).

Five major vegetation formations occur within the boundaries of the Macaya Biosphere Reserve.

1) Foret tres humide de Montagne de basse altitude (Fth-Mb)
Tropical lower montane wet forest formation.
-Precipitation 2,000-4,000 mm.
-Plain of Formon, foot hills of massif and karst hills.

2) Foret tres humide de la zone Sous-Tropicale (Fth-S)
Subtropical wet forest formation.
-Precipitation 2,000-4,000 mm.
-Valley of Riviere des Roseaux and north face of Pic Macaya.

3) Foret tres humide de Montagne (Fth-M)
Tropical Montane wet forest formation.
-Precipitation 1,000-2,000 mm.
-Upper ridge and peak of Formon and Macaya.

4) Foret pluvieuse de Montagne de basse altitude (Fp-Mb)
Tropical lower montane rain forest formation.
-Precipitation over 4,000 mm.
-Upper "Gran Ravin" and Ravine du Sud and the plain east of Macaya towards Catiche and Duchity (Mare Cochon).

5) Foret pluvieuse de la zone Sous-Tropicale
Subtropical rain forest formation.
-Precipitation over 4,000 mm.
-Lower area of Ravine of Ravine du Sud and along the edge of the plateau of Mare Cochon towards Catiche where the road from Cayes to Jeremie crosses over to the top of the plateau.

A total of 463 species of vascular plants (including 359 flowering plants, 1 conifer, 102 ferns and fern allies) were collected in Macaya National Park. These belong to 263 genera in 109 families. The largest families (excluding the Orchidaceae) include the Melastomataceae (34 species), Asteraceae (30), Polypodiaceae *s. str.* (22), Piperaceae (19), Rubiaceae (19), Urticaceae *s. lat.* (19), Dryopteridaceae (17), Poaceae (15), Solanaceae (13), Bromeliaceae (12), and Myrtaceae (12). The total vascular flora includes 130 species endemic to Hispaniola (28% of the flora of the park). Of these, 69 are endemic to the Massif de la Hotte (15% of park flora). The degree of endemism among the flowering plants was slightly greater with 124 endemic species (34%). Of these, 68 (about 19%) are endemic to the Massif de la Hotte. Only six percent of the fern and fern allies of Macaya are endemic. Families with large numbers of endemic species include Melastomataceae (26), Urticaceae (12), Asteraceae (15), Solanaceae (7), and Myrtaceae (6). A total of 99 species of mosses and over 49 species of liverworts were collected in Parc Macaya. Very few of these are endemic.

The species of special concern (endangered species) in Parc National Pic Macaya as determined by Dr. Walter Judd of the University of Florida include a number of endemics with ranges restricted to the Massif de la Hotte.

Species that are especially susceptible to disturbance are listed below:

Myrsine magnoliifolia
Meliosoma abbreviata
Calycogonium torbecianum
Tabebuia conferta
Brunfelsia picardae

The Orchids of Parc National Pic Macaya

There are at least 133 species in 42 genera of orchids in Parc National Pic Macaya. Of these, 38 are endemic to the Massif de la Hotte (often to the park area itself), and 58 are endemic to Hispaniola. The most important habitats for

One of the endemic orchids of Haiti

orchids are the mesic broadleaved forests of the karst hills along the edge of the Plain of Formon between 950-1,150 meters elevation. Many of the orchids in this area are small and inconspicuous, but none-the-less scientifically important.

The diversity of orchids growing in the upper areas of the park is considerably below the incredible diversity found in the forests of the karst hills. Only 40 species were found on a flat basin below the ridge of Formon at 1,550 meters elevation, and even fewer orchids were found at higher elevations in the park.

The diversity of orchids in Parc National Pic Macaya is truly phenomenal. The presence of 133 species of 42 genera in an area of less than ten square kilometers is extraordinary, especially when it is realized that Hispaniola has fewer than 350 orchids recorded for the entire island. This means that almost 40% of all the orchids of the island occur in Parc Macaya. Almost all of these occur in the broadleaved forests of the Plain of Formon. The region of Parc Macaya, and especially the region including the karst hills and Morne Cavalier (Bwa Formon and Bwa Durand) is a piece of ecology so valuable that it must be preserved.

The Macaya Biosphere Reserve and its Butterflies

Eleven species of butterflies are known from Parc Macaya, which is almost half the number of species known to occur in Parc La Visite (20, and possibly 21). The two parks have six species in common. One species, *Calisto loxias,* is known only from the Massif de la Hotte. The genus *Calisto* is predominantly an upland group, often restricted to one mountain massif. It is not surprising, therefore, that a member of this genus is apparently endemic to the Parc Macaya region while another is endemic to the Parc La Visite.

The reason so many more butterflies occur in the Parc La Visite region than in Parc Macaya is unresolved. Several species missing from Parc Macaya are widespread in Hispaniola, and it is surprising that they are not found in the Macaya area. One explanation is clearly that Parc Macaya is more isolated than Parc La Visite. This appears to be one of the main explanations for why five endemic birds which are common in La Visite do not occur in Macaya. A second possible explanation may relate to the more complete forest cover in the Parc Macaya region, which may reduce the chance occurrence of lowland forms. A list of the species of butterflies found in each park is presented in Table 1.

Parc National Pic Macaya and its Land Mollusks

At least 23 endemic species of land snails are known only from the immediate area of Parc National Pic Macaya.

Fifty-seven species of land snails were reported from Parc Macaya by Thompson (1986). Of these, 23 are endemic species that are known only from the immediate area of the park. Twenty-seven new species (two of which represent new genera) were collected in Parc Macaya.

The large number of new endemic taxa is an indication of the importance of the habitats included within the boundaries of Parc Macaya. The most important habitat for land snails in Parc Macaya is the "Bwa Formon" region along the escarpment at the edge of the Plain of Formon. This middle elevation region (1,000 meters) is one of the few such undisturbed habitats left in Haiti. The higher elevations of the park are more depauperate in the number of species; however, nearly all species occurring in habitats above 1,800 meters are locally endemic. Table 2 lists all of the land snails known to occur in Parc Macaya.

The Reptiles and Amphibians of the Macaya Biosphere Reserve

The Annotated List (Table 3) cites more than 50 amphibians and reptiles in the Massif de la Hotte area. This list and the analysis below do not take into consideration those taxa whose distributions are confined to coastal and low elevations sites (under 700 meters), and undescribed or unidentified taxa found during recent explorations. At least two of the new taxa are unique frogs from the ridge of Formon in the vicinity of Pic Le Ciel, Pic Formon and the north slope down to approximately 1,650 meters. This species is now under study by Blair Hedges, Richard Thomas, and Richard Franz and will be described in a separate publication.

Collections from the study area include 18 frogs, 11 lizards, and five snakes. These represent approximately 63% of the taxa presented in the Annotated List. In general, Parc National Pic Macaya includes a mixture of both wide-ranging and highly restrictive species. The wide-ranging amphibians and reptiles are usually well-represented in collections from lower elevations, while the restrictive ones are confined to specific habitats and/or certain altitudes. The greatest species richness occurs at elevations under 1,300 meters. As one ascends in elevation the number of species decreases markedly until there are but three species on Pic Macaya (elevation 2,347 meters). Within the proposed park area (between 1,600 and 2,347 meters), eight species were found. Five were restricted to mid and high elevation sites, while three where wide-ranging. Only *Eleutherodactylus ventrilineatus* and the two undescribed frogs appear to be endemic to the proposed park itself.

Expansion of the park boundaries would increase the number of species present in the park. Inclusion of Morne Cavalier and the south slopes of Pic Formon and Pic Macaya add an additional seven taxa (*Eleutherodactylus nortoni, Celestus costatus costatus, Anolis coelestinus coelestinus, Chamaelinorops barbouri, Leiocephalus melanochlorus melanochlorus, Antilliophis parvifrons parvifrons, Darlingtonia haetiana haetiana*). Inclusion of portions of the upper Plain of Formon, the karst hills to Sous Bois, and Grande Ravine du Sud add 15 more taxa (*Eleutherodactylus chlorophenax, Eleutherodactylus lamprotes, Eleutherodactylus wetmorei wetmorei, Hyla heilprini, Hyla pulchrilineata, Hyla vasta, Osteopilus dominicensis, Celestes stenurus stenurus, Anolis cybotes cybotes, Anolis dolichocephalus sarmenticola, Anolis monticola quadrisartus, Anolis ricordi leberi, Epicrates gracilus hapalus, Epicrates striatus exagistus, Uromacer catesbyi catesbyi*). Inclusion of portions of the north slope of Pic Macaya including areas near Castillon (Mare Cochon) adds at least 16 more taxa (**Eleutherodactylus audanti audanti, *Eleutherodactylus abbotti, *Eleutherodactylus eunaster, *Eleutherodactylus glaphycompus, *Eleutherodactylus heminota, *Eleutherodactylus hypostenor, *Eleutherodactylus inoptatus, **Eleutherodactylus pictissimus pictissimus, *Eleutherodactylus sciagraphus, Eleutherodactylus semipalmatus, Sphaeodactylus elasmorhynchus, *Anolis darlingtoni, Anolis distichus suppar, Anolis dolichocephalus dolichocephalus, Anolis monticola monticola, Anolis ricordi viculus*), and probably others (* = those taxa that may eventually be found in one of the other proposed areas of inclusion, ** = those taxa known to occur at lower elevations just outside of the park boundaries).

Many of the amphibians and reptiles listed above occur in very specific habitats. Those species occurring at elevations above 1,300 meters are found in mesic broadleaved and wet pine forest. Species found below 1,300 meters are associated with wet forests and limestone. Both of these habitat types provide cool and humid environments for their inhabitants. Data suggest that when conditions become more arid through deforestation and agriculture, many of the species disappear from the surface, with some taking refuge in sinkholes and caves. Other

The Massif de la Hotte is rich in endemic species of frogs, especially of the genus *Eleutherodactylus*. Fifteen endemic species of these frogs are restricted to the Macaya area, and 12% of all of the known species of this large and important genus are endemic to the Massif de la Hotte.

species are probably extirpated. It is also apparent that certain species (*Eleutherodactylus oyrhynchus, Osteopilus dominicensis, Anolis coelestinus, Anolis distichus, Leiocephalus melanochlorus, Celestus costatus, Celestus stenurus, Darlingtonia haetiana*) are apparently able to thrive under those new conditions, and in some cases spread. This has probably enabled certain "weed" species to follow trails where the forest canopy has been removed into areas that were previously uninhabited by them. Franz and Cordier (1986) believe that *Eleutherodactylus oxyrhynchus* and *Anolis distichus* used these corridors to gain access to high altitude sites on Pic Formon, Pic Macaya and the ridge connecting these two parks. The intrusion of exotic species probably adversely impacts resident species.

The creation of a park within the Massif de la Hotte is absolutely essential for the survival of the region's herpetofauna. The region is an important center for endemism in southern Hispaniola and contains over 30 restricted species and subspecies. In addition, there are at least 15 other taxa which are also found in the Massif de la Selle area but are missing from intervening lowlands.

To preserve portions of the Massif de la Hotte means to provide sanctuary for approximately 30% of amphibian and reptile species known from Hispaniola (including 17 species which are found nowhere else in the world).

The Birds of the Macaya Biosphere Reserve Area

A complete list of all bird species of Parc National Pic Macaya is presented in Chapter IV. There are fewer resident bird species in Macaya because of the absence of five endemics that do not occur west of the Jacmel-Fauche depression ("Bond's line"), such as the Black-crowned Palm Tanager, Ground Warbler, Hispaniolan Parakeet, Palm Crow and La Selle Thrush. The group of year-round residents is an assemblage of species that are found in a variety of habitats, mostly associated with the mesic broadleaved forest (lower montane rain forest of Holdridge). This habitat occurs throughout the higher elevations of the Macaya region, while in the "Gran Ravin," subtropical rain forest occurs (Holdridge map, 1972 in OAS report on Haiti). This habitat does not occur in La Visite because less rain falls in the Massif de La Selle than in the Macaya region (OAS Holdridge map, Sedwitz and Canet, 1972; Atlas d'Haiti, Lasserre et al., 1985).

The total number of bird species so far reported for the Macaya Biosphere Reserve region is 65. Several of these are very endangered, such as the White-winged Warbler and the Hispaniolan White-winged Crossbill.

The pattern of isolation observed in Parc Macaya may be the result of ecological conditions rather than the geographical remoteness of the area. Indeed, Macaya is not very distant from the Massif de la Selle, since the mesic broadleaved forest of Morne D'Enfer is only 175 kilometers distant from a similar forest on the ridge of Pic Macaya. The test of the ecological hypothesis would be if species from La Visite began to spread into Macaya as the habitat there is altered by human activities. This has not occurred in the case of species such as the Black-crowned Palm Tanager, Ground Warbler or La Selle Thrush which are closely associated with mesic broadleaved forest, the habitat that is being destroyed in the Macaya region. However, the Haitian White-winged Crossbill and Antillean Siskin showed up in the Macaya region for the first time during the course of this study. These birds are associated with open areas and mature pines. The expansion of their range into Parc Macaya may be the result of the increased destruction of the mesic forest in the Macaya region documented by Cohen (1984). The loss of the mesic forest is followed by rapid regeneration of pine, making the area more suitable for species such as the crossbill and siskin. Large flocks of crossbills were present from 1982 through the last survey in April, 1992. The transition is not complete, however, since Hispaniolan Parakeets and Palm Crows, two other species that do well in the open pine habitats of La Visite have not yet spread to Macaya. Should these two species spread into the Macaya region it would be a

further indication that Macaya has been isolated by its abundant rainfall and rich, dense mesic forest. Therefore, the appearance of crossbills and siskins in the Macaya area, which at first thought seems to be a good sign since the species are important Antillean endemics, may be instead a reflection of the distribution of the rich mesic broadleaved forest that covered the region until the last two decades (Cohen, 1984). More research is necessary to clarify this question.

The list of resident birds is swelled by the addition of migrant species that arrive in late September and stay until April. This brings the total number of species found in the Macaya region to 65, two less species than found in Parc National La Visite. The difference in the number of bird species, however, is largely the result of the fewer number of endemics that occur in western Haiti. The difference in the number of species would be even more dramatic if it were not for the presence of the lower area of Parc National Pic Macaya in the region of the Plain of Formon at 1,000 meters elevation. The broadleaved forests of the karst hills along the edge of the Plain of Formon have a number of bird species that are characteristic of lower elevations (Broad-billed Tody, Loggerhead Kingbird, Mango Hummingbird) as well almost all of the species found in high montane regions (except for the White-winged Crossbill and Antillean Siskin). This mid-montane forest is the habitat that has been severely deforested in most parts of Haiti. It is the most important and vulnerable of all the habitats in Parc National Pic Macaya, as is readily apparent when the number of species found in this small subregion (500 hectares) of the park is compared with the list of species occurring in the rest of the park (7,000 hectares). On the Plain of Formon and the adjacent karst hills, 51 species occur; in the montane zone of the park about 1,300 meters elevation, 47 species occur (Table 6).

The total number of individual birds is greater in Parc National La Visite than in Parc National Pic Macaya. During the winter census period on La Visite, an average of 242 birds were seen per day, while in Macaya an average of only 151 birds were observed. A reason for this difference may be that in the open ruinate ("Raje") areas of La Visite, huge flocks of migrant warblers feed in abandoned corn fields and gardens during the winter months. Some of these mixed flocks (mostly Yellow-rumped Warblers, Palm Warblers and Cape May Warblers) number over 300 individual birds. These flocks inflate the data on bird numbers, but are not a true reflection of species richness. It is true that the area of Parc National Pic Macaya above 1,500 meters has fewer species than Parc National La Visite (Table 8). This is in part a reflection of the greater percentage of land area in La Visite above 1,500 meters, as well as the reduced number of endemics in Macaya (see previous discussion). However, the combination of the very important mid-montane habitats of the Plain of Formon with the high montane forests of Pic Formon and Pic Macaya create a combined ecosystem in Parc Macaya that is richer in bird species than is the case in Parc La Visite.

The presence of breeding Black-capped Petrels on the south face of Pic Macaya is an important new observation.

The small colony of petrels on Macaya was discovered for the first time in January, 1984, and surveyed in detail in January, 1985. An additional colony may exist on the northwest face of Pic Formon. The presence of Black-capped Petrels in Parc Macaya adds special significance to the park, since the species has been eliminated from most islands in the Antilles. The birds are nesting in burrows at about 2,200 meters elevation at the transition zone between wet broadleaved forest and scrubby second growth occurring where fires and erosion have disturbed the steep mountainside. Many rock slides further disturb the habitat below 2,200 meters. The zone where the petrels nest is especially vulnerable to damage from below by fire as it sweeps up the mountain and kills the vegetation that provides cover for the petrels and protects the steep mountainside from

The presence of nesting Black-capped Petrels on steep cliffs near the summit of Pic Macaya is very important. This nesting colony is threatened by fires sweeping up the slopes of Macaya from the peasant settlements in the upper valley of the Riviere Trois Sources.

further erosion. The open areas that occur following fires also expose the petrels to predation by dogs, cats and mongoose. Cats and mongoose now occur on the peak of Macaya where the density of Black and Norway rats is very high. All of these real and potential problems mean that the colony of breeding Black-capped Petrels is "threatened." Because the colony is small and the habitat has been badly damaged by fires that have swept over the area since 1978, the status of the colony will be changed to "endangered" if any more habitat is lost. The area below the petrel colony should be totally protected.

No gardens, ajupas, fires or deforestation should be allowed from the base of the mountain or on either side of the connecting ridge between Pic Formon and Pic Macaya. Since this is in the area of land claimed by the coffee cooperative (UNICORS) and several private individuals, great care must be taken to work with individuals and institutions in the area to insure that the petrel colony is protected.

The Mammals of Macaya Biosphere Reserve Area

There were originally 18 species of land mammals occurring on the Plain of Formon and the higher montane areas of Pic Formon and Pic Macaya (see Chapter V). The remains of these species were recorded in sinkholes on the upper Plain of Durand near Morne Cavalier, as well as from a sinkhole on the ridge of Pic Macaya. These 18 taxa were distributed between two rodents similar to the zagouti, two hutias of the kind kept by Indians as a domestic species, one giant hutia, one small zagouti-like form and one new genus and species of rodent found no place else in Hispaniola (for a total of six rodents). In addition there were five insectivores, one monkey and as many as five ground sloths. Of these 18 endemic land mammals, only one survives in abundance within the boundaries of the park today. This is *Plagiodontia aedium*, the "zagouti." It survives in the karst hills along the edge of the Plain of Formon and Plain of Durand, but does not occur in higher montane areas of the park where there are few areas of exposed rocks or large trees with cavities where the zagouti can find shelter.

The other surviving mammal, *Solenodon paradoxus*, is very rare within the boundaries of the park. It is most abundant in mid-elevation forested regions (500-1,000 meters). It has been eliminated from most areas of the Plain of Formon by deforestation, and because so many dogs are found in the region. Dogs kill large numbers of *Solenodon*, and this species, unlike the zagouti, has a difficult time surviving in areas where dogs and people are abundant, even when large blocks of karst are available where the animals can take refuge in rock crevices. *Plagiodontia* can escape from dogs and people by climbing into trees or running into rock crevices, but Solenodon is less wary and more frequently killed. *Solenodon* continues to survive in the Parc Macaya region only in the mesic forest east of Pic Macaya and west of Catiche and Duchity (Mare Cochon area). If dogs and cats were controlled within the park, especially in the "Gran Ravin" area which is adjacent to the area where Solenodon is still found, then it is possible that the species will become more abundant in the region of Parc National Pic Macaya.

There is at least one, and maybe two species of Solenodon living in the Macaya area. These "living fossils" are in critical need of protection.

Plagiodontia and *Solenodon* are both abundant in the remote area east of the main ridge of Pic Macaya (designated Diquillon and Mare Cochon on 1:50,000 topographic maps). This habitat is similar to the karst hills along the edge of the Plains of Formon and Durand that have been included within the boundaries of the park. Based on the results of the mammal survey (as well as the survey of the herpetofauna), we recommend that the park boundaries be expanded an additional 2,000 hectares to the northeast to include the Mare Cochon region, which is the most important habitat for mammals remaining in the vicinity of either natural park. In addition, we recommend that a buffer zone be created beyond

this zone where coffee can be grown, but from which dogs and cats are eliminated, and where mesic broadleaved forest can return in a large block. An examination of the ecological maps by Holdridge (Sedwitz and Canet, 1972) and in the Atlas d'Haiti (Lasserre et al., 1985) reveals that this broad rough plateau is at about 1,200 meters elevation in the area of Haiti with the most abundant precipitation. *Plagiodontia* and *Solenodon* thrive in this zone of mesic broadleaved forest (much of which has been cut or burned), karst exposures and abundant rainfall.

The 15 species of bats recorded from area of the Macaya Biosphere Reserve represent more than twice the number of taxa collected in Parc La Visite during the period of the Biogeophysical Survey. Four bat species were collected in Parc La Visite. An examination of cave and sinkhole deposits, however, indicate that eight bat species are known to have occurred in the Parc La Visite area during the past several thousand years. The reason fewer bats now occur in Parc La Visite than occurred there in the recent past or occur in Parc Macaya cannot be resolved with certainty. Some possible reasons are: 1) the disturbance of bats in the La Visite region by peasants burning the forest in ravines at the mouth of caves in order to plant gardens in the rich, mesic ravine habitats; 2) the general deforestation of the La Visite area; 3) the greater proportion of land area in La Visite that is above 1,500 meters elevation which makes the habitat less suitable for frugivorous bat species. It is clear from the above data, however, that Parc Macaya is currently much more important to the preservation of bat species than is Parc La Visite. Parc Macaya is also more important for terrestrial mammals. Indeed, in terms of the conservation of all of the remaining endemic mammals of Haiti, the area of Parc National Pic Macaya including the Plain of Formon and the Mare Cochon region to the east of Pic Macaya is the most important region in all of Haiti. If this region can be protected from further deforestation, and the "quality" of the habitat improved (regeneration of the mesic broadleaved forest, removal of domestic and feral dogs and cats), then *Solenodon paradoxus*, *Plagiodontia aedium* and a number of bat species have a good chance of surviving in the country and being part of the natural ecosystem for decades to come. Research on the status of *Plagiodontia* and *Solenodon* including specific studies on their habitat requirements and the impact of dogs, cats, mongoose, Black Rats and Norway Rats, is necessary to insure that proper data is available for use in wise management decisions.

"Species Recovery Plans" for endangered species of Haiti provide important data for programs in land stewardship. Such plans are presented in this volume for the *Solenodon* and for the White-winged Warbler and Black-capped Petrel.

Paleobiology of the Macaya Biosphere Reserve Area

Between February, 1978, and May, 1984, excavations were made in a hillside rock shelter located at 250 meters elevation two kilometers SSW of Camp Perrin. Trou Woch Sa Wo is the local Creole name for the location, and translates as, "the hole in the rock that is up there." Because the site is a rock shelter, it is called in Creole a "Trou Woch" as opposed to a cave ("Kaven") or a sinkhole ("Trouing"). This locality is the same site referred to as Caverne Sa Wo in MacPhee and Woods (1982). The bones occur in dry red paleosols intermixed with medium-sized rocks and speleothems.

Between February and August, 1984, excavations were made in a series of sinkholes on the Plain of Formon and the Plain of Durand across from the Headquarters of the Macaya Biosphere Reserve Project. These sinkholes are located in the western margin of a plateau that lies at the southern base of the Massif de La Hotte at the edge of Parc National Pic Macaya. The sinkholes have steep sides and served as natural traps for the fauna living in the region. The bones occur intermixed with large rocks that have accumulated in the center of the sinkholes and in the paleosols along the margin of the central rock piles as well as at the outer margins of the sinkholes. The most important sinkhole in this region is located in the Jeremie district of the upper plateau, and is designated as

"Trouing Jeremie #5." This sinkhole is 1,275 meters in elevation. The main shaft opening is 2.5 meters in diameter and the sinkhole is 16.5 meters deep. There are no indications of owls or other predators having used this sinkhole, and there is no sign of human use or disturbance. All of the bones in this sinkhole are presumed to have accumulated there after animals fell through the opening and were killed on the rocks below or died after having been trapped in the sinkhole.

In July 1984, excavations were made in sinkholes along the northern slopes of the ridges east of Pic Macaya in the center of Parc National Pic Macaya. This area of abundant rainfall extends from Pic Macaya (elevation 2,347 meters) eastward as a narrow series of heavily forested ridges. The ridges lie north of the deep Ravine du Sud that separates Pic Formon from Pic Macaya. There is an extensive karst plateau stretching to the northeast of these ridges at approximately 1,200 meters, just as the Plateau de Formon stretches southeast of Pic Formon. The most important sinkhole investigated on the ridges of Pic Macaya is "Trouing Lan Genti #1," located at 1,365 meters in elevation.

The La Hotte Zagouti, the Unique Mammal of Macaya

The endemic La Hotte Zagouti (*Rhizoplagiodontia lemkei*) is known from Trou Woch Sa Wo, Trouing Jeremie #1, Trouing Jeremie #5 and Trouing Lan Genti #1. This region ranges in altitude from 300 meters at Sa Wo to 1,365 meters at Lan Genti. It is not clear whether the natural distribution of *R. lemkei* included the lowland drier site at Sa Wo or if owls carried the remains of the rodent to the cave.

Fossil remains of *R. lemkei* are abundant on the Plain of Formon, an area of abundant rainfall (exceeding 3,000 mm annually), dense forests, steep ravines, numerous areas of exposed limestone, and the tributaries of four major rivers (Woods and Harris 1986). The known area of distribution includes the watersheds for the Riviere L'Acul and Ravine du Sud and extends over an area of 120 square kilometers. The presence of a few remains of *R. lemkei* in Trouing Lan Genti #1 on the north side of the Ravine du Sud and at the edge of a broad plain northeast of the Pic Macaya suggests that *R. lemkei* may have inhabited this plain also. The plain is very similar in geology and ecology to the Plain of Formon and is associated with the Riviere Glace. It is located west of the old road that connects Les Cayes, Camp Perrin, Duchity and Beaumont to Jeremie on the north coast of the southern peninsula. In the Catiche and Duchity areas of this plain (called "Plaine Martin" near Catiche), *Solenodon paradoxus* is still present and *Plagiodontia aedium* is abundant (Woods 1976, 1981, 1983, 1981). Excavations of several caves and sinkholes near Duchity and Beaumont have not indicated the presence of *Rhizoplagiodontia lemkei*. However, based on the similarity of habitat of the region with the Plain of Formon and the presence of *R. lemkei* in Trouing Lan Genti #1 at the western edge of the Plaine Martin and adjacent areas, we predict that *R. lemkei* may also have been found in this area.

The La Hotte Hutia is now extinct, but it lived only in the area of the Macaya Biosphere Reserve.

Other Fossil Mammals found in the MBR Area

The composition of the mammalian fauna of Trouing Jeremie #5, based on an analysis of a sample of bones collected at random in the top four centimeters of the deposit, is listed in Table 4. The order of abundance calculated on the basis of the number of left mandibles. The most common mammal is the "Zagouti," *Plagiodontia aedium* (20.1%) followed by the Black Rat, *Rattus rattus* (13.9%); the La Hotte Zagouti, *Rhizoplagiodontia lemkei* (12.3%); two Small Island Shrews, *Nesophontes paramicrus* and *N. hypomicrus* (combined, 11.5%); the

"Quemi", *Plagiodontia velozi* (9.0%); the "Mohuy" or Haitian Spiny Rat, *Brotomys voratus* (8.2%); the Even-toothed Hutia, *Hexolobodon phenax* (7.4%); several species of megalonychid ground sloths (5.7%); Giant Island Shrews, *Solenodon paradoxus* and *S. marcanoi* (combined, 4.1%); the Indian Hutias, *Isolobodon portoricensis* (4.1%), and *Isolobodon montanus* (1.6%); the House Mouse, *Mus musculus* (0.8%); and the Haitian Monkey (.08%), preliminarily referred to the same taxon as "*Saimiri*" *bernensis* (see MacPhee and Woods 1982). The common names in quotes are based on known names for the species (Woods et al., 1986). No remains of cats or of the mongoose (*Herpestes auropunctatus*) were found in Trouing Jeremie #5.

The top 4 cm is composed of mucky black soils rich in organic matter. Rats and Mice appear to be restricted to this upper zone. *Nesophontes, Solenodon, Brotomys, Plagiodontia aedium*, and *P. velozi* occur together with Rats and Mice in the upper organic layer. At the bottom of the organic layer *Rhizoplagiodontia lemkei* is very abundant, and remains abundant throughout the deeper layers which are composed of very wet reddish-orange clays. The other common mammals in the deeper layers are *Plagiodontia velozi, P. aedium, Hexolobodon phenax*, and megalonychid sloths, although all of the endemic mammals discussed above are found in the clay layer. *Plagiodontia velozi* is more common in Trouing Jeremie #5 than it is in any other sinkhole or cave analyzed in Hispaniola, suggesting either that the region was the center of distribution of this taxon or that the Plain of Formon represents more optimal habitat for the taxon than the other sites examined, all of which are in more xeric regions.

The mammalian fauna of Pic Macaya at Trouing Lan Genti #1 is composed of *Plagiodontia velozi* (a nearly perfect cranium with attached mandibles), *Hexolobodon phenax, Isolobodon portoricesis*, megalonychid sloths, and a few remains of *Rhizoplagiodontia lemkei*. Some mammalian remains found in Camp Perrin at Trou Woch Sa Wo are distributed in the gray, powdery top 15 cm of sediment. These remains include well-preserved specimens of *Isolobodon portoricensis, Rattus rattus* and *Nesophontes paramicrus*. There were occasional pieces of carbon in this layer and a few remains of humans. Below the top powdery stratum are paleosols of red sand and clay in which bones are unevenly distributed in several zones extending 200 cm below the surface to the rocky cave floor. The endemic mammals found in the deeper strata are: 1) *Brotomys voratus* (extremely common); 2) *Plagiodontia aedium*; *Plagiodontia ipnaeum* (or small individuals of *P. velozi*); *P. velozi* (isolated teeth); *Isolobodon portoricensis*; *Isolobodon montanus*; *Hexolobodon phenax*; magalonychid sloths; *Nesophontes paramicrus*; *N. hypomicrus*; *N. zamicrus*; *Solenodon paradoxus*; *S. marcano*i and "*Saimiri*" *bernensis* (see MacPhee and Woods 1982).

Trouing Jeremie #5 in the western Plain of Formon has more specimens of *Rhizoplagiodontia lemkei* in it than does Trou Woch Sa Wo. In addition, this sinkhole also has more specimens of *Plagiodontia velozi* and megalonychid sloths. *Brotomys voratus* and *Isolobodon portoricensis* are more common in Trou Woch Sa Wo than in the sinkhole locations. These differences may be the result of the selection of smaller prey by hunting giant barn owls in the Trou Woch Sa Wo region, or may be the result of ecological differences such as forest cover, precipitation, or elevation. The long history of human occupation in the valley of the Ravine du Sud near Camp Perrin could account for the larger endemic mammals having been hunted out by Indians long before the same mammals disappeared from the remote Plain of Formon.

The mammalian fauna of the Trou Woch Sa Wo/Plain of Formon/Massif de la Hotte area appears to differ from the known mammalian faunas of the Massif de la Selle in several important ways.

The most common mammal in the Macaya area 7,000 years ago was the "zagouti." It is the only endemic rodent that still survives.

1. *Solenodon paradoxus* and *S. marcanoi* are more abundant than from any other known fossil locality in Hispaniola. The only other known locality where *S. marcanoi* is abundant is Cueva Rancho de la Guardia on the north slope of the Sierra Neiba in the Dominican Republic at 850 meters elevation, also an area of abundant rainfall and heavy forest cover.

2. The large wide-toothed rodents *Quemisia gravis* and *Plagiodontia araeum* are not found in western Haiti. An extremely large morph of *P. araeum* is found on the flat plateau of the western Massif de la Selle. This area is now a pine savanna and is drier than the massif de la Hotte. A smaller morph of *P. araeum* is found in lowland areas west of Port-au-Prince and on Ile de la Gonave, both of which are dry regions. The type locality for *P. araeum* is Cueva Rancho de la Guardia (Ray 1964). *Quemisia gravis* also appears to be restricted to drier regions and is known only from the type locality near Saint Michel de l'Atalaye at the edge of the broad dry central plateau of northern Haiti.

3. Primates are more common in the Trou Woch Sa Wo/Plain of Formon/Massif de la Hotte region than anywhere else in Hispaniola. The only other reported locations with primate remains are from a kitchen midden at Rio Naranjo Abajo on the south shore of Samana Bay in the Dominican Republic where Miller (1929b) reported finding the distal end of a tibia he was able to identify only as "*Cercopithecus*? sp.?", and the type locality for *Saimiri bernensis* at Cueva Berna in the eastern Dominican Republic near the mouth of the Rio Yuma (Rimoli 1977). I have found remains of "Saimiri" bernensis in a sinkhole near Morne la Visite in the western Massif de la Selle. In far western Haiti, however, a dentary fragment was found at Trou Woch Sa Wo (MacPhee and Woods 1982) and numerous remains of primates that appear to be of the same taxon have been found in several sinkholes on the Plain of Formon.

4. *Rhizoplagiodontia* appears to be restricted to the Trou Woch Sa Wo/Plain of Formon/Massif de la Hotte area.

5. A large, apparently extinct diploglossine lizard tentatively identified as *Diploglossus* sp. is restricted to the Plain of Formon region.

Two species of Solenodons still survive in the MBR area. The preservation of these species should be given very high priority.

Origin of Fossils Collected in the Macaya Area

The vertebrate fauna of Trouing Jeremie #5 is presumed to have accumulated in the sinkhole by natural means, most likely by having fallen directly into the sinkhole. The evidence that a number of the sinkholes in the Jeremie area served as series of pit traps over the last several thousand years comes from the composition and taphonomy of the associated fauna. *Plagiodontia aedium*, the extant capromyid rodent known in Haiti as the "Zagouti" or "Rat Cayes," is still common in adjacent karst areas that are covered with a broadleaved forest composed of numerous trees that now rarely exceed 25 cm in diameter. This habitat is found within 100 meters of Trouing Jeremie #5.

Plagiodontia aedium feeds on bark, leaves, and buds of trees in the areas of karst where it is difficult to move around on the ground because of the massive blocks of limestone, but often feeds on the ground and in gardens along the edge of these rocky areas (pers. obs.). The habitat adjacent to Trouing Jeremie #5, and the series of nine other sinkholes that are part of the Jeremie sinkhole system, is composed of pockets of soil near rocky exposures. Rodents foraging in these areas would be exposed to the danger of falling into the openings of the sinkholes. Several of the sinkholes in the Jeremie system had the bones of *Plagiodontia aedium* on the surface of the rocks below. The bones were closely associated and in one case still had fur and some flesh attached. In other cases, completely

associated skeletons of *Plagiodontia aedium* were found in side chambers or pockets above the margin of the sinkholes at floor level. We believe the animals fell into the sinkholes and crawled into the chambers to die at a later time. Other evidence that indicates that many, if not all of the fauna in Jeremie #5 fell into the sinkhole comes from the lack of bones of predators such as barn owls in the deposit. In addition, the following evidence supports the hypothesis that this sinkhole served as a natural trap: 1) the remains of ground sloths were common in the sinkhole deposits; 2) a large sample of fossils gathered in the top few centimeters of the deposit produced a number of nearly intact crania of capromyid rodents and many mandibles where both the left and right rami were closely associated; 3) the remains of a large ground lizard (*Diploglossus* sp.) were common (3% of the sample of bones discussed above), and many of these remains were articulated; 4) no owl pellets were found in the sinkhole.

The Camp Perrin area to the east of Trouing Jeremie #5 is one of steep limestone cliffs and rolling hills at an elevation of 250 meters. The current rainfall at Camp Perrin is 2,271 mm per year, with over 5,000 mm falling in some areas of the Massif de la Hotte five kilometers to the northwest (Sedwitz and Canet 1972). The natural forest cover in the area has been destroyed, but rainfall and evaporation data indicate that the natural forest should be very humid subtropical forest (Fth-S) at Camp Perrin (Sedwitz and Canet 1972).

Few human artifacts are present in Trou Woch Sa Wo, and much of the deposit is presumed to have been accumulated by raptors, probably barn owls. Barn owls have been shown to take prey in excess of their immediate needs and to discard surplus items near the nest site (Wallace 1950). Barn owls can, therefore, accumulate large numbers of animal remains from a wide area around a cave.

The hunting range of the barn owl (*Tyto alba*) is unknown. Barred owls (*Strix varia*), however, require 231 hectares in which to live (Fuller et al. 1974), move up to 1.5 kilometers in their normal search for food, and have been shown to move as far as 2.5 kilometers (Fuller et al. 1974). Barn owls probably have a greater hunting range than barred owls, because they are restricted in their natural roost sites to hollow trees, rocky crevices, and caves. These sites are limited in number and distribution in Hispaniola. It is not uncommon to see several barn owls using the same cave as a roost in Haiti. Barn owls are probably territorial; however, Smith et al. (1974) have shown that the ranges of barn owls can overlap. Therefore, it is probable that in Hispaniola the two extant species of barn owl (*Tyto alba* and *Tyto glaucops*) have ranges that overlap, and that they hunt over areas that take them farther than 2.5 kilometers from the cave in which they roost during the day. The two species can inhabit the same cave in Haiti (pers. obs.).

Zagouties (*Plagiodontia aedium*) are still locally abundant less than two kilometers from Trou Woch Sa Wo in the area of Camp Perrin and in the nearby mountains to the northwest. Remains of this rodent have not been found in recent cave deposits at Trou Woch Sa Wo or in owl pellets found in nearby areas, presumably because *T. alba* and *T. glaucops* are not large enough to take rodents the size of the Zagouti, which often exceed 1,500 grams in body weight. The faunal assemblage is therefore presumed to have been accumulated by a larger raptor. An analysis of the faunal remains indicates that Trou Woch Sa Wo was also inhabited by a large barn owl, the now extinct *Tyto ostologa*. The remains of this large raptor are common in caves throughout Hispaniola and are often associated with deposits containing concentrations of large rodents, some of which were of individuals several times the body size of the Zagouti (*Plagiodontia aedium*). This giant barn owl presumably hunted over an even wider area than present day barn owls *T. alba* and *T. glaucops* and, therefore, ranged beyond 2.5 kilometers from Trou Woch Sa Wo. Within four kilometers of Trou Woch Sa Wo are open areas along rivers, streams, and ponds, as well as forest edges on the nearby steep mountains characterized by abundant rainfall and dense forest cover.

The Plain of Durand in the middle of the Macaya Biosphere Reserve Project area is one of the best places to collect fossil vertebrates in Haiti. These fossils are found in deep sinkholes in the karst topography.

Dates of Fossils Collected in the MBR Area

The surface paleosol of Trou Woch Sa Wo was gray and fluffy with numerous shells of land snails. The gray, snail-rich layer was deepest at the base of a tall limestone block, along the west wall of the cave, which is the lowest area of the cave. The paleosols in deeper layers of the cave varied from brown mixtures of sand and clays nearer the surface to red paleosols near the base rock. The red paleosols were richest in bone, with the largest concentrations of bony material found around rocks, where bones appear to have been concentrated during deposition or subsequent changes in the position of sediments. The dates obtained via Carbon 14 analysis of broken appendicular elements gathered at specific levels in the cave indicate ages varying from 3715 $\pm$ 175 years before the present (yBP) 100 cm below the surface in the red bone rich sediments to 10,320 $\pm$ 170 yBP in the deepest bone-bearing layers near the apparent bedrock of the cave, which slants westward at a 45 degree angle. The deepest layers are generally older than more superficial zones; however, the deepest layer is slightly younger (9660 $\pm$ 140 yBP) than the next most superficial zone (#5 = 10,320 $\pm$ 170 yBP). This indicates that some reorganization of the material may have occurred after deposition, or that a minor discrepancy occurred in the Carbon 14 dates. The former is supported by the generally fragmented nature of the larger bones. The mammalian fauna is not divided into distinct stratigraphic zones, and the various taxa are randomly associated in all but the most superficial layers.

Dates were obtained on bone samples by pooling samples of damaged postcranial elements from nearby faunal associations at the same stratigraphic layers. Dating bone via Carbon 14 analysis is difficult and can lead to an underestimation of the true age of the material (M.A. Tamers, Beta Analytic Inc., Coral Gables, Florida, pers. comm.). Dates from bony material from other caves in Hispaniola using the same technique reveals similar patterns of total age, scope, and stratigraphic association. In the southwestern Dominican Republic, bones from Cueva de las Abejas have dates ranging from 5270 to 9565 yBP. In this cave, the bone-bearing zones also lie at the base of a slope, with the sequence of dates being 6720 yBP at 25 cm; 9565 yBP at 50 cm; 5270 yBP at 100 cm. The lack of sequential dates could indicate even more reorganization of the material after deposition than at Trou Woch Sa Wo or could be associated with deposition of animal remains on top of an extremely irregular surface (i.e., one filled with large rocks of different sizes). The dating technique was double-checked by analyzing two separate lots of bone fragments collected at the same location. The results indicate ages of 9565 $\pm$ 495 yBP (reported above at 50 cm) for the first lot and 8415 $\pm$ 390 yBP for the second lot. When the potential error was considered in seeking the closest possible match between the dates, a difference of 265 years (2.8%) remained. Bony material from Kaven Dadier, a cave with a flat floor near Miragoane in southern Haiti, dated at 1600 yBP 15 cm below the surface and 19,960 yBP at 100 cm. On Ile de la Gonave in Haiti bony material from Trou Zombie, a very similar cave to Kaven Dadier near Miragoane, dated at 6405 yBP at 25 cm and 19,800 yBP at 100 cm. Bones collected from near the surface in some caves can be much older than bones from the surface of the above caves, as indicated by analysis of bone from a large cave on Ile de la Tortue off the north coast of Haiti. In this cave, the bone dates at 17,405 yBP at 25 cm and 21,170 yBP at 100 cm. The bony material from 75 cm in Kaven San Francisco, the famous bone-rich caves at Saint Michel de l'Atalaye, Haiti, analyzed by Miller (1922, 1929a) date at 8120 yBP.

The oldest fossils collected in the Macaya Biosphere Reserve area were over 10,000 years old.

Paleo Climates and Environments of the Macaya Area

The above data indicate that the mammals collected in the Formon area (Trouing Jeremie #5) and at Trou Woch Sa Wo near Camp Perrin were living in this area of western Haiti in latest Pleistocene and early Holocene times. During this time period, environmental conditions in Hispaniola were probably very different from what they are today. The faunal information for Puerto Rico and the Bahamas (Pregill 1981; Pregill and Olson 1981) and Florida (Woods et al. 1982), as well as paleoecological and palynological data from areas adjacent to the Antilles (Lynts and Judd 1971, Bonatti and Gartner 1973, Lynts et al. 1973, Watts 1975, 1980, Watts and Stuiver 1980, Schubert and Medina 1982), indicate that Florida and the Antilles were cooler and much drier in Wisconsinan times. These more xeric conditions resulted in an avian fauna that was rich in xeric-adapted species that have since become extinct or restricted to relictual areas of xeric habitat (Pregill and Olson 1981). In Florida, the climate and associated mammalian fauna came to resemble current conditions by about 3500 years ago (Webb 1974, Woods et al. 1982). Hispaniola during the period represented by the Trou Woch Sa Wo fauna (10,300 yBP) therefore was probably cooler and drier than at present, becoming gradually more moist up until 3000 yBP.

It is tempting to conclude that conditions in the mountains of western Haiti were also drier and that these factors directly influenced the fauna under consideration. However, it can be extremely hazardous to make such extrapolations. The area between Camp Perrin, the western margin of the Plain of Formon, and the high mountains to the north is the area of highest rainfall in Haiti (Sedwitz and Canet 1972). This high precipitation is caused by local conditions and not by the direct influence of prevailing northeast trade winds blowing into the mountains. As a result, it is probable that the area was one of high rainfall during the period when other areas of southern Hispaniola were more xeric. The mammal fauna at Trou Woch Sa Wo could have been associated with a montane area of relictual mesic habitat that was confined to this and other mesic montane sites in Haiti during more xeric Wisconsinan and early Holocene times. Evidence to support this possible explanation comes from current distributions of Plagiodontia aedium and Solenodon paradoxus and several species of endemic birds in Haiti. The animals survive in pockets of mesic and well-wooded habitats in the Massif de la Hotte and Massif de la Selle (Woods 1981, Woods and Ottenwalder 1983). Remaining areas of Haiti, where the animals have been extirpated, have been made xeric by habitat destruction. It is likely, therefore, that the faunal assemblages of the Formon area and at Camp Perrin, which include unusually large numbers of Giant Island Shrews (Solenodons), as well as primate remains, were associated with a moist, well-forested habitat even 10,000 yBP. Our recent find of the remains of a primate in the area of mesic forest at 1,900 meters in the Massif de la Selle further supports the concept that the Massif de la Hotte and some regions of the Massif de la Selle were areas of refugial mesic forest during drier post-Wisconsinan times.

The climate in Haiti 10,000 years ago was much cooler and drier.

The genus *Rhizoplagiodontia* appears to be restricted to the Massif de la Hotte of far western Hispaniola. Distributions of other plant and animal taxa across southern Hispaniola are similarly disjunct. The distinctness of the flora of the Massif de la Hotte was noted by Ekman (1928), who worked exhaustively throughout Hispaniola and found remarkable differences between the plants of La Hotte, which lack any "andine-continental" forms, and the high areas of the Massif de la Selle in Haiti and the Cordillera Central of the Dominican Republic, which are similar to each other and rich in "andine-continental" forms. In his recent field work in the La Hotte area of Haiti, Donald Dod (1984a, 1984b) has noted an extremely high level of endemism of the orchids and has described six new species. A similar pattern is reflected in the distribution of birds in southern Haiti (Woods and Ottenwalder 1983). Black-crowned Palm Tanagers

(*Phaenicophilus palmarum*), White-winged Crossbills (*Loxia leucoptera megaplaga*), Antillean Siskins (*Carduelis dominicensis*), La Selle Thrushes (*Turdus swalesi*), and Ground Warblers (*Microligea palustris*), which are common in the Massif de la Selle of southern Haiti, have not become established in similar habitats in the Massif de la Hotte 150 kilometers to the west. The Chat Tanager (*Calyptophilus frugivorus*) from the La Hotte area is darker in coloration and has a more elaborate vocalization than does the form from La Selle.

An apparent important line of separation between the avian faunas of southern Haiti is the Trouin Valley, which follows the Riviere Gauche between Jacmel and Carrefour Fauche near Grand Goave. This area in pre-Pleistocene times was a sea passage across peninsular Haiti separating the Massif de la Hotte and Massif de la Selle. Maurrasse et al. (1982) refer to the boundary area as the Jacmel-Fauche depression, and conclude that it was a deep precipitous trough in the mid-Miocene, and that the la Selle-Baoruco block to the east must have been an isolated island until at least the early late Pliocene. Emerging land and late Pleistocene uplifts (Maurrasse and Pierre-Louis 1981) resulted in the unification of the southern peninsula to form its present configuration. Until early to mid-Pleistocene times, however, the land vertebrates of the Massif de la Hotte to the west would have been separated from those of the La Selle-Baoruco island to the east by a wide, deep sea channel which was probably characterized by rapid tidal currents (Maurrasse pers. comm.). Sea levels 17,000 years ago were estimated to have been between 40 meters (Dodge et al. 1983) and 120 meters (Gascoyne et al. 1979) below present, and 10,000 yBP sea levels were 30 meters lower than present (Bloom 1977), so no water boundary separated these two areas during the Holocene. Most endemic rodent taxa, other than the genus *Rhizoplagiodontia*, were distributed throughout Hispaniola during the same time period.

The absence of *Rhizoplagiodontia* from a large and diverse faunal assemblage (Carbon 14 of dates between 1600 and 19,960 yBP) collected at Kaven Dadier in the foothills (elevation 300 meters) southwest of Miragoane, 85 kilometers to the east of Sa Wo, may be an indication that the isolation of *Rhizoplagiodontia* to the Sa Wo area of La Hotte is governed by ecological factors rather than past geological history. *Rhizoplagiodontia*, like Chat Tanagers, White-winged Crossbills, Antillean Siskins, Ground Warblers, and La Selle Thrushes discussed earlier, may have had more limited habitat tolerances than the other more widespread rodent taxa, and their distributions related to the presence of wet montane forests. The annual rainfall at Miragoane is 1,413 mm, and even in the wettest areas of the high Massif de la Selle rainfall does not exceed 2,163 mm. Therefore, in southern Haiti the la Hotte region is an island of dense wet forest.

The flora and fauna of southern Haiti indicates that there are important differences between the Massif de la Selle and the Massif de la Hotte. The line of separation is the Trouin Valley near Carrefour Fauche.

Evidence that the Massif de la Hotte was separated from the Massif de la Selle by ecological factors in the past comes from preliminary pollen stratigraphy (Binford and Higuera-Diaz, pers. comm.). These data indicate that the environment in the Etang Miragoane area was dry 7500 years ago. Between 6500 and 7500 years ago, the region become more moist and may have resembled present conditions in the area if the forests were left in their natural state. Sometime between 6500 years ago and the present there was another dry cycle. If we assume that the environment during these dry cycles was much drier than the present environment, it is possible to extrapolate from the pollen data to reconstruct a habitat with open scrub forest and little understory vegetation. These interglacial wet/dry cycles would produce dry cycles of much less severity than would have characterized the region at the glacial maximums, when the lowland areas would have been even more desert-like.

In addition, there might have been other climatic factors at work during the late Pleistocene that influenced the distribution of mammals specialized for areas of

wet montane forests. Recent evidence indicates that in the Cordillera Central of the Dominican Republic, which rises to an elevation of 3,087 meters, glaciation may have occurred down to a level of 1,800 meters during the latest Pleistocene (Schubert and Medina 1982). The authors contend, based on evidence from cirques, aretes, glacial channels, moraines, and bog-filled depressions, that in the late Pleistocene the snowline in the Cordillera Central extended down to 2,200-2,300 meters, and the lower limit of glaciers was between 1,500 meters and 1,800 meters. At the present time, frost is common in the Cordillera Central down to 1,800 meters (Garcia 1980). While there is no evidence that glaciers existed in other areas of Hispaniola at the same time, it is likely that ice and snow, and some glacier activity, were present in the Massif de la Selle during the late Pleistocene. The highest elevation of the Massif de la Selle, which is the second highest mountain range in Hispaniola and the highest area of Haiti, is Pic la Selle at 2,674 meters. This area is a high plateau, mostly above 2,000 meters, and stretches 45 kilometers from Pic la Selle in the east to an abrupt termination at Morne d'Enfer in the west. There are geological features along this ridge that suggest the possibility of glaciation, such as a cirque-like hanging basin between Morne Cabaio (elevation 2,350 meters) and Morne la Visite (elevation 2,262 meters). If snow and ice covered the plateau of the Massif de la Selle 20,000 yBP, then it could have eliminated certain mountain species from areas of suitable habitat, which was not available at lower elevations because of increased aridity (Schubert and Medina 1982).

The areas of the Massif de la Hotte near Trou Woch Sa Wo may not have been subjected to the same severe problems of ice and snow. While Pic Macaya rises to 2,347 meters and Pic Formon to 2,219 meters, these are really two isolated peaks surrounded by much lower ridges and valleys. If snow and glaciers affected the highest areas of la Hotte in the same way they affected the Cordillera Central, the overall effect on the flora and fauna would be minimal because of the steepness of the high peaks. There is very little area in the Massif de la Hotte above 1,500 meters, and extensive wet ridges and ravines exist at 1,000-1,300 meters. These areas are near the south coast, and are subject to local patterns of precipitation that currently account for some of the heaviest precipitation anywhere in Hispaniola, even though the areas are technically in the rain shadow of higher peaks from the prevailing northeast winds that bring precipitation to the rest of the island. As noted above, Ekman (1928) detected a difference in vegetation between the ridges of la Hotte, which contain no plants belonging to the andine-continental group, while the flora of the ridges of la Selle and the Cordillera Central is dominated by andine-continental plants. Ekman's observation further supports the hypothesis that the wet slopes of the Massif de la Hotte served as a refugium for plants and animals adapted to mesic environments during periods of cold and aridity in the Pleistocene.

During the Pleistocene in Haiti, Pic Macaya and Pic Formon may have been covered with snow and ice.

Extinctions of animals in the Macaya Area

During the past 20,000 years, 25 species of endemic land mammals occurred in Hispaniola (Morgan and Woods, 1986). Of these, all but *Plagiodontia aedium* and *Solenodon paradoxus* have become extinct (Woods et al., 1986). This extinction rate of 92% is more extreme than the average for the West Indies as a whole, where 67 of the 76 recognized species of endemic land mammals have become extinct since the late Pleistocene (a rate of 88%). Most of the endemic land mammals known to occur in southwestern Haiti (Tables 4 & 5) persisted in the region until after humans became established in Hispaniola 4500 yBP (Rouse and Allaire, 1978). Several species, especially the smaller forms such as rodents, are likely to have persisted in Hispaniola in regions such as the Massif de la Hotte into the last century, and therefore long after the arrival of Europeans and

Africans in the region. The extinctions of most rodents, insectivores and primates was not caused by the sudden exploitation of these animals by Amerindians soon after their arrival on the island (Woods et al., 1986). It is also unlikely that the extinctions resulted from periodic fluctuations of climate (temperature and rainfall) during the last 20,000 years, since all of the mammals known to exist 20,000 yBP were also present in deposits that date within the last 3,600 years. A major component of the endemic land mammal community of Hispaniola persisted in montane regions of the Massif de la Hotte and the high plateau of the Massif de la Selle until the last few centuries when habitat destruction and the pressures associated human-related activities became intense. Table 4 compares the known endemic land mammals of the montane regions of the Massif de la Hotte with the Massif de la Selle.

The 12% of the mammals which survived did so because of the presence of karst topography. If the forest cover in areas of karst is cut down, these mammals will become extinct.

Exactly when *Rhizoplagiodontia lemkei* became extinct cannot be established based on the work completed on the Plain of Formon other than to say that the animal survived until the time Rat remains are present in the deposits analyzed from Trouing Jeremie #5. Remains of *R. lemkei* do not occur in deposits from any other region of Hispaniola in spite of extensive collections made in numerous caves from throughout the island. Some of these deposits date back over 23,000 years. It is most likely, therefore, that the distribution of *R. lemkei* was restricted to the Massif de la Hotte region of western Haiti, rather than to conclude that *R. lemkei* became extinct in all other regions of Haiti before 20,000 yBP.

Table 1. Butterflies of the National Parks of Haiti

	Parc La Visite	Parc Macaya
Ubranus proteus domingo	0	+
Wallengrenia druryi	+	+
Paratrytone batesi	+	+
Panoquina sylvicola woodruffi	+	0
Panoquina nero	+	0
Eurema pyro	0	+
Nathalis iole	+	0
Dismorphia spio	+	0
Strymon columella cybirus	+	0
Hemiarqus hanna watsoni	+	0
Helioconius charitonius churchi	+	0
Dryas iulia hispaniola	+	0
Junonia evarete zonalis	+	0
Vanessa cardui cardui	+	0
Vanessa virginiensis	+	+
Calisto archebates	+	0
Calisto loxias	0	+
Calisto chrysaoros	+	+
Calisto tragia	+	0
Calisto hysia	?	+
Calisto clenchi	+	0
Danaus cleophile	0	+
Danaus plexippus megalippe	+	+
Anetia briarea briarea	+	0
Anatia jaegeri	+	+
	20	11

Total number of families 7
Total number of species 25

Table 2. Land Mollusks of the National Parks of Haiti

Taxon	La Visite	Macaya
Camaenidea		
Polydontes obliteratus (Ferussae)	0	+
P. Undulatus Ferussae	+	0
Coloniconcha n. sp. ?	+	0
Xanthonychidae		
Coryda sp.	0	+
C. n. sp.	0	+
C. cerosa	+	0
Plagioptycho n. sp. A	0	+
P. n. sp. B	+	0
Cepolis cepa (Miller)	0	+
Mcleania n. sp.	+	+
Sagdidae		
Hojeda inaguensis (Weinland)	0	+
H. micromphala (Pilsbry)	+	+
Odontesanda n. sp. A	0	+
O. n. sp. B	0	+
O. n. sp. C	0	+
O. n. sp. D	0	+
O. n. sp. E	+	0
O. n. sp. F	+	0
O. n. sp. G	+	0
O. n. sp. H	+	0
Sagidade n. gen., n. sp.	0	+
Suavitus taenioraphe (Pfeiffer)	+	+
S. sp.	+	0
S. sp.	0	+
Lacteoluna selenia	0	+
Urocoptidae		
Autocoptis sp.	+	0
A. juliae (Clench)	0	+
Archegocoptis n. sp. A	0	+
A. n. sp. B	0	+
Brachypodella obesula (Pilsbry)	0	+
B. n. sp. A	0	+
B. n. sp. B	0	+
B. n. sp. C	0	+
B. sp.	0	+
B. n. sp. E	+	0
B. n. sp. F	+	0
Helicinidae		
Helicinidae n. gen. n. sp. A	0	+
Helicinidae n. gen. n. sp. B	+	0
Helicinia n. sp. A	0	+
H. n. sp. B	0	+
H. n. sp. C	0	+
H. n. sp. D	0	+
H. n. sp. E	+	0
H. n. sp. F	+	0

Table 2. Land Mollusks of the National Park of Haiti (cont.)

Taxon	La Visite	Macaya
Helicinidae (continued)		
Lucidella sp.	0	+
L. n. sp. A	+	0
L. n. sp. B	+	0
Fedeyenia n. sp. A	0	+
F. n. sp. B	+	0
Ceratodiscus n. sp. ?	+	0
Helicidae		
Helix aspersa (Muller) (introduced European Garden Snail)	+	0
Zonitidae		
Guppya gundlachii (Pfeiffer)	+	+
Glypyhyalina sp.	+	0
G. n. sp. A	+	0
G. n. sp. B	+	0
G. n. sp. C	0	+
G. n. sp. D	0	+
Habroconous n. sp. A	+	0
H. n. sp. B	0	+
Hawaia minuscula (Binney)	+	+
Zonitoides arboreas (Say)	+	+
Zonitidae n. gen. n. sp. A	+	0
Zonitidae n. gen. n. sp. B	+	0
Oleacinidae		
Varicella sp. A	0	+
V. sp. B	0	+
V. sp. C	0	+
V. n. sp. A	+	0
V. n. sp. B	+	0
Oleacina sp. A	0	+
O. sp. B	0	+
O. sp. C	+	0
O. sp. D	+	0
O. sp. E	+	0
Spiraxis n. sp.	+	0
Sigmataxis sp. A	0	+
S. sp. B	0	+
S. n. sp. A	+	0
Streptostylops n. sp. A	0	+
S. sp.	+	0
Subulinidae		
Lamellaxis gracilis (Hutton)	+	+
Obeliscus n. sp.	+	0
O. sp.	0	+
O. dominicensis (Pilsbry)	0	+
Annulariidae		
Chondropoma manni (Clench and Aguayo)	+	0

Table 2. Land Mollusks of the National Parks of Haiti (cont.)

Taxon	La Visite	Macaya
Annulariidae (cont.)		
Orcuttipoma rolleii (Weinland)	0	+
Weinlandipoma sp.	0	+
Colobostylus n. sp.	0	+
Cyclophoridae		
Crocidopoma sp.	+	0
Prosperpinidae		
Proserpina n. sp.	+	0
Pupillidae		
Gastrucopta pellucida (Pfeiffer)	0	+
Succinidae		
Succinea sp.	0	+
Clausiliidae		
Nenisca n. sp.	0	+
Haplotremaatidae		
Haplotrematidae n. gen. n. sp.	0	+
Bulimulidae		
Drymaeus sallei (Pilsbry)	0	+
Totals		
Species	45	57
Species unique to each park	38	50
New Taxa	27	27

Table 3. Annotated List of Amphibians and Reptiles known from the Massif de la Hotte and Adjacent Areas.

The following 54 amphibians and reptiles were reported in Schwartz and Thomas (1975). Henderson and Schwartz (1984), and/or this report, as occurring in the Massif de la Hotte in the weestern Tiburon Peninsula, Haiti. * = indicates those taxa listed in the literature from the Massif de la Hotte, but not reported from the study area; ** = includes those taxa represented in collections from the study area; [1] = includes those taxa not previously listed from the Massif de la hotte, but are represented in our collections. Those species without notation are reported as occurring in the general area by Henderson and Schwartz (1984) and may eventually be found within the study area.

Order ANURA
Family Leptodactylidae (22 taxa)

Eleutherodactylus abbotti Cochran
** *Eleutherodactylus apostates* Schwartz
* *Eleutherodactylus audanti audanti* Cochran
** *Eleutherodactylus bakeri* Cochran
** *Eleutherodactylus brevirostris* Shreve
** *Eleutherodactylus chlorophenax* Schwartz
** *Eleutherodactylus counouspes* Schwartz
* *Eleutherodactylus eunaster* Schwartz
** *Eleutherodactylus glandulifer* Cochran
* *Eleutherodactylus glaphycompus* Schwartz

Table 3. Reptiles and Amphibians--Massif de la Hotte (cont.)

** *Eleutherodactylus heminota* Shreve and Williams
* *Eleutherodactylus hypostenor* Schwartz
Eleutherodactylus inoptatus Barbour
** *Eleutherodactylus lamprotes* Schwartz
[1] *Eleutherodactylus nortoni*
** *Eleutherodactylus oxyrhynchus* Dumeril and Bibron
** *Eleutherodactylus pictissimus pictissimus* Cochran
** *Eleutherodactylus ruthae aporosstegus* Schwartz
* *Eleutherodactylus sciagraphus* Schwartz
* *Eleutherodactylus semipalmatus* Shreve
** *Eleutherodactylus ventrilineatus* Shreve
** *Eleutherodactylus wetmorei wetmorei* Cochran

Family Hylidae (4 taxa)
** *Hyla heilprini* Noble
** *Hyla pulchrilineata* Cope
** *Hyla vasta* Cope
** *Osteopilus dominicensis* Tschudi

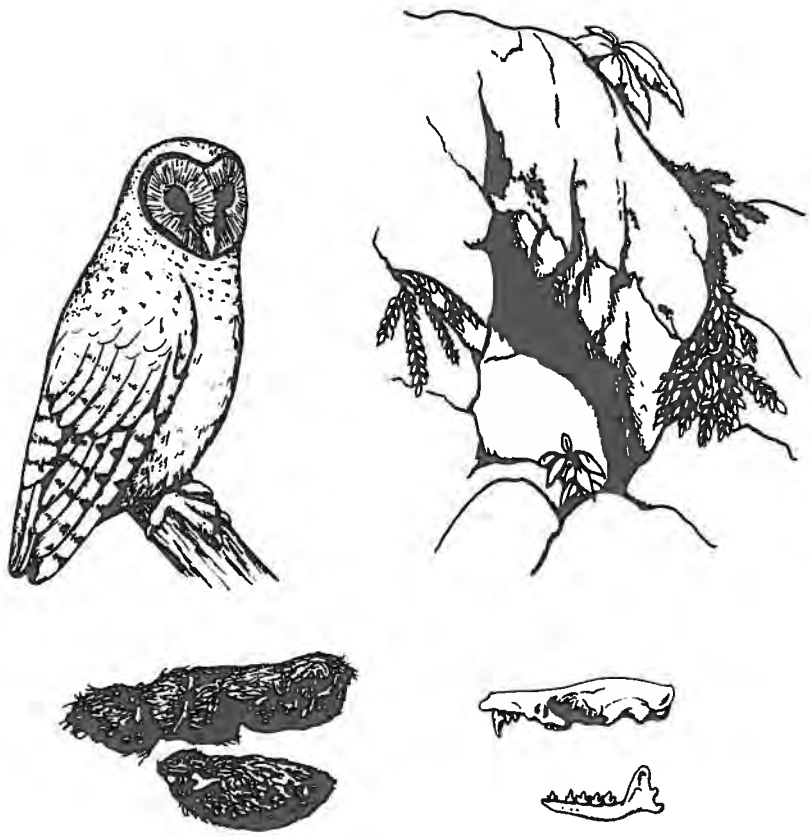
Order Squamata
Suborder SAURIA
Family Gekkonidae (1 taxon)
* *Sphaerodactylus elasmorhynchus* Thomas

Family Anguidae (3 taxa)
** *Celestus costatus costatus* Cope
** *Celestus stenurus stenurus* Cope
* *Sauresia sepsoides* Gray

Family Iguanidae (19 taxa)
[1] *Anolis armouri* Cochran
** *Anolis coelestinus coelestinus* Cope
** *Anolis cybotes* Cope
* *Anolis darlingtoni* Cochran
** *Anolis distichus aurifer* Schwartz
* *Anolis distichus suppar* Schwartz
* *Anolis distichus vinosus* Schwartz
** *Anolis dolichocephalus dolichocephalus* Williams
* *Anolis dolichocephalus sarmenticola* Schwartz
* *Anolis koopmani* Rand
* *Anolis monticola monticola* Shreve
** *Anolis monticola quadrisartus* Thomas and Schwartz
** *Anolis ricordi leberi* Williams
* *Anolis ricordi viculus* Schwartz
* *Anolis rupinae* Williams and Webster
Anolis semilineatus Cope
* *Anolis singularis* Williams
** *Chamaelinorops barbouri* Schmidt
** *Leiocephalus melanochlorus melanochlorus* Cope

Family Boidae (2 taxa)
** *Epicrates gracilis hapalus* Sheplan and Schwartz
** *Epicrates striatus exagistus* Sheplan and Schwartz

Family Colubridae (3 taxa)
** *Antillophis parvifrons parvifrons* Cope
** *Darlingtonia haetiana haetiana* Cochran
** *Uromacer catesbyi catesbyi* Schlegel



A modern barn owl (Tyto alba) portrayed on a card we hand out on our search for owls, caves, and fossil mammals. The fossil drawn here is the Small Island Shrew.

Table 4. List of fossil and Recent land mammals in order of abundance collected from Trouing Jeremie #5, the type locality of Rhizoplagiodontia lemkei, located the base of Pic Formon in the upper Plain of Formon. (C = common, U = uncommon; R = rare; EX = extinct). The analysis is of the top 4 cm of sediment.

Species	Status Recent	Status Fossil	% of Sample
Plagiodontia aedium	R	C	20.1
Rattus rattus	C	C	13.9
Rhizoplagiodontia lemkei	C	C	12.3
Nesophontes hypomicrus	EX	C	11.5
N. paramicrus			
Plagiodontia velozi	EX	C	9.0
Brotomys voratus	EX	C	8.2
Hexolobodon phenax	EX	C	7.4
Ground sloths (several species)	EX	C	5.7
Isolobodon portoricensis	EX	U	4.1
Solenodon paradoxus	R	U	2.5
Solenodon marcanoi	Unknown	R	1.6
Isolobodon montanus	EX	R	1.6
Mus musculus	U	R	0.8
Saimiri bernensis	EX	R	0.8

Table 5. Endemic land mammals of montane regions of the Massif de la Hotte and Massif de la Selle of southern Haiti. (**EX** = extinct; **PR** = present; **NP** = never present.)

Species	La Selle	La Hotte
Order Rodentia		
Family Capromyidae		
Plagiodontia aedium	PR	PR
P. velozi	EX	EX
P. araeum	EX	NP
Isolobodon portoricensis	EX	EX
I. montanus	EX	EX
Rhizoplagiodontia lemkei	NP	EX
Family Echimyidae		
Brotomys voratus	EX	EX
Order Primates		
Family Cebidae		
Saimiri bernensis	EX	EX
Order Insectivora		
Family Solenodontidae		
Solenodon paradoxus	EX	PR
S. marcanoi	EX	PR(?)
Family Nesophontidae		
Nesophontes zamicrus	EX	EX
N. hypomicrus	EX	EX
N. paramicrus	EX	EX
Order Xenarthra		
Family Megalonychidae		
Synocnus comes	EX	EX
Parocnus	EX	EX
New taxon	EX	EX
New taxon	EX	EX
New taxon	EX	EX
Total number of taxa	17	18
Number of surviving taxa	1	2
Number of endemics not found in other park	1	1

CHAPTER IV

THE BIRDS OF MACAYA

Introduction

Hispaniola has 73 species of resident land birds, the largest number of any island in the West Indies (Lack, 1976). Twenty species (28%) are endemic to Hispaniola (Table 6). Two additional species are resident in high elevation pine forests in Hispaniola but are not found elsewhere in the Antilles. They are the Hispaniolan-White-winged Crossbill (*Loxia leucoptera megaplaga*) and the Hispaniolan Pine Warbler (*Dendroica pinus chrysoleuca*), both of which probably became restricted to the island from their natural range in North America during Pleistocene climate cycles. Another species, the Rufous-collared Sparrow (*Zonotrichia capensis*), is a South American migrant that now breeds in montane forests (including pine forests) above 1,250 meters in Hispaniola, but is not found elsewhere in the Greater Antilles. *Corvus leucognaphalus*, the White-necked Crow, which is now extinct in Puerto Rico, is another species restricted to Hispaniola. Of these "endemic" (*sensu lato*) land birds found only on Hispaniola, ten are restricted to habitats occurring above 1,000 meters. Another nine species occur in these same habitats, but also occur in forest habitats below 1,000 meters. Only five endemic species are specifically associated with lowland xeric or savannah habitats. The ecological importance of broadleaved and pine forests occurring above 1,000 meters elevation to the conservation of the avifauna of Hispaniola is very clear.

Haiti is especially important in the development of conservation strategies for birds in the West Indies.

Hispanolia has more species of resident land birds than any other Antillean island. With 73 resident land birds, it has five more species than Cuba even though Cuba is closer to the North American mainland and is 30% larger in area. There are 66 resident land birds in Jamaica, which is only 14% the size of Hispaniola. A higher number of these are endemics (27 species, 41%) because of the remote and isolated location of Jamaica. In his analysis of the birds of Jamaica and the

West Indies, David Lack (1976) noted that 25 species of Hispaniolan land birds are absent from Jamaica and Cuba. Nine of these have close relatives on one or both of the other islands, but 16 are without close relatives in either Jamaica or Cuba. Hispaniola, therefore, is the West Indian island with the largest and most unique avifauna.

This chapter concentrates on resident land birds found in montane habitats of the Macaya area occurring above 1,000 meters. There are three important reasons for this emphasis. First, 80% of the endemic species of Hispaniola occur in such habitats; secondly, habitats occurring above 1,000 meters are in a more natural state because they have been less exploited and usually receive more rainfall; and thirdly, it is possible to justify conservation efforts in these regions because of the importance of high montane regions in watershed conservation. Almost all of the land area within Parc National Pic Macaya are above 1,000 meters elevation, as are most of the regions of the proposed Macaya Biosphere Reserve.

This chapter concentrates on the status of resident land birds (plus the Black-capped Petrel) and their critical habitats within the Macaya area. It does not discuss the status of migratory species. The mountains of Haiti, and especially the Massif de la Hotte provides habitat for a large number of North American migratory song birds, and the destruction of the forests of the region is a major threat to the stability of these species. A study of the status of migratory species that are winter residents of the Macaya area should be given high priority in the plans for Macaya Biosphere Reserve, and Parc National Pic Macaya. Such studies are planned as part of the MacArthur Foundation conservation Project in Haiti.

This chapter emphasizes resident species in the Macaya area because of the immediate need for data in planning the conservation program for the biosphere reserve and national park, and because these species are so important to the natural patrimony of Haiti. Some of the reasons for this importance are:

1). Southern Haiti has a resident land bird that is restricted to the mountains of the southern peninsula, the Grey-crowned Palm Tanager (*Phaenicophilus poliocephalus*);

2). One of the most endangered birds of Haiti, the White-winged Warbler, still occurs within the boundaries of Parc National Pic Macaya, and it is very important to initiate a Species Recovery Plan for this bird as soon as possible;

3). Three birds are dependent on upland pine forests (Pine Warbler, Antillean Siskin, Crossbill), and the management of this threatend forest community in the Macaya area is of great urgency for both the protection of the six watersheds of the region as well as for the preservation of the area's unique level of biodiversity;

4). The pending World Bank Project, and USAID and MARNDR will need data and information on the flora and fauna of Macaya in order to make wise decisions on plans for the land stewardship of the Macaya highlands. Birds are one of the best indicators of the state of the environment in an area. Most of the species discussed here are true "indicator species".

One endemic species of land bird is restricted only the the mountains of southern Haiti, the Grey-Crowned Palm Tanager, or "Kat Je Sid."

Terminology

Names of birds are presented in the Species Accounts section as: 1) English name and scientific nomenclature, which follow the current checklist by the American Ornithologist Union (AOU,1983); 2) Haitian Creole name as determined by our own fieldwork and the work of Nelson (1979), and with the spelling as presented in Valdman's Dictionary of Haitian Creole; 3) French name as stated in Bond (1985); 4) Spanish name as determined from the list of Aves de la Republica Dominicana prepared by La Sociedad Dominicana de Ornitologia.

The status of each species is defined as a percent figure for each habitat. 1) **Common**: readily encountered during any week of observations of a particular season. 2) **Uncommon**: encountered more than once but less than five times during any week of observations of a particular season. 3) **Rare**: not encountered on a regular basis but recorded as present. 4) **Vulnerable:** birds that are common in certain parts of their natural range but which are in habitats or situations that are not stable and are declining. 5) **Threatened**: birds that are in immediate danger of being severely reduced in numbers or eliminated by current trends even though the current status may be common or uncommon. 6) **Endangered**: birds that are uncommon or rare and are likely to be eliminated unless immediate action is taken to alter current land use practices or affirmative action is taken to protect the species in some manner. For the latter three categories, the "Conservation Index" is used as the basis for the determination of status. An index of aabove 80 indicates Endangered; 65-80 indicates Threatened; 50-65 indicates Vulnerable.

Bird Census Techniques

1. **Daily lists**. Data were collected daily as to: 1) species observed; 2) individuals seen or heard; 3) habitat associations; 4) noteworthy information on habits, vocalizations, associations or densities. These data were summarized and analyzed on a weekly basis and used to make decisions as to where to run transects and set mist nets, as well as to provide the data set for the study.

2. **Mist nets**. In selected habitats mist nets were monitored from dawn to dark at the same location for at least a week, and repeated at different seasons and in subsequent years. Nets were set in locations such as ravines or along riparian habitats where observation of birds was difficult because of the thick vegetation and the secretive habits of certain species. Birds captured were evaluated as to species, sex and reproductive status. Photographs were taken of all species. Some species were frequently captured in mist nets but not located in transects or via regular observations. When unusual birds were encountered in transects, mist nets were used to confirm the identifications (i.e., the possibility that Black-crowned and Gray-crowned Palm Tanagers hybridize in the Massif de La Selle; the presence of White-winged Warblers in the Massif de La Hotte).

3. **Transects**. Transects were run on a daily basis for at least 7 days during two subsequent seasons to determine habitat associations of each species. Routes were selected to pass through major habitat types in the approximate percentage that the habitat occurs in the region. Following the technique of Emlen (1977), one or two observers walked the transect for a four-hour period beginning at 0600 hours. Species were identified by visual contact or by song, call or note. Data were recorded as to: 1) species; 2) number of individuals; 3) time; 4) habitat; 5) type of observation (visual, auditory); 6) distance from observer.

4. **Special Counts**. Some species are difficult to census via mist nets or transects. Data on these species were compiled separately and treated on an individual basis.

Black-capped Petrels can only be located, identified and censussed by using their unusual vocalizations.

a. Parrots were recorded as numbers of individuals in flocks, and where the flocks were feeding or roosting.

b. Hawks, Swallows, and Swifts were recorded as numbers of flying individuals observed. Efforts were made to locate nests of Collared Swifts in caves.

c. Black-capped Petrels were identified by locating the area of their vocalization at night. The number of individual birds was determined by counting the number of distinct vocalizations per minute over a ten minute period and then averaging these data (Table 7). Where possible, more than one observer was used to count the vocalizations and several different observers counted Petrels at different locations to establish the areas where nesting burrows were located and the directions the birds were coming from as they returned from the sea in the early evening hours.

Analysis

Data were compiled into tables, and observations were tallied by habitat to produce a count and percent figure of the number of times each species was encountered in each habitat. The data were analyzed as to total number of individual birds per sample period, total number of species and average number of individual birds encountered per day. Table 8 briefly summarizes the data for one collecting period.

Final List. All of the data collected over the study period were analyzed to determine the fifteen species most closely linked to forest habitats in montane areas. The original list included twenty species, but the Limkin, Hispaniolan Parakeet, Collared Swift, Black Swift and Hispaniolan Pine Warbler were eliminated because their status is less specifically linked to montane mesic forest habitats.

Conservation Index. An index was calculated for all species on the list. The index is a measure of the priority that should be given to each species in developing a conservation effort. Five individual factors were considered in calculating the Conservation Index.

The Conservation index has been developed to be able to make decisions about conservation priorities of birds in Haiti. The species in this chapter are listed in order of rank on the conservation index. The most endangered species of bird in Haiti is the White-winged Warbler.

A. Generic uniqueness (5)
   Highest # for monotypic genera.
B. Habitat Specificity (10)
   Highest # for a very specific association.
C. Status (10)
   Highest # for most endangered status.
D. Endemicism Factor (10)
   Highest # for most endemic.
E. Biotic Potential (10)
   Highest # for lowest clutch size.

The final Conservation Index is the sum of A-E x 2.2 (to produce a maximum score of 100). The species of highest priority have the highest score. An index figure above 80 is considered Endangered; between 65-80 is considered Threatened; between 50-65 is considered Vulnerable.

Itinerary

Initial fieldwork was done in the Massif de La Hotte area in May of 1975 when we surveyed the north side of Pic Macaya and west as far as Morne Deux Mammelles. In January, 1977, we expanded the survey to the western portion of the La Hotte range in the Morne Mansinte, Morne Epine and Morne Grand Bois area near the southwestern tip of the southern peninsula. In January, 1979, the survey also included the Mont Des Cartaches, a separate series of mountains in the far tip of the southern peninsula of Haiti north of Riviere de Grande Anse. Fieldwork continued in January, 1983, with support by the International Foundation for the Conservation of Birds, when we surveyed Pic Formon from the south. Additional fieldwork in January, 1984, established a new trail along the ridge of Formon westward across 2,200-meter Pic Le Ciel ("Le Syel", the sky, in creole) and along the narrow connecting ridge to the top of Pic Formon. The trail then followed the narrow steep ridge connecting Pic Formon to Pic Macaya. A base camp was established on the top of Pic Macaya in February, 1984. Ekman (1926, 1928) had tried to climb Pic Formon and Pic Macaya from this direction several times between 1917 and 1928 but was unsuccessful because of the rugged terrain and dense vegetation. Nobody has ever penetrated this region all the way to Pic Macaya from the south. Fieldwork continued in the same area in May, 1984, January and February of 1985 and November, 1985. Additional surveys were conducted as part of the Sondeos in 1988 and 1989. The final survey was done in April, 1992.

INDIVIDUAL SPECIES ACCOUNTS

Eighteen (18) resident bird species have been selected as being closely linked to mesic forests in montane regions in Haiti. These species are listed in Table 9 along with an indication of their status and conservation index. The species were selected from a list of over 70 species studied over a ten year period (1975-1985). Some of these data have previously been discussed (Woods, 1975; Woods, 1985; Woods and Ottenwalder, 1986) and were the subject of a paper presented at the first Jean Delacour Conference (Woods and Ottenwalder, 1983). Of the 18 species, 16 are found in the Macaya area. The additional two species, the La Selle Thrush and the Ground Warbler are included in this chapter because of their importance in the avifauna of Haiti, and because they are critical species in Haiti's other main national park--Parc National la Visite.

The species discussed below are arranged in order of their conservation index. The most endangered species are discussed first, followed in ranked order by species less endangered or threatened. It should be noted, however, that the method of calculating the conservation index is not perfect, and does not take into account all of the factors that might lead to the loss of a particular species. All of the species discussed here are closely associated with the montane habitats found in the area of Parc National Pic Macaya. The species accounts also include discussions of two birds from Parc National La Visite: the La Selle Thrush and the Green-tailed Ground Warbler. These two species are included in this chapter because of their importance in the avifauna of Haiti, and because we hope that the conservation efforts presently underway in the Macaya area will be expanded to the La Selle region that includes the zone between the national park at Morne La Visite and the top of Haiti's highest mountain, Pic La Selle.

WHITE-WINGED WARBLER

Xenoligea montana

Ti Chit Kat Je

Petit Quatre-yeux

Ciguita Aliblanca

Description: This endemic warbler resembles the Ground Warbler. It is greenish above with a grey neck and head. However, the tail is slate grey with the outer tail feathers black--edged in white. There is a prominent white streak on the wing. On the head there is a white stripe in front of the eye, and a white spot below the eye--hence the common name in creole "little bird with four eyes" or "little four eyes" in reference to its resemblance of the Palm Tanager which is called "four eyes".

Habitat and Distribution: This secretive species is most often found in dense stands of broadleaved vegetation. It is encountered more frequently in trees and open areas than is the Ground Warbler. It is larger and has a much heavier bill than the Ground Warbler. According to Wetmore and Swales (1931), the White-winged Warbler combines the mannerisms of a warbler and a vireo. It has been reported by Bond (1928), Wetmore and Swales (1931) and Wetmore and Lincoln (1933) in both the La Selle and La Hotte areas, where they found the White-winged Warbler to be fairly common. We did not find it in La Visite, and had difficulty locating it in Macaya. We most often found it in Disturbed Broadleaved Forest (80%) at 1,800 meters elevation on Pic Formon, and in the Mature Broadleaved Forest (20%) habitat along the ridge of Formon at about the same elevation. Wetmore and Lincoln (1933) also found the White-winged Warbler at intermediate elevations in the Macaya area and observed that they were most common between 1,300 and 1,800 meters elevation in the broadleaved forest. Bond (1928) found this warbler to be common in the Morne Malanga, Morne Tranchant and Crete-a-Piquant areas above Port-au-Prince and on the slopes of the Massif de La Selle where he noted that they were about as common as the Ground Warbler. All of these areas have been severely deforested, and the White-winged Warbler has been nearly (if not completely) extirpated. In Southern Haiti the White-winged Warbler hangs on by a thread, dependent upon thick stands of Mature Broadleaved Forest between 1,300 and 1,800 meters elevation.

White-winged Warbler

ENDEMIC

ENDANGERED

Seasonal Status: Year round resident. Nests in April-May. (ENDEMIC).

Status: The most endangered bird of Haiti. Very rare and possibly extirpated from the Massif de La Selle; rare and endangered in the Massif de La Hotte.

Recommendations: This species is dependent on Mature Broadleaved Forest at intermediate elevations (1,200-1,800 meters). These habitats must be preserved if the White-winged Warbler is to survive. The area west of Morne La Visite all the way to, and including Morne d'Enfer, must be included in Parc National La Visite. This region has extensive areas of Mature Broadleaved Forest which have been preserved because the Morne d'Enfer area is extremely inaccessible. Morne d'Enfer must be added to Parc National La Visite, and all cutting of the Mature Broadleaved Forest above the Plain of Formon within Parc National Pic Macaya must be stopped if this species is to be prevented from becoming extinct in Haiti in the near future.

Conservation Index = 92.4

CHAT TANAGER

Calyptophilus frugivorus

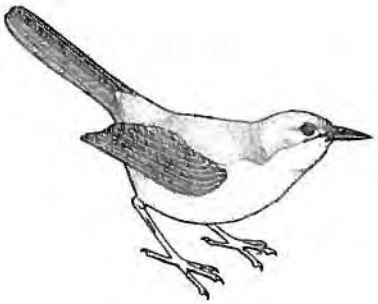
Konichon

Cornichon

Chirri, Patico

Description: This very secretive bird is largely terrestrial in habits. It is olive-brown above and white below with a yellow spot in front of the eye (loris) and on the bend of the wing. It is most frequently identified by its vocalizations, which are loud and very diagnostic. The song is a clear, ringing "chip-chip-swerp-swerp-swerp" or a "swerp-swerp-chip-chip-chip". The same bird can give both songs. The song can be heard throughout the year, but is most common in spring. The Chat Tanager can also be located in its thick, brushy habitat by its note, a distinctive, loud "tic".

Habitat and Distribution: This species is associated with remote areas, and dense, wet thickets of Mature Broadleaved Forest. Dod (1981) notes that it is not found below 1,650 meters elevation in the Dominican Republic, but we found it down to 1,000 meters in the wetter areas of Macaya and La Visite. Wetmore and Swales (1931) did not find the species in the La Visite area, but did encounter one individual at 1,000 meters on Pic Macaya. We found the bird to be much more common than did Wetmore. In La Visite we found the bird in Mature Broadleaved Forest (75%) and Disturbed Broadleaved Forest (25%) areas. It was common on the steep face of the massif (Nan Nway) and in dense stands of Mature Broadleaved Forest, such as the forest behind the park headquarters. It is always in areas that are wet and densely forested. In the Macaya area, we encountered Chat Tanagers in Mature Broadleaved Forest (75%), Disturbed Broadleaved Forest (15%) and Mature Pine Forest (10%). It was most common in the Mature Broadleaved Forest underneath the towering pines on the peak of Macaya. On the Plain of Formon we encountered Chat Tanagers in Mature Broadleaved Forest on Karst (75%) and Disturbed Broadleaved Forest (25%) habitats.



Chat-Tanager

ENDEMIC

ENDANGERED

Because this species is confined to areas of mesic broadleaved vegetation (La Hotte, La Selle, Cordillera Central, Sierra de Neiba as well as La Gonave Island) that are surrounded by drier lowland regions where Chat Tanagers do not occur, there are five distinct and widely separated populations. Chat Tanagers in each of these regions differ from one another, and range from individuals that are paler in coloration and have more basic vocalizations in the east, to larger, darker birds with long complex vocalizations in the west. Wetmore and Swales (1931) noted four forms (designated as subspecies) and Bond and Dod (1977) described a fifth one from the Sierra de Neiba. The two populations that apply to the mountains of southern Haiti are:

Calyptophilus frugivorus tertius from the Massif de La Hotte, and therefore Parc National Pic Macaya.

Calyptophilus frugivorus selleanus from the Massif de La Selle and nearby Morne Malanga, Morne Tranchant, Morne Brouet and Crete a Piquants. This form has long been considered a synonym of *C. f. tertius* (dating from 1936, see Bond and Dod, 1977).

The Chat Tanager of Pic Macaya is a distinct subspecies, and has a long and beautiful song that distinguishes it from all other populations of this species in Hispaniola.

The status of these local populations and the validity of the various subspecies is in need of review. We believe that the birds from the La Hotte area are noticeably larger and darker in coloration with more dramatic yellow lores than

the Chat Tanagers on La Visite, and that their vocalizations are more elaborate. It is questionable to lump the La Selle and La Hotte (South Island) populations together as *C. f. tertius*. The La Hotte and La Selle populations should be regarded as distinct subspecies. The Chat Tanager from the Sierra de Neiba, Calimete and Cordillera Central of the Dominican Republic is *C. f. neibae* (Bond and Dod, 1977).

Seasonal Status: Year-round resident. (ENDEMIC)

Status: Restricted to mesic Mature Broadleaved Forest in both the Massif de La Selle and Massif de La Hotte. Because it is only found in these wild wet places, and is restricted in distribution into distinct subspecies, the Chat Tanager is **endangered.**

Recommendations: Mature Broadleaved Forest habitats must be protected in some areas, most appropriately within the boundaries of the national parks in the Massif de La Selle and Massif de La Hotte.

Conservation Index = 90.2

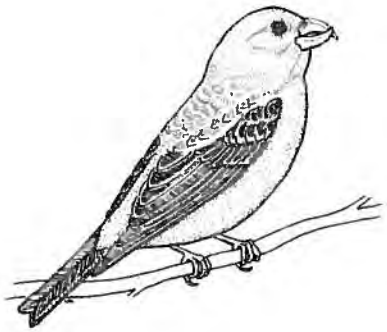
HISPANIOLAN WHITE-WINGED CROSSBILL

Loxia leucoptera megaplaga

Bek Kwaze

Bec-Croise, Gros Bec

Pico Cruzado, Turquesa



Hispaniolan White-winged Crossbill

ENDEMIC

ENDANGERED

Description: This species is distinguished from all other birds in Hispaniola by its bill, which overlaps above and below. The male is rosy red in coloration with black wings and tail. The wings have two white wing bars. The female is yellow-green in coloration and streaked with brown. It also has wing bars. The species spends most of its time on the top of tall pines and is difficult to observe unless one is familiar with the vocalizations: a dry "chif-chif" or "shik-shik" that is repeated on and on.

Habitat Distribution: The White-winged Crossbill or "Bek Kwaze" is confined to the pine forests, where it feeds on the cones of mature pines. Wetmore and Swales (1931) found crossbills to be abundant on the Morne La Visite area, but did not find it in Macaya. We found crossbills in both La Visite and Macaya. In La Visite, 100% of the observations were in forests or open areas of mature Pine Forest. In Macaya, the birds were more widespread (probably because there are few pure stands of old-growth Pine Forest). We found crossbills most often in Pine Forest mixed with Broadleaved Deciduous Forest (93%), especially on the top of Pic Macaya, and in open Successional Broadleaved Forest on the upper slopes of Pic Macaya (7%).

Seasonal Status: Year-round resident. (ENDEMIC)

Status: Frequently observed in suitable high mountain habitats of Macaya, but very vulnerable to extirpation. Depends on mature pines producing seeds. Recent sutides indicate there may be as few as 500 individuals surviving on Hispaniola. This species is **endangered.**

Recommendations: This species is dependent upon large areas of mature pines. No pines should be cut in the park, and large areas of pine should be

planted and allowed to reach mature size in the buffer zone (Macaya Biosphere Reserve).

Special Comments: The White-winged Crossbill had never previously been reported from Haiti west of La Selle, and we did not observe the species in Macaya until 1984. We found two flocks of 12-15 birds each on the top of Pic Macaya in January of 1984 and 1985, suggesting that the species has been expanding its former range. Crossbills were also present on Macaya in November, 1985, and in addition, a flock of 12-15 birds was observed in November on Pic Formon and in the saddle between Pic Formon and Pic Macaya. Whether the extent of pines on Macaya is sufficient to support a breeding population of the White-winged Crossbill is questionable and unresolved. It is extremely important to note, however, that the cutting of all mature pine trees in the Macaya/Formon region must be stopped if there is going to be any chance for crossbills to establish themselves successfully in the Parc National Macaya.

The White-winged Crossbill is a species of the northern conifer forests, and within the Antilles is found only in Hispaniola. It is one of the most unusual birds of the Antilles, and its presence in Haiti is a relict of the last great Ice Ace in North America when the climate was much cooler and drier in Haiti.

Special note: Recent studies indicate that this bird is probably a distinct species. Pine forests in Haiti should be managed to insure the continued presence of mature con-bearing trees to protect this species.

Conservation Index = 81.4

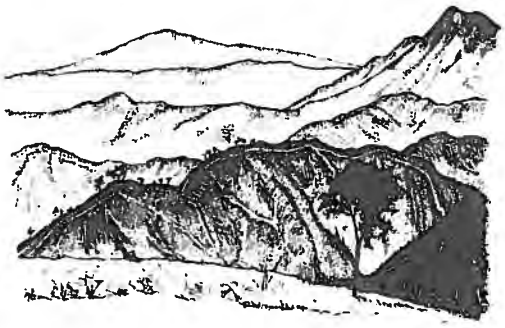
BLACK-CAPPED PETREL

Pterodroma hasitata

Chanrouan Lasel

Chat-huant

Diabiotin



Drawing of Morne La Visite area with Pic La Selle in background. The steep cliffs are nesting areas for Black-capped Petrels.

Description: This seabird is about the size of a crow (38 cms) and is grey-black on the wings and back above and white below on the body. The neck and base of the tail are white and there is a distinct black cap on the head. The beak is dark in color, hooked at the tip and has a pair of external tubular nostrils. They fly very fast and are observed over land in Haiti only at night when they return to their breeding areas in the high mountains. They are best identified by their distinctive vocalizations which can be heard off the cliffs where they breed. The vocalization resembles a "hum" with a distinct sharp note (tick-ek). Wingate (1964) described three distinct vocalizations by courting birds, all of which we heard and identified. These vocalizations are: 1) "a long drawn out aaa-aw ending abruptly with eek, repeated several times in succession..."; 2) "a long drawn out ooow ending abruptly in uk, repeated several times in succession..."; 3) "...a series of whines and yelps like a hurt puppy-- week-week-week-cueek cu-u-cek cu-u-eeck".

Habitat and Distribution: The Petrel nests on forested cliffs in mountainous areas, which in Haiti are above 1,500 meters in elevation. They excavate burrows that are 1-3 meters deep or utilize rock crevices on the face of cliffs. In the Massif de La Selle, Petrels have been known to occur since 1963 when Wingate (1964) reported their presence and described their status on the north face of the La Selle escarpment between 1,500 and 2,000 meters elevation. Wingate reported

Black-capped Petrel being held by Dr. David Wingate on Morne la Visite.

two colonies between Morne La Visite and Morne Cabaio, two colonies between Cabaio and Tete Opaque, and one colony on the southwest boundary of Parc National La Visite. In total, he estimated the existence of 11 colonies along the Massif de La Selle, each colony containing a minimum of 50 pairs (1,100 individuals). Five colonies of 50 pairs of Petrels (500 birds) were estimated by Wingate to be present in the western third of the Massif de La Selle in 1963. Our census in the winter of 1984 indicates that there are now fewer colonies within this same area. The colony still exists on Morne La Visite and there are two colonies in the Tete Opaque area within the boundaries of the Parc National La Visite. Using Wingate's standard of 50 pairs per colony, the park would now contain 300 birds (a 40% reduction in 20 years). We are not familiar with Wingate's census technique, which is based on his experiences with known populations of the closely-related Cahow from Bermuda, so we are not able to relate our estimates to Wingate's data. Our estimates are based on the number of complete vocalizations recorded per minute, and are presented in Table 7.

A high priority should be given to protecting the habitat of the Black-capped Petrel in the center of Parc National Pic Macaya.

In the Massif de La Hotte there is comparable habitat (steep cliffs) on upper slopes of both Pic Formon and Pic Macaya above 1,500 meters elevation. In 1975, we searched the north slope of Pic Macaya for Petrels without success. In 1982, Wingate and Paul Paryski searched the south areas of Pic Formon without success. In 1984, Paul Paryski and Charles Woods located and evaluated the status of a colony of Petrels on the south facing cliffs of Pic Macaya. The colony is concentrated above 2,000 meters elevation west of the ridge connecting Pic Formon with Pic Macaya. A second group of birds can be heard vocalizing south and west of the colony on Pic Macaya, and is probably located on the northwest face of Pic Formon. Efforts to document the exact location of a colony on Pic Formon were unsuccessful because of repeated bad weather (high winds and rain). On nights with high wind and rain, no vocalizations can be heard even at sites with large colonies.

Seasonal Status: Black-capped Petrels arrive at their breeding sites in the mountains of Haiti (and a few sites in the Dominican Republic) beginning in late September. Peak breeding occurs in late December, January and February. Eggs

(a single egg by each female) are laid during January and February. The young are fledged in the spring and vocalizations are no longer heard after late April. From May until late September (5 months), the birds are presumably away from their breeding grounds in Haiti.

Status: In both the Massif de La Selle and Massif de La Hotte, the Black-capped Petrel is common in suitable habitats. These habitats are limited in number and are rapidly being deforested. Dogs, cats and the mongoose are becoming more abundant in the nesting areas. The Black-capped Petrel is **endangered** as a result.

Before 1850, the species was known to occur in the higher mountains of Martinique, Dominica, Guadeloupe and Jamaica as well as Hispaniola (and presumed to have occurred in Cuba). They were presumed to have become extinct in Dominica by 1881, although they were reported on Diablotin Mountain in 1977 (Bond, pers. comm.). They disappeared from Martinique and Guadeloupe in the 1840s, in Jamaica sometime in the late 1800s. The only known localities where Black-capped Petrels are documented to still breed are Haiti, two small colonies in the nearby Sierra de Baoruco Mountains of the Dominican Republic, and the Sierra Maestra mountains of Cuba (Bond, 1978).

Recommendations: The Black-capped Petrel is vulnerable to exploitation, predation and habitat destruction. By lighting a fire on a cliff top above a colony of Petrels on a foggy moonless night, birds can be easily captured as they fly near the fires and crash into the fire or nearby vegetation (Wingate, 1964). This technique, called "sen sel", works only when the species is breeding between January and March and when the fires are set above the colony. No fires should be allowed on the peaks of the mountains during the winter months, and no peasants should be allowed to capture Petrels. Furthermore, we have documented dogs digging Petrels from burrows, and Petrels are vulnerable to predation by cats. We recommend that all dogs and cats in the national parks be killed and that no gardens or trails be allowed anywhere near the steep cliffs within the boundaries of the parks. Petrels depend on vegetation to protect the burrows and rock crevices. This vegetation is easily destroyed by fires that sweep up the mountainside from below. We recommend that no gardens or fires be allowed in a buffer zone that extends down to an elevation of at least 1,400 meters elevation below the cliffs within each park. This buffer zone should extend all the way to the base of the mountains and the flat areas below.

The effects of the mongoose and *Rattus* on the Black-capped Petrel is undocumented. Rats may destroy Petrel eggs and can easily kill young birds. Bell and Keith (1983) concluded that rats could affect the reproduction of Dark-rumped Petrels in the Galapagos Islands, and that "even though the facts are not clear...rat control should be undertaken in Petrel colonies." We do not recommend the control of rats in Parc National La Visite until a way can be found to guarantee the security of the populations of Haitian hutias *(Plagiodontia aedium)* that occur in close proximity to the colonies of Petrels all along the ridge of La Visite.

The mongoose, introduced in Haiti in 1907, is now widespread up to even high elevations of the Massif de La Selle and Massif de La Hotte. It occurs above 2,000 meters in both ranges, and therefore is found within the area of all known breeding colonies of Petrels. Goats and sheep also occur widely and should be removed from both national parks since they are capable of destroying valuable forest cover and disturbing nesting Petrels.

Conservation Index = 81.4

ANTILLEAN PICULET

Nesoctites micromegas

Chapantie Bwa

Charpentier Bois, Pic

Carpintero de Sierra

Description: The Antillean Piculet looks and acts quite unlike a woodpecker. It is greenish in color on the back and whitish (or yellowish) on the belly, streaked with black. The top of the head is yellow. The bill is short, as is the tail (which is soft and not used as a brace in climbing). The Antillean Piculet climbs about on the bark of trees more like a nuthatch than a woodpecker. It is secretive and difficult to observe. The best field characteristic is its vocalization, a loud, rapid "kuk-ki-ki-ki-ke-ku-kuk" or "tu-tu-tu-lo-feo". The male and female often answer each other (duet singing).

Habitat and Distribution: This is one of the most unusual birds of Hispaniola. The Antillean Piculet, unlike the Hispaniolan Woodpecker, is not an agricultural pest. The Piculet occurs in a variety of habitats. It is most common in humid Mature Broadleaved Forest environments at middle elevations (700-1,700 meters). Its characteristic vocalizations were not heard in the Massif de La Selle area, probably because the Mature Broadleaved Forest habitats in the region are so fragmented. The Piculet is widely distributed and frequently observed in the La Hotte region. It is common in the Mature Broadleaved Forest on Karst (17%) and Disturbed Broadleaved Forest on Karst (35%) habitats of the karst hills of the Plain of Formon. In the higher mountains, the Piculet is abundant in the basin on the slopes of Formon at 1,700 meters (67%) in Mature Broadleaved Forest, (33%) in Disturbed Broadleaved Forest), but was not observed on the peaks. It was observed in the Gran Ravin.

Antillean Piculet

ENDEMIC

THREATENED

Seasonal Status: Year-round resident. (ENDEMIC)

Status: Common in specific mesic habitats up to 1,700 meters in the Massif de La Hotte, but not observed in the Massif de La Selle. **Threatened** by habitat destruction.

Recommendations: The preservation of this species depends upon the existence of mesic broadleaved forest at middle elevations. The Antillean Piculet is not able to find refuge in the remaining high mountain forests, and its preferred habitat in middle elevation areas is frequently deforested. A major effort should be made to preserve patches of mesic forest in the buffer zones surrounding each park.

Conservation Index = 74.8

HISPANOLIAN TROGON

Priotelus roseigaster

Kalson Wouj

Calecon Rouge, Dame Anglaise, Pic de Montagne

Papagayo or Cotorrita de Sierra

Description: This is one of the most dramatic and attractive birds in Hispaniola. The head, back and tail are bright green while the throat and chest are grey. The belly and rump are bright red and the long flowing tail has white spots on the underside. The short bill is bright yellow and the eyes are bright orange. The vocalization, a loud but mellow "krack-kaow" or "cuh-kwao," is very characteristic and can be heard from a great distance.

Habitat and Distribution: The Trogon nests in cavities in trees, often an abandoned nest-hole of a Hispaniolan Woodpecker. It can be found in a variety of habitats including Mature Pine Forest and Mature Broadleaved Forest, but prefers well-forested regions in the mountains where it feeds on wild fruits. In upper elevations of Pic Macaya, 85% of the sightings were from Mature Broadleaved Forest habitats with the remaining sightings being in Mature Pine Forest (8%), and Disturbed Broadleaved Forest (8%). On the Plain of Formon, 100% of the observations were in Mature Broadleaved Forest on Karst. Wetmore noted that in 1931, Trogons were common up to the summit of Pic Macaya, and were especially numerous among the great pines of higher altitudes. They were observed daily in the trees around their camp at 1,275 meters elevation. The Trogon is now less abundant in the region because of habitat destruction. In the Massif de La Selle, 100% of the observations were in Mature Broadleaved Forest habitats in diverse locations from the La Selle escarpment to mesic hollows and ravines at lower elevations on the plateau.

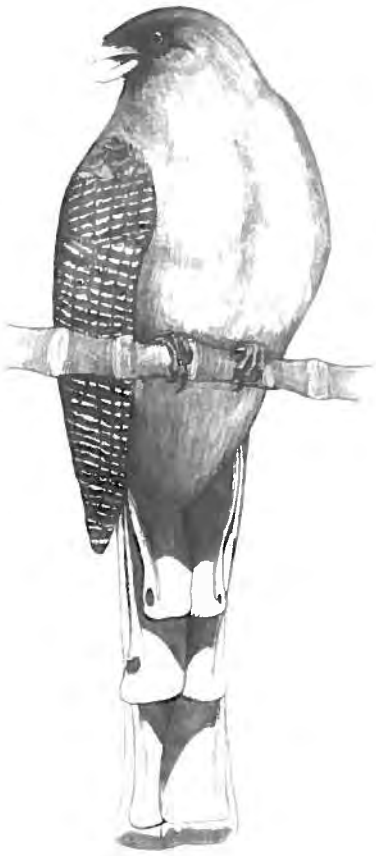
Seasonal Status: Year round resident. (ENDEMIC)

Status: The Trogon is more abundant in the Massif de La Hotte than La Selle because more Mature Broadleaved Forest remains in that area of high rainfall. It is common in all sections of Parc National Pic Macaya; uncommon in Park National La Visite. The Trogon is dependent on mature trees to nest in, and diverse stands of Mature Broadleaved Forest for shelter and food, and this habitat is rapidly disappearing. So much of this habitat has been cut in the past five years that the Trogon is now **threatened** in all areas of Haiti.

Recommendations: The large stands of Mature Broadleaved Forest that are so important to the preservation of this species must be protected, especially in the national parks. Artificial nest boxes should be placed in forested areas within the national parks as a method of encouraging breeding.

Special Note: The bird is an excellent candidate for distinction as the National bird of Haiti: it is beautiful, depends on mature broadleaved forest for nesting and refuge, and is vocal, so it is one of the most characteristic species of the mountains of Haiti. Its very characteristic song is a true measure of an envrionment in balance with nature.

Conservation Index = 74.8



Hispaniolan Trogon

ENDEMIC

THREATENED

ANTILLEAN EUPHONIA

Euphonia musica

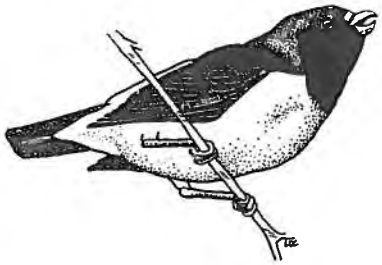
Louido

Louis d'Or or Oiseau Grand-pere

Jilguerillo

Description: This tiny species, among the smallest passerine birds of Haiti, is secretive and difficult to observe. The male is very colorful, being deep violet blue on the back, wings and tail, light blue on the crown of the head and hindneck and yellow on the rump. The underparts are yellow. The female is green above with a light blue crown and neck and yellow underparts. The bird is almost impossible to observe because of its habit of feeding in the upper limbs of trees, and is most easily recognized by its characteristic vocalization--a plaintive whistle followed rapidly by a soft tuk-tuk so it sounds like "ee-oo-tuk-tuk", or "i-i-i-u-u-...tuk, tuk".

Habitat and Distribution: The Antillean Euphonia or "Louido" feeds on the soft fleshy bones of mistletoe, and is common in well-forested regions, especially at higher elevations. Wetmore and Swales (1931) and Wetmore and Lincoln (1933) recorded the species at 1,500 meters on the north slope of Morne Cabaio, and in Macaya from 900 meters to the summit of the mountain. We did not encounter the Euphonia in transects on the ridge and plateau of La Visite, indicating the species may not occur in open pinelands. We found the species only in dense stands of Mature Broadleaved Forest in Macaya on the ridges of Formon, and in the Mature Broadleaved Forest on Karst of the karst hills adjacent to the Plain of Formon. The species is dependent upon the presence of Mature Broadleaved Forest. The Euphonia is difficult to census because of its secretive habits, and so we cannot accurately evaluate its abundance in historical times in Haiti because the bird was observed by few early naturalists.



Antillean Euphonia

THREATENED

Seasonal Status: Year-round resident.

Status: Rare in the Massif de La Selle, apparently found only in the dense Mature Broadleaved Forest on the north face of the La Selle escarpment (Nan Nway). Uncommon in the Massif de La Hotte, where it is only found in dense stands of Mature Broadleaved Forest. Throughout Haiti the Euphonia is **threatened.**

Recommendations: This species is absolutely dependent upon Mature Broadleaved Forest. All cutting or burning of the Mature Broadleaved Forest should be restricted within the areas of the national parks.

Conservation Index = 70.4

HISPANOLIAN PARROT

Amazona ventralis

Jako

Jacquot

Cotorra

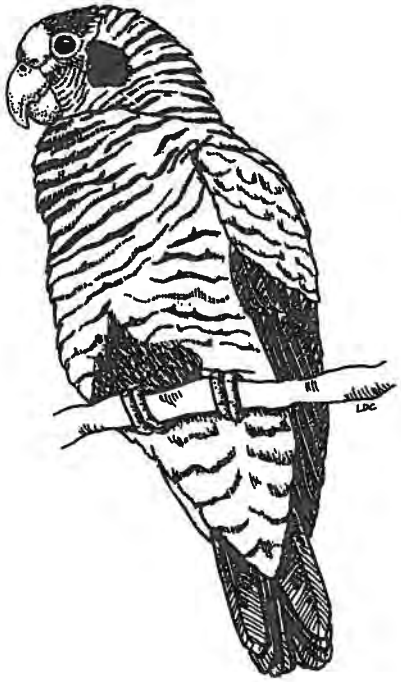
Description: This species is bright green in coloration with a short tail. There is a white spot on the forehead above the bill. The abdomen is red. The crown, sides of head and wings are blue. Parrots are very noisy and call while flying as well as when perched in a tree. The song is a continuous series of screams and screeches. Any one of three main series can be heard, but only one series is heard at a time. One series is "keeek, keeek, keeek, keeek", and is often heard from flying birds. Another series is "che-week, che-week, che-week", and a third series is "weeek, weeek, weeek, weeek". Any one series can be repeated on and on, and can be very loud.

Habitat and Distribution: The Parrot feeds on wild fruits and nests in cavities in large old forest trees. The habitat of the species therefore is Mature Broadleaved Forest. This habitat occurs naturally in both parks, although it is more abundant in Parc National Pic Macaya. The Parrot should be abundant in montane areas of both the Massif de La Selle and Massif de La Hotte. We observed large numbers of this species in flocks of up to 80 individuals in the Massif de La Hotte in the past (1975), and Wetmore and Swales (1931) noted that parrots ranged to the top of Pic Macaya. Both Bond and Wetmore record significant numbers of parrots on the ridge of La Selle. We observed large flocks of parrots in the Sierra de Baorucos of the Dominican Republic near the Haitian frontier at the same elevation as Parc National La Visite. However, during the course of the study, we found the Parrot to be almost missing from La Visite. It was common in the Mature Broadleaved Forest on Karst of the Plain of Formon where small flocks are easily observed. No large flocks were seen in the Formon area during the course of the study except for one flock of 24 birds in November, 1985, near Bwa Durand. No Parrots were seen on the upper slopes of either Pic Formon or Pic Macaya.

The Parrot is becoming much less abundant. Dod (1981) refers to the species as reduced in numbers, and on the way to extinction in the Dominican Republic. Only 50 years ago there were large flocks of Parrots in the mountains of Haiti. Loud screeching calls invariably announced the coming of a flock amid the forests clothing the great ridges, or in the broad open valleys in times gone by. An active conservation program must be initiated if this species is to be saved from extinction. It is important to develop and enforce legislation to prevent exploitation of the species as a household pet and item of commercial value, as well as to protect its habitat in the region of the national parks. Parrots are more common in the mountains than in lowland areas, but can be found in dry lowland habitats. They are known to nest on Isla Cabritos in Lago Enriquillo (Ottenwalder, 1978) which is in the Cul-de-sac Plain of the Dominican Republic.

Seasonal Status: Year-round resident. (ENDEMIC)

Status: The Parrot in the Massif de La Selle is rare and endangered. In the Massif de La Hotte, the species is rare and endangered in the upper mountains, and uncommon but threatened on the Plain of Formon and surrounding mid-elevation areas. The general status of the Parrot throughout its range is **threatened.**



Hispaniolan Parrot

ENDEMIC

THREATENED

Recommendations: One problem for the Parrot is that it is a favorite household pet in Haiti, and young birds are easily taken from their nests. The keeping of Parrots as pets in Haiti must be stopped, and all selling or trading of Parrots in market places must be prevented. Parrots found for sale in market places or by private individuals should be confiscated, although it would be too controversial and damaging to the public image of the conservation program to confiscate pet parrots from households. Forest practices, especially in the parks and surrounding buffer zones should preserve and promote Mature Broadleaved Forest habitats. We recommend placing artificial nest boxes in the parks to promote breeding in these cavity-nesting birds.

Conservation Index = 68.2

HISPANIOLAN PINE WARBLER

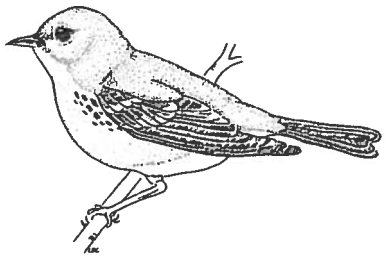
Dendroica pinus chrysoleuca

Ti Chit Bwa Pin

Petit Chitte de Bois Pin, Chardonneret

Ciguita del Pinar

Description: The upper parts of this large warbler are yellowish-green. The underparts are yellow on the throat and chest, becoming white in the abdomen. There are two clear white wing-bars. There is a faint stripe above each eye and white spots on the tail. This warbler spends most of its time high in pine trees and is difficult to observe. It is most easily identified by its characteristic song, a musical trill all in one pitch: "chip, chip, chip, chip, chip, chip, chip, chip...". It sounds somewhat like a sewing machine.



Hispaniolan Pine Warbler

ENDEMIC

THREATENED

Habitat Distribution: The Pine Warbler is found in mature Pine Forests, hence is confined to high montane areas in most parts of Hispaniola. Wetmore and Swales (1931) found the Pine Warbler "fairly common" over the high summit of the La Visite area, but did not record them from the Macaya region. Since pine forests are more limited in Haiti than in the Dominican Republic, the Pine Warbler is less well known in Haiti; Wetmore's specimens from La Visite seem to be the first definite report of the species in Haiti. We found the Pine Warbler in the Macaya area. Eighty percent of the observations were in Pine Forests, 12% on Broadleaved Forests (with mixed pine trees), 6% in small, second-growth patches of pine trees, and 3% in very disturbed patches of Broadleaved Forest (with nearby pines). On the Plain of Formon, the Pine Warblers were seen (but rarely heard) in Broadleaved Forest in the karst hills. Therefore, Pine Warblers are most closely associated with pines, and one often hears and sees Pine Warblers where only a few scattered pines are present. The birds are the most common in great stands of mature pine.

Seasonal Status: The subspecies *D.p.chrysoleuca* is a year-round resident that breeds in the pine forests in April and May. During the winter months, migrant Pine Warblers from North America are also found in the parks. (ENDEMIC).

Status: Common on the higher ridges of Macaya where there are pines. uncommon to rare on the Plain of Formon. Overall, the species is **threatened.**

Recommendations: The Pine Warbler, like several other species, is closely associated with mature pines, and the Pine Forest areas must be carefully protected and managed to insure that large stands of mature pine remain as breeding sites for this unique subspecies.

Special Comments: Along with the chattering of crossbills, the song of the Pine Warbler is one of the most characteristic sounds of the pine forests of Hispaniola.

Conservation Index = 64.9

ANTILLEAN SISKIN

Carduelis dominicensis

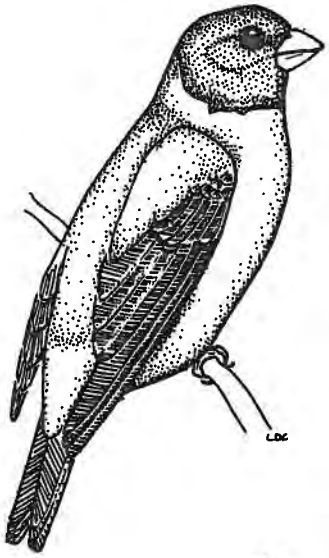
Ti Serin

Petit Serin

Canario

Description: The male of this colorful species is yellow-green on the back and bright yellow on the breast. The head and wings are black, and the bill is yellow. The female is olive green on the back and whitish below. It frequently flies in large flocks, and emits a characteristic "e-see-zip" vocalization, often given as the bird flies.

Habitat and Distribution: The Antillean Siskin inhabits high, open pine forests where it feeds in the trees and on weeds near the ground. Bond (1928), Wetmore and Swales (1931) and Wetmore and Lincoln (1933) observed them in the La Visite area, but not in Macaya. We observed large numbers of the species in La Visite. We most frequently encountered Antillean Siskins in open Mature Pine Forests (37%), and Disturbed Broadleaved Forests near gardens (24%), followed by open Ruinate Areas (17%), Mature Broadleaved Forests (12%), Gardens (8%), and Successional Pine Forests (2%). In May, Antillean Siskins were encountered more frequently in Mature Pine Forests (50%) and open Ruinate Areas (26%). In Macaya, where the pines are mixed in with broadleaved vegetation and there are no open pinelands, the Antillean Siskin does not occur in numbers. There is one record from near Jeremie (in 1917, Wetmore and Swales, 1931:440). We heard several Siskins on Pic Macaya, although it is probable that these were stray birds from the pine forests of the Massif de La Selle, There are no indications that the Antillean Siskin now nests on Macaya. This species continues to be restricted as a breeding bird to the Massif de La Selle and eastward in the Dominican Republic. It is curious that it has not taken advantage of chance introductions into the Macaya region to establish a breeding population there. The only explanation for this is that areas in Macaya where pines occur are not sufficiently "open" for the habitat requirements of the Antillean Siskin.



Antillean Siskin

ENDEMIC

VULNERABLE

Seasonal Status: Year-round resident. (ENDEMIC)

Status: Common in the Massif de La Selle and a rare vagrant in the Massif de La Hotte. The Siskin is **vulnerable.**

Recommendations: This species is doing well in the La Selle area, but depends upon stands of Mature Pine Forest to breed, which should be protected from exploitation. Forestry practices on the plateau of the Massif de La Selle should always be planned to leave blocks of mature pines. Clear-cutting of pines would be destructive to the status of the Antillean Siskin.

Conservation Index = 61.6

HISPANOLIAN EMERALD

Chlorostilbon swainsonii

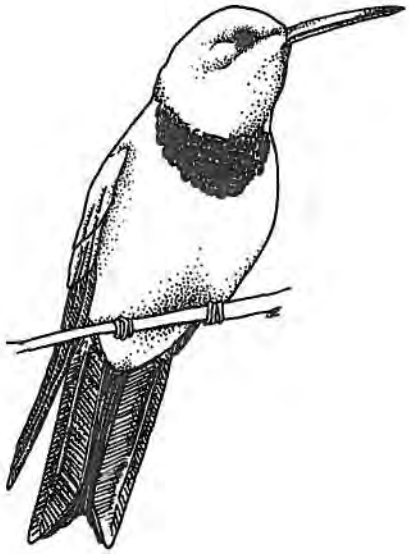
Wanga Neges Mon

Ouanga Negresse, Colibri

Zumbador Verde

Description: The Hispaniolan Emerald is the intermediate-sized hummingbird of Hispaniola. The male is brilliant green with a long forked tail and a velvety black patch on the throat and breast. The lower mandible is pinkish. The female is similar with a duskier tail and lacking the black patch on the breast.

Habitat and Distribution: This species is most numerous at higher elevations in well-forested habitats. The Hispaniola Emerald is most abundant in the Massif de La Selle in Disturbed Broadleaved Forest (63%), with other observations spread equally among various other habitats. In the Massif de La Hotte, 50% of the observations were in Mature Broadleaved Forest while 20% were in Disturbed Broadleaved Forest. The Emerald is least common in Ruinate Areas and Gardens. Wetmore and Swales (1931) comment that "the emerald hummer is found mainly in heavy forest in the hills and is most common in regions of considerable rainfall". The species is common above an elevation of 1,500 meters. When the Mango Hummingbird, the lowland counterpart of the Emerald Hummingbird, is found in areas above 1,500 meters, as it is on Morne La Visite, it is a sign of habitat degradation.



Hispaniolan Emerald

ENDEMIC

VULNERABLE

Seasonal Status: Year-round resident. (ENDEMIC)

Status: Common but **vulnerable** in both the Massif de La Selle and Massif de La Hotte. The most abundant species in the dense mesic high mountain forests.

Recommendations: The Emerald Hummingbird is dependent on mesic forest, and Mature Broadleaved Forest habitats must be protected to guarantee the preservation of this endemic species.

Conservation Index = 61.6

HISPANIOLAN GREY-CROWNED PALM-TANAGER

Phaenicophilus poliocephalus

Kat Je Sid

Oiseau Quatre Yeux du Sud

Cuatro Ojos

Description: This well-known bird has an olive (yellowish-green) back, wings and tail. The hindneck is grey as are the flanks, with the rest of the underparts white (including the throat). The white throat is reduced in extent and contrasts with the dark grey of the chest, so that there is a white band under the black mask, boardered below by the grey of the hindthroat. The grey on the hindneck extends upward onto the top of the head so that the black on the crown is a band across the forehead. There are white spots at the base of the bill (lores) and above and below the eyes. This species is quite similar to the Black-crowned Palm-Tanager in which the black on the head extends to the rear of the head, and there is a broad white throat. The Palm-tanager is easy to observe and forages in low trees and in

open areas; however, it is possible to identify the birds by their vocalization alone: a clear, nasal "peee-u".

Habitat and Distribution: The habitat of the Grey-crowned Palm-Tanager ranges from sea level up into the highest mountains. Wetmore found them to be "fairly common" on the slopes of Pic Macaya from the forest border above their camp at 1,275 meters to the summit. We also found them on the summit of Pic Macaya, where they were one of the more abundant species. In Parc National Pic Macaya, we most frequently observed them in Mature Broadleaved Forest (43%), followed by Disturbed Broadleaved Forest (30%), Mature Pine Forest (23%), Ruinate Areas (4%) and Successional Pine Forest (3%). We also found the species in forested areas of the Plain of Formon, most often in Disturbed Broadleaved Forest on Karst (75%), but also in Gardens (25%). The habitat requirements of this species are similar to those of the Black-crowned Palm-Tanager. Both species forage widely and can be found in dense stands of Mature Broadleaved Forest as well as in more open areas.

This is the only avian species found only in Haiti. The distribution of the Grey-crowned Palm-Tanager is west of the lowland area between Jacmel and Fauche ("Bond's Line"), with the Black-crowned Palm-Tanager being found east and north of this line (except La Gonave Island, where large pale Grey-crowned Palm-Tanagers occur). Wetmore and Swales, (1931:417) noted that it is strange that Grey-crowned Palm-Tanagers do not range onto the ridge of La Selle, since the break in the Cul-de-Sac Plain would seem a more natural boundary. We agree, and have looked carefully for the ecological significance of "Bond's Line" and can find none.

We predict that Grey-crowned Palm-Tanagers should occur along the ridge of La Selle further to the east than the Jacmel-Fauche depression, and that it should be possible to find evidence of the species along the ridge of the Massif de La Selle east of Morne d'Enfer (either as distinct representatives of Grey-crowned Palm-Tanagers, or as hybrids with Black-crowned Palm-Tanagers). Observations of birds that are intermediate in morphology between the two forms (including photographs of mist-netted birds) indicate that the two forms are hybridizing in the area of Morne La Visite. Dod (1981) also noted the eastward expansion of the range of the species, and indicates that the range of the Grey-crowned Palm-Tanager extends eastward into the Sierra de Baorucos.

Seasonal Status: Year-round resident. (ENDEMIC)

Status: Status uncertain in the Massif de La Selle (see above). Common in the Massif de La Hotte. **Vulnerable** in southern Haiti because of habitat destruction.

Recommendations: The species is a habitat generalist, and appears to do well as long as there are some areas of broadleaved forest around. It is important to prevent complete deforestation of the mountains to protect the status of this species.

Special Note: This bird is another excellent candidate for designation as the official national bird of Haiti. It is the only Hispaniolan species found only in Haiti. It is also common, attractive and likely to survive into the next century in spite of severe deforestation.

Conservation Index = 59.4

Hispaniolan Grey-Crowned Palm-Tanager

ENDEMIC

VULNERABLE

The interactions of the two species of Palm Tanagers in southern Haiti is one of the best examples of "biogeography" in the West Indies.

SCALY-NAPED PIGEON

Columba squamosa

Ranmye Kou Wouj

Ramier Cou-rouge or Ramereau

Paloma Torcaza or Paloma Turca

Description: Dark slate-grey in color with the hindneck chestnut and metallic purple. In the male, the skin around the eye is reddish (yellow in females). The feet and base of the bill are red. The vocalization is a loud "croo-cru-cru-crooo".

Habitat and Distribution: The Scaly-naped Pigeon, or "Ranmye" as it is frequently called, is found in dense stands of Mature Broadleaved Forest. On Macaya, 84% of the observations were in Mature Broadleaved Forest and 16% in Disturbed Broadleaved Forest. On La Visite 50% of the observations were in Mature Broadleaved Forest habitat. Wetmore and Swales (1931) noted that in Haiti the birds were abundant in forested areas, but not found elsewhere. They observed them regularly in the Massif de La Selle. Dod (1981) reports that their numbers are very reduced in the Dominican Republic. Quantitative data from our transects indicate that while the species can occur in Mature Pine Forests (Bwa pen), it is closely associated with very mesic sections of this forest. It is most frequently found in mature stands of Mature Broadleaved Forest. This species usually was observed singly or in pairs; we never observed large flocks.

Seasonal Status: Year-round resident.

Status: The Scaly-naped Pigeon is common in Mature Broadleaved Forest habitats, but uncommon otherwise. Because of the great loss of montane Mature Broadleaved Forest in recent years, this species is **vulnerable.**

Recommendations: The mesic Mature Broadleaved Forests must be preserved if this species is to survive.

Conservation Index = 59.4

Narrow-Billed Tody

ENDEMIC

VULNERABLE

NARROW-BILLED TODY

Todus angustirostris

Kolobri Mon

Colibri, Chicorette

Barrancoli, Chi-cui

Description: This tiny, vivid green bird has a bright red throat, pink sides and yellow under the tail. The underside of the bill is black at the tip. The vocalization is very characteristic, and the bird is heard more often than seen. It makes a loud, harsh "tick-cherek" or "chic-cui", which is very different from the "terp-terp-terp-terp..." of the Broad-billed Tody.

Habitat and Distribution: The Narrow-billed Tody (Kolobri Mon) is a bird of wet montane areas in Haiti and is occasionally sympatric with the Broad-billed Tody (Kolobri) which occurs in lowland areas and more open environments. In

the Dominican Republic, both species are locally sympatric, and the Narrow-billed Tody has occasionally been recorded from the lowlands (Bond, 1985; Jose Ottenwalder, pers.obser.). Wetmore and Swales (1931) reported that the two Tody species are sympatric only on and near the Samana Peninsula of the Dominican Republic. Kepler (1977) reported another area of overlap (sympatry) in "dry lower montane forest" which occurs in ravines on the north side of the Sierra de Baoruco range of the Dominican Republic at about 1,000 meters elevation. It is Kepler's view (1977:19) that sympatry may be more common than previously believed in areas where transitional forest dominated by the sumac-like *Brunellia comocladifolia* grades into drier lowland forest and mesic montane forest. This transition is most often between 900 and 1,100 meters. The Narrow-billed Tody is almost never found below 800 meters, and the Broad-billed Tody rarely occurs above 1,070 meters. This species is found in dense Mature Broadleaved Forest and Disturbed Broadleaved Forest habitats in the higher mountains. It does well in Disturbed Broadleaved Forest habitats, but is rarely found in Ruinate habitats. Along with the Hispaniolan Emerald, it is one of the most common species of wet areas and thick cover on the tops of the highest mountains. In the Macaya area, it was most abundant in Mature Broadleaved Forest (43%), followed by Disturbed Broadleaved Forest (36%), Mature Pine Forest (16%). Few individuals were present in Successional Pine Forest or Ruinate Areas. On the Plain of Formon, 65% of the observations of the Narrow-billed Tody were in Mature Broadleaved Forest on Karst and 35% in Disturbed Broadleaved Forest on Karst. The Narrow-billed Tody is the only Tody present above 1,200 meters elevation in the Massif de La Hotte, but is sympatric with the Broad-billed Tody at 1,000 meters. Narrow-billed Todies do not occur below 900 meters elevation in the Macaya region. Within Parc National La Visite, more Narrow-billed Todies were observed in Disturbed Broadleaved Forest habitats. Forested areas in the Massif de La Selle are more fragmented and less abundant than in the Massif de La Hotte. In La Visite, 75% of the observations of Narrow-billed Tody were in Disturbed Broadleaved Forest, 25% in Mature Broadleaved Forest.

Seasonal Status: Year-round resident. (ENDEMIC)

Status: Common in wet forests above 1,000 meters in all areas of Haiti, but **vulnerable** because of the rapid destruction of this habitat.

Recommendations: The species is closely associated with Mature Broadleaved Forest habitats, and would benefit from the conservation of the wet broadleaved forest in the national parks and surrounding buffer zones. The karst hills of the Plain of Formon adjacent to the Massif de La Hotte lie along the edge of a steep escarpment at approximately 1,000 meters elevation. The area is characterized by karst and is not well suited for gardens. Large areas of natural forest still remain. It is one of the few areas in Haiti where natural areas of drier lowland forest come into contact with wet montane forests. The karst hills region adjacent to Parc National Pic Macaya is important because of the large number of endemic species found there. It is also one of the few areas of Haiti where both species of Tody can be found together, which further indicates the need to preserve the forest cover in the region, and to include all of this region into Parc National Pic Macaya.

Conservation Index = 57.2

RUFOUS-THROATED SOLITAIRE

Myadestes genibarbis

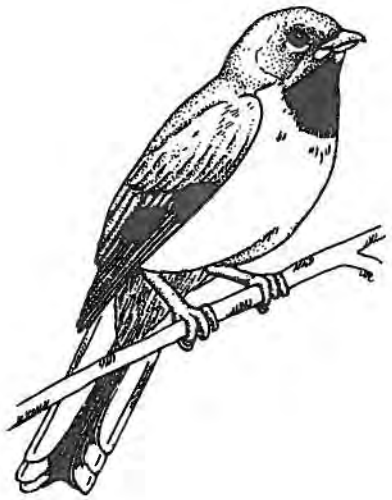
Mizisyen

Oiseau Musicien

Jilguero

Description: The Solitaire or "Mizisyen" is grey on the back and white on the chest and belly. The throat and under the tail are rufous red. The lower eyelid and chin at the base of the bill are white, as are the outer tail feathers which flash when the bird flies, much like the Red-legged Thrush with which it can be confused in thick brush. The best field characteristic is the beautiful and very diagnostic song, a flute-like, slow, melodious, often-repeated series of notes. The song can be heard during all times of the year, but is most common in May.

Habitat and Distribution: This bird is most frequently found in dense stands of Mature Broadleaved Forest in the mountains. Wetmore and Swales (1931) and Wetmore and Lincoln (1933) found it in stands of mesic forest up to the summits of both La Visite and Macaya. We found it so abundant on the north face of Pic Macaya in May that the entire mountain above 1,200 meters elevation echoed with its flute-like song. The dense mixed pine and broadleaved forest on both Pic Formon and Pic Macaya had many individuals, and the Solitaire is one of the most abundant species there. The species begins to sing half an hour or more before dawn and is one of the first birds to sing in the morning. They sang from just over our tents on the summit of Pic Macaya where many were observed together in foraging flocks in January. On La Visite, the Solitaire is found only in a few sections of the park because of limited areas of Mature Broadleaved Forest habitat, and is most frequently heard on the north face of the Massif below the ridge of Morne Cabaio. On La Visite, we observed the Solitaire (75%) of the time in Mature Broadleaved Forest in May and (50%) in December. The remaining observations were in Disturbed Broadleaved Forest, with one observation in Mature Pine Forest. On Macaya, where there were eight times as many individuals counted during the same time of year as the La Selle census period, (69%) of the observations were in Mature Broadleaved Forest habitat, followed by (28%) in Mature Pine Forest (mixed stands with broadleaved vegetation), (6%) in Disturbed Broadleaved Forest and (2%) in Successional Pine Forest. On the Plain of Formon, (90%) of all observations were in Mature Broadleaved Forest on Karst habitats.



Rufus-Throated Solitaire

VULNERABLE

The Solitaire is one of the most beautiful birds in Haiti, and is the most beautiful songster. It is beloved by peasants. The following quote by Wetmore (Wetmore and Swales, 1931:343) about the Solitaire in La Visite brings forth the feeling of the bird. "The birds were found principally in the steep-sided ravines below the summit of the long ridge that forms the top of this range. In early morning their clear, flute-like notes came with indescribable purity to the listener resting on the brink of the great precipice that forms the face of Morne La Visite, a marvelously beautiful song and one never to be forgotten."

Seasonal Status: Year-round resident. Breeding in May.

Status: Generally uncommon in the Massif de La Selle; Common in the Massif de La Hotte. If the cutting of Mature Broadleaved Forest continues, the Solitaire will soon become threatened. The Solitaire is much reduced in numbers since the time of Wetmore's survey in 1927. Today the Solitaire is **vulnerable.**

Recommendations: The Solitaire is clearly dependent on large stands of Mature Broadleaved Forest habitat if it is going to survive. All cutting of Mature Broadleaved Forest and Disturbed Broadleaved Forest must be prevented in the national parks and surrounding buffer zones.

Conservation Index = 57.2

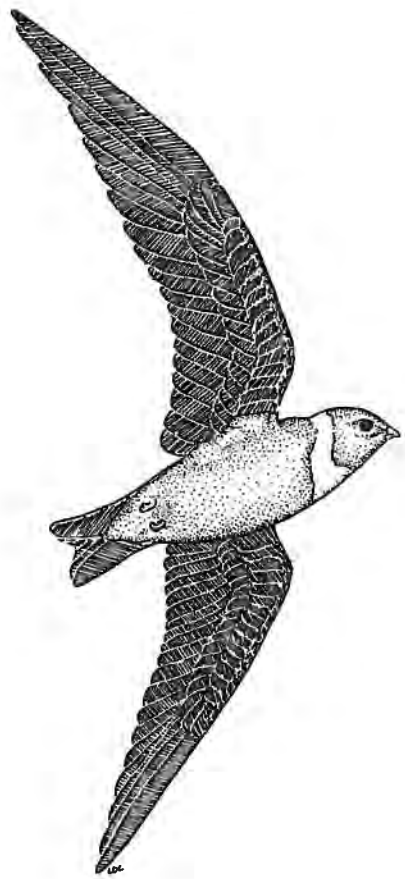
COLLARED SWIFT

Streptoprocne zonaris

Zowazo Lapli Kou Blan

Oiseau de la Pluie

Vencejo de Collar



Collared Swift

Description: This large black bird has a white ring around the neck and flies exceedingly fast. It is usually observed in small flocks of three to five birds. The birds make a "whish" noise as they fly rapidly overhead, often right over the tree tops. Their vocalization is a loud, shrill "screee-screee".

Habitat Distribution: The habitat of this species is high mountain regions with towering cliffs and steep-sided precipices, such as the upper Ravine de Sud below Pic Macaya. It flies fast and feeds over a wide area, so it can be seen almost anywhere in the Macaya area. However, it needs caves (often near water) in order to nest. These habitats occur in the upper regions of Parc National Pic Macaya. Collared Swifts were observed and nests were found in caves of Parc Macaya, indicating that breeding populations occur there.

Seasonal Status: The Collared Swift was observed in March, April, May, September, December, January and February, and is a year-round resident.

Status: Collared Swift nests were found in a cave at 1,040 meters in the Grand Ravin below Pic Macaya. A large pile of insect parts is often found below the nest.

Recommendations: Cave environments should be protected.

Special Comments: This species was known as the Antillean Cloud Swift to Wetmore and Swales (1931). They noted that Zowazo Lapli are irregular in occurance, and that sometimes none were observed for a period of a week in areas where they are known to occur. Wetmore found the species to be especially abundant near the Riviere Blanche, and in April, 1927, observed thirty or forty circling over a valley opposite the tremendous cliffs that mark the north face (Nan Nway) of Morne La Visite. We rarely saw flocks of more than ten birds in the area, and the species appears to be less abundant now than in 1927.

Conservation Index = 55.0

GREEN-TAILED GROUND WARBLER

Microligea palustris

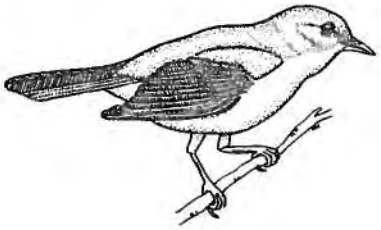
Ti Chitte Lasel

Petit Chitte La Selle

Ciguita Coliverde

Description: This endemic and very special warbler is greenish in coloration on the wings, back and tail. On the hindneck and crown of the head, it is greenish grey. On the chest and belly it is greyish white, becoming pure white on the abdomen. It has a long tail, and a bright red iris in the eye, surrounded by a broken eye-ring.

Habitat and Distribution: The Ground Warbler usually feeds alone or in small groups, and is rarely found mixed with foraging flocks of migrant warblers. This secretive little warbler is found in dense thickets of Mature Broadleaved Forest and Disturbed Broadleaved Forest where it feeds close to the ground. Ground Warblers were observed feeding in branches of a large tree, but this was the exception. It is widespread in its distribution in the Dominican Republic. In Haiti, it is most common in the Massif de La Selle and nearby mountains above Port-au-Prince near Furcy. Wetmore and Swales (1931) and Wetmore and Lincoln (1933) found them abundant in the La Visite region of the Massif de La Selle from below Morne Cabaio across the summit to the great ravine of the Riviere Blanche, but did not find them in La Hotte. Ground Warblers are abundant in the La Visite area at all times of the year. In January, Ground Warblers were found in Disturbed Broadleaved Forest (55%), Mature Broadleaved Forest (25%), Mature Pine Forest (9%), Riparian habitats (6%), in Ruinate Areas (3%) and Successional Pine Forest (2%). In May, Ground Warblers were observed in Disturbed Broadleaved Forest (59%), Mature Broadleaved Forest (30%), and in Riparian habitats (12%). In September, all observations were in Disturbed Broadleaved Forest (80%) or Mature Broadleaved Forest (20%). It is clear, therefore, that the Ground Warbler is a species of dense broadleaved growth and is ideally adjusted to the thick, scrubby stands of Mature Broadleaved Forest that characterize the steep face (Nan Nway) of the Massif de La Selle, and the ravines of the plateau. In Haiti, it is a species that is closely tied to the Massif de La Selle, including Parc National La Visite. We observed Ground Warblers in northern Haiti near Saint Raphael in xeric scrub areas similar to the habitats where Ground Warblers occur in the arid southwestern corner of the Dominican Republic. Ground Warblers have never been reported in the Massif de La Hotte.



Green-Tailed Ground Warbler

ENDEMIC

THREATENED

Seasonal Status: Year-round resident. (ENDEMIC). It nests in May and June.

Status: The Ground Warbler is closely associated with broadleaved vegetation in the central part of its range and is vulnerable to extirpation if this habitat is eliminated by continued deforestation. However, it is able to survive in extremely arid areas if Scrub-thorn Forest habitat persists. Its status is **threatened.**

Recommendations: This species is dependent upon the presence of dense stands of Mature Broadleaved Forest in the Massif de La Selle, and this habitat in the La Visite region should be protected from fire and deforestation, especially along the La Selle escarpment between Morne La Visite and Tete Opaque. No gardens, ajupas, domestic animals or additional deforestation should be allowed from the base of the ridge to the summits of the escarpment.

Conservation Index = 79.2

LA SELLE THRUSH

Turdus swalesi

Kouet kouet Nwa

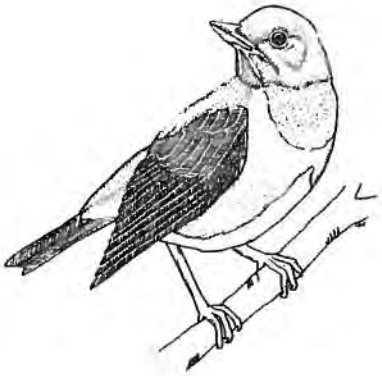
Ouete Ouete Noir

Chu-cho

Description: The head and all upperparts are black. On the underside, the throat has traces of white, the chest is dusky and the belly and abdomen are chestnut-colored. There is a distinctive median streak of white on the belly from the base of the tail to the breast that is variable in size and shape (sometimes dividing into several parts) so that it is possible to identify individual birds. The bill of this thrush is bright orange, and there is a light orange eye ring. The vocalization is very unusual and beautiful, consisting of three or four slightly different notes delivered slowly, clearly and with decided intervals between notes, followed by a "zeek". The notes sound like "tu-re-oo" and "cho-ho-cho" (from which it receives its local name in the Dominican Republic). Hardy and Parker (1985) note that the song of the La Selle Thrush is "low-pitched, variable notes so slowly and deliberately spaced that the song is reminiscent of that of the Yellow-breasted Chat, *Icteria virens*, a Woodwarbler." However both Bond and Wetmore noted that the song is "thrush-like." The alarm note of the La Selle Thrush is a loud "wheury-wheury-wheury."

Habitat and Distribution: Wetmore (Wetmore and Swales,1931) discovered this species in the dense Mature Broadleaved Forest of Morne La Visite on April 11, 1927, and considered its range to be 1,500-2,100 meters on the high ridge of La Selle. He did not find the bird anywhere else in Haiti or the Dominican Republic. He saw the bird only in little clearings where the La Selle Thrush or "Kouet Kouet Nwa" spends time on the ground "running with lowered head across little open spaces and then pausing abruptly with head thrown erect" (Wetmore and Swales: 1931:338). In subsequent years, the La Selle Thrush has been discovered in other places in Hispaniola, indicating that it has either expanded its range or that it was originally more widespread than Wetmore realized. The La Selle Thrush is now known from the Sierra de Baoruco (a continuation of the Massif de La Selle in the Dominican Republic), the Sierra de Neiba (the next mountain range north of the Cul-de-Sac separating southern Hispaniola from the north), as well as from the Cordillera Central near Alto Bandera. The habitat is usually stated to be "dense shrubbery." I observed this thrush most often in areas of Disturbed Broadleaved Forest with nearby gardens (42% in December, 50% in May, 100% in September), followed by dense Mature Broadleaved Forest where it was feeding in trees, especially *Persea anomala* (a shrub related to the avocado with small succulent fruits), (33% in December and May). Thrushes were also observed in Ruinate Areas (5%), Gardens (25% in December, 10% in May) and in Riparian habitats (3%). The La Selle Thrush is frequently observed feeding out in the open rather like an American Robin. It does well where Gardens and Mature Broadleaved Forest are adjacent to one another, and appears to have expanded its range in recent years as a result of agriculture spreading in high mountain areas. It may have originally been confined to the La Selle area because of the unique natural vegetation pattern of dense wet mesic broadleaved forests along the La Selle escarpment occurring adjacent to the open pine savanna of the plateau.

Seasonal Status: Year-round resident. (ENDEMIC)



La Selle Thrush

ENDEMIC

THREATENED

The habitat of the La Selle Thrush is being rapidly destroyed in the Parc National La Visite area.

Status: Common in the Massif de La Selle, but **threatened** because of deforestation of the Mature Broadleaved Forest.

Recommendations: Even though this species appears to be doing well at the present time, it is extremely threatened by continued deforestation, especially along the La Selle escarpment. No fires or woodcutting should be allowed in this region of Parc National La Visite.

Conservation Index = 72.6

CONCLUSIONS

This review of selected birds of Haiti has concentrated on montane species that are closely associated with specific habitat types. The rate of deforestation in the mountains of Haiti is increasing at an alarming rate, and there has been a dramatic decline in forest cover in the last ten years. In the remote wilderness of Pic Macaya in the center of the Massif de La Hotte, 100% of the region was in virgin broadleaved and pine forest in 1956. There has been a 97% loss of these virgin habitats in the last 30 years, with a 76% loss occurring in the six-year period between 1978 and 1984. The photographs on page 48 illustrate the extent of the change in one area of Morne Macaya between 1977 and 1986. The loss of available habitat is influencing the distribution and abundance of Haitian birds. Some species, such as the La Selle Thrush are expanding their range, while others such as the White-winged Warbler are nearing extinction. It is possible that species are changing their habits to compensate for the loss of suitable habitats, which may account for the apparent hybridization now occurring between the Grey-crowned and Black-crowned Palm-Tanagers. Another example of changing patterns of behavior is in the Black-throated Blue Warbler, a winter migrant that competes for the same diminishing resources in mesic montane forests as the sixteen species discussed in this study. Individual winter migrants return to very specific areas each year, and it is not uncommon to find the same individual bird in the same patch of forest on subsequent years (Woods, 1975). When the rate of deforestation is as rapid as it is in Haiti, returning warblers are often unable to find suitable habitat and are forced into increased competition with other migrants and resident species. The Black-throated Blue Warbler compensates by differential utilization of available habitats by males and females (Woods, 1975). The trends that we reported in the region of the Plateau Rochelrois (1,000 meters) in 1975 are now spreading into the Massif de La Hotte, with females and juveniles feeding in more open ruinate areas, and males concentrating in the remaining patches of Mature Broadleaved Forest.

The population of Haiti is growing at a rate of at least 2%, and will double in the next 34 years to over 12 million.

The species of resident birds studied can be ranked in terms of a Conservation Index (CI) to produce a listing of the the species of greatest concern (Table 9). All species with a CI greater than 65 should be considered worthy of special actions in developing a conservation strategy. Eleven species on the list have such ratings: 1) White-winged Warbler; 2) Chat Tanager; 3) White Winged Crossbill; 4) Black-capped Petrel; 5) Green-tailed Ground Warbler; 6) Antillean Piculet; 7) Hispaniolan Trogon; 8) La Selle Thrush; 9) Antillean Euphonia; 10) Hispaniolan Parrot; 11) Hispaniolan Pine Warbler. This group contains four endangered, and seven threatened species. The remaining species that are not in the special group with scores above 65 are all vulnerable with the exception of the Scaly-naped Pigeon, which is threatened. The Scaly-naped Pigeon fell below the critical scoring threshold because of its wide distribution in the West Indies. We recommend that it be included on the list of sixteen most threatened and endangered birds of Haiti because it is decreasing in numbers rapidly and is

endangered birds of Haiti because it is decreasing in numbers rapidly and is specifically associated with mesic forest habitats.

The key activity necessary to improve the status of the 16 species of greatest concern is habitat protection. There are a variety of conditions in Haiti that have a negative impact on birds. Many of these, such as predation on nests and individual birds by rats, dogs, cats, and the ever-spreading mongoose are difficult to control, as is the need of the increasing human population for space and resources. The population of Haiti is growing at a rate of two percent, and will double in the next 34 years to over ten million. The habitat is already badly degraded, and birds and humans together are already suffering.

However, it is not a hopeless cycle. The key to preserving the species discussed in this study is protecting large blocks of Mature Broadleaved Forest and areas of Mature Pine Forest from deforestation. These habitats in mountain areas above 1,000 meters are still available in some areas of the country, and in many areas above 1,600 meters, the forests are associated with the watersheds of major river systems. The heart of the Massif de La Hotte is Pic Macaya, and off its slopes arise four of the most important rivers of Haiti. Three major rivers arise from the Massif de La Selle. In both of these areas the broadleaved forest serves as protection of the soil and helps hold the water to be slowly released into the rivers. The pine forest along the peaks and ridges helps comb additional moisture from the ever-present clouds, increasing the overall amount of precipitation and quality of the watershed (Vogelmann et al., 1968). It is clear, therefore, that finding ways to meet the future needs of Haiti does not have to be at the expense of the birds discussed here. It is in the best interest of the future of Haiti that broadleaved and pine forests flourish in carefully selected and protected mountain habitats. The future prospect of all of the species discussed here will be improved by wise management of the forest resources. However, if the current rate of deforestation continues, most mesic forests will be gone from the mountains of Haiti by the year 2000. If this happens, many of the species on the list in Table 9 will fall by the wayside, and the toll of human suffering associated with declining water quantity and quality and the continued loss of soil will be enormous.

The lost horizons of Haiti are the vast areas of forest that once made Haiti the Perle des Antilles and the Wondrous Isle. These are gone forever. The new hopes are the efforts that are now underway to develop a meaningful watershed conservation program in the Massif de La Hotte, and the fledgling national parks program that is struggling with task of managing the newly established Parc National La Visite and Parc National Pic Macaya in the mountains of southern Haiti. The other sign of new hope lies in the documentation of the developing disaster in the natural systems of Haiti. For the first time, data on the extent of the pattern of deforestation are available, and the specific ways necessary to improve the status of the endangered and threatened flora and fauna are understood. With these tools, and an improved awareness in Haiti of the link between the conservation of natural resources and the quality of life for all, comes a glimmer of hope. The remaining horizons of Haiti may yet survive to be part of a new century, and with them the endangered and threatened birds of the mountains.

SPECIES	STATUS
LAND BIRDS	
Cuculidae	
Hispaniolan Lizard Cuckoo	
Saurothera longirostris	E
Bay-breasted Cuckoo	
Hyetornis rufigularis	E
Caprimulgidae	
Least Pauraque	
Siphonorhis brewsteri	E
Trochilidae	
Hispaniolan Emerald	
Chlorostilbon swansonii	E
Psittacidae	
Hispaniolan Parrot	
Amazona ventralis	E
Hispaniolan Parakeet	
Aratinga chloroptera	E
Trogonidae	
Hispaniolan Trogon	
Priotelus roseigaster	E
Todidae	
Broad-billed Tody	
Todus subulatus	E
Narrow-billed Tody	
Todus angustirostris	E
Picidae	
Hispaniolan Woodpecker	
Melanerpes striatus	E
Antillean Piculet	
Nesoctites micromegas	E
Corvidae	
White-necked Crow	
Corvus leucognaphalus	R-PR
Muscicapidae (Turdinae)	
La Selle Thrush	
Turdus swalesi	E
Dulidae	
Palm Chat	
Dulus dominicus	E
Vireonidae	
Flat-billed Vireo	
Vireo nanus	E
Emberizidae (Parulinae)	
Hispaniolan Pine Warbler	
Dendroica pinus chysoleuca	R-NA
Green-tailed Ground Warbler	
Microligea palustris	E
White-winged Warbler	
Xenoligea montana	E
Emberizidae (Thraupinae)	
Black-crowned Palm-tanager	
Phaenicophilus palmarum	E
Grey-crowned Palm-tanager	
Phaenicophilus paliocephalus	E*
Chat Tanager	
Calyptophilus frugivorus	E
Fringillidae	
Antillean Siskin	
Carduelis dominicensis	E
White-winged Warbler	
Loxia leucoptera	R-NA
Rufous-collared Sparrow	
Zonotrichia capensis	R-SA
NON-LAND BIRDS	
Accipitridae	
Ridgway's Hawk	
Buteo ridgwayi	E
Total	**24 Species**

TABLE 6. Bird species that are endemic (E) or restricted (R) to Hispaniola. Species endemic only to Haiti (E*); once found in Puerto Rico (extirpated) but now confined to Hispaniola (R-PR); restricted to Hispaniola in the Antilles but also occurring in North America (R-NA) or South America (R-SA).

Table 7. Vocalizations of Black-capped Petrels. Recorded as number of complete vocalizations/minute over 10 one minute intervals (averaged from all observers at a specific site).

LOCATION	NUMBER VOCALIZATIONS 2000 hrs.	2100 hrs
Massif de La Selle		
Morne La Visite		
Jan.15	14.54	9.06
Jan.16	10.73	10.60
Morne Cabaio		
Jan.15	3.57	6.35
Tete Opaque (West Head)		
Jan 16	14.07	14.70
Tete Opaque (East Head)		
Jan 15	20.43	15.60
Massif de La Hotte		
East of Pic Macaya		
Jan 25	10.0	--
South of Pic Macaya		
(S. ridge)		
Jan 27	8.8	--
West of Pic Macaya		
(50 meters)		
Jan 25	12.27	--
Jan 27	12.80	--
West of Peak		
(300 meters)		
Jan 25	9.95	--

Table 8. Comparison of summary bird data between La Visite and Pic Macaya areas based on eight census days in each season during 1982.

	LA VISITE		MACAYA *	
	2000 m	2000 m	1000 m	
	Dec	May	December	
Total # observations	1932	897	1397	433
Total # species	62	41	47	51
Average of birds/day	242	112	116	151

* The combined total number of species for both regions of Parc National Pic Macaya is 65.

TABLE 9. Status and Conservation Index of 18 Haitian Birds

Species	Status	Status Index	Habitat Index	Endemic Index	Biotic Index	Generic Index	Conserv Index
Macaya Area Birds							
WW Warbler	E	10	10	9	8	5	**92.4**
C Tanager	E	9	9	10	8	5	**90.2**
WW Crossbill	E	10	9	9	8	1	**81.4**
BC Petrel	E	10	10	6	10	1	**81.4**
A Piculet	T	6	7	8	8	5	**74.8**
H Trogon	T	7	7	8	8	4	**74.8**
A Euphonia	T	7	8	8	8	1	**70.4**
H Parrot	T	9	7	8	6	1	**68.2**
Pine Warbler	T	4	8	8.5	8	1	**64.9**
A Siskin	V	4	8	8	7	1	**61.6**
H Emerald	V	5	5	8	8	2	**61.6**
GCP Tanager	V	3	4	10	6	4	**59.4**
SN Pigeon	T	7	7	4	8	1	**59.4**
NB Tody	V	4	5	8	6	3	**57.2**
Solitaire	V	4	5	7	8	2	**57.2**
C. Swift	V	5	8	3	8	1	**55.0**
Found in La Visite but not Macaya							
GTG Warbler	T	7	6	10	8	5	**79.2**
LS Thrush	T	7	8	10	7	1	**72.6**

CHAPTER V

Beasts of the Haitian Hills

The Mammals of Macaya

Introduction

This chapter reviews the mammals of the Pic Macaya region, both living and extinct. No other work is available that synthesizes this information, and presents it in enough detail to make it possible to visualize the flow of time in the mountains surrounding Pic Macaya, and to document how much the mammal community of the region has changed. This change in the composition of both small and large mammals has been profound, even in the last few decades, and the change continues as introduced species capitalize on deforestation and increased destruction of the last remaining natural forest areas in Haiti. Few other groups illustrate the consequences of habitat destruction in the Macaya area as well as do mammals. With two, and perhaps three, native mammals in the area on the verge of extinction, and with habitat destruction in the region accelerating at an alarming rate, the lesson to be learned from history of the mammals of Macaya is more important than ever. This story is part of a much larger pattern of habitat destruction, introduction of exotic species, and waves of extinction of native mammals that involves all of Haiti. That story will be told in a book on the history of mammals in Haiti to be published in the next year as part of the overall conservation program in Haiti funded by the MacArthur Foundation. We hope that the story of Macaya, and of Haiti in general, will make all those who are interested in the natural resources of Haiti realize what a remarkable natural patrimony Haiti has, and how vulnerable that patrimony is to destruction.

Much of the discussion about the mammals of Macaya will be about creatures who have never been seen alive. They survive only in our imaginations; they are ghosts of the past. The native mammals that do survive are "living fossils." Most Haitians think of the native mammals of their country as creatures that exist far away in some remote place (the "gran bwa"). There is a tendency to merge the present with the past, and the real with the imagined. As a result, there is a great deal of confusion about the mammals of Haiti, real or imagined, extant or extinct. There are some astonishing beasts in the hills of Haiti.

In this chapter, only mammals living, or known to have lived in the region of the Massif de la Hotte will be be considered. This area includes the higher peaks surrounding Pic Macaya, and the surrounding hills, plateaus, valleys, and watersheds. The region consists mainly of upland habitats above 200 meters in elevation. It includes some of the most remote and well forested habitats left in Haiti, such as the upper slopes of Pic Formon and Pic Macaya, as well as some of the most altered and agriculturally developed, such as the Plaine of Cayes. It is a microcosm of what has happened, and is happening to Haiti. However, because most species of land mammals have very broad ranges, the discussions in this chapter sometimes include information on the status of mammals Haiti in general. Since this chapter is designed to provide basic information on the biology of rare species that are in danger of becoming extinct, we hope it will be used by people interested in developing conservation programs throughout Haiti. It is for this reason that we have included some information on Haitian mammals applicable beyound the boundaries of the Massif de la Hotte.

Mammals of Modern Haiti

Introduced Mammals

A list of Haiti's mammals in the 1990s would include a large number of introduced species. The following eight free-living introduced mammals dominate the Haitian landscape today, and are the only terrestrial mammals that most Haitian people or visitors (including hard-working scientists) will ever see in the Haitian countryside.

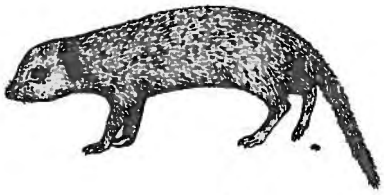
Introduced species such as the dog, cat, mongoose, rats and mice cause ecological chaos in Haiti and led to the extinction of several native small mammals.

Feral Domestic Dog. Dogs stay close to houses, but move about the countryside in a nearly feral state. They were introduced very early by the Spanish, and according to Watts (1987) feral dogs were "major agents of ground fauna disturbance...". Larger Spanish dogs were introduced to Hispaniola by 1494, but the smaller Barkless dog of the Tainos was introduced in pre-Columbian times. The "dumb dogs" of the Indians were small, and were kept for food as well as used in hunting game. Sauer (1969) believes that Indian dogs were not used in hunting, but rather were "both family pet and entree served up at festivals." A number of other accounts indicate that they were used in hunting, however, and the status of the dog at about the time of the first European contact can be summarized in the following quote (Charlevoix in Fewkes, 1907:50). "The *goschis* were little dogs, which are dumb, and served for the amusement of the ladies, who carried them in their arms. They were also used in hunting in starting up other animals, were good to eat, and were a great resource to the Spaniards in the period of their first famine." The barkless dogs became extinct before the Indians did, partly as a result of being eaten up by the Spaniards and Indians during the famine of 1494, and the times of hunger in the early 1500s. These dogs were probably quickly replaced by the Spanish dogs that began to arrive at about the time of the second voyage of Columbus in 1493. Reports indicate that these Spanish dogs became feral very rapidly in Hispaniola.

Feral Domestic Cat. Cats skulk through the countryside, and live in a totally feral state. It is not known when the first cats were brought to Hispaniola, but we assume it could have been as early as the second voyage of Columbus in 1493. As noted by Watts (1987), cats became naturalized very quickly in areas like Hispaniola, and many ground-nesting birds were "decimated" by cats and rats. The potential threat of cats to the endemic small mammals of Haiti would have been very high. Nearly five hundred years of impact throughout every major habitat of the island could have been the major factor leading to the extinction of small mammals below 1,500 grams in mass. At the current time, cats are common in the wild in all regions of the country. They are considered a delicacy by some people, and are hunted in some rural areas. In the eastern Massif de la Hotte region near Duchity, as many as 12 have been captured in a single day. Some houses in the area have cat skins tacked to the outside walls. In towns it is not uncommon for pet cats to disappear, and end up in somebody's cooking pot. The negative impact of predation by feral cats would have been especially severe on the three Island Shrews, and on the Hispaniolan Spiny Rat, all of which became extinct after the arrival of cats. Cats could also have had a severe impact on the La Hotte Hutia after the forest cover on the Plaine Formon was removed.

Small Indian Mongoose. The Mongoose was introduced in about 1895 to control rats and snakes in the cane fields. It has now spread to even the highest mountaintops in the most remote districts. Cats and mongooses have become the carnivores of the countryside. The mongoose was not found on Ile de La Tortue as of 1985, and so a close comparison of the vertebrate fauna of that island with the adjacent mainland ("Gran Te," as it is called on Tortue) of Haiti could be very informative about the impact of mongooses on the local fauna. The mongoose is found on Ile de La Gonave.

Black Rat. This rat inhabits a wide range of habitats, including the nearly pristine forests on the summits of the highest mountains. However, it is most common in dry areas and in natural forests where there is shallow leaf litter. Black rats are good climbers, and are commonly found in the thatched roofs of houses (cayes) in the countryside. This animal is less common in semi-aquatic environments, and in the dense rain forest of the high mountains. Black rats occur in four color morphs in Haiti: 1) all brown; 2) brown with white belly: 3) all gray; 4) gray with white belly. Since Black rats are found in so many different habitats, come in four distinct morphs, and are heavily preyed upon by barn owls, which are also very abundant in many different habitats, it is possible that the color of the morph is related to the habitat that the rats live in. If this is true, brown morphs would dominate in habitats with brown soils or substrates, and gray morphs would be more common in more open karst (gray background) habitats. The results so far suggest a trend in this pattern, but the data are far from conclusive. The selective pressure of predation on coat color might be lessened because barn owls are nocturnal predators, and Black rats are often found in trees or other above ground situations.



Small Indian Mongoose

Herpestes javanicus

One of the most destructive introduced mammals in Haiti.

Norway Rat. This rat is more limited in distribution. It is most frequently encountered in the rice fields of the Riviere de l'Artibonite delta, and in the high montane forests of the Massif la Hotte where the ground is deep pine litter and extensive areas of sphagnum moss. On Pic Macaya, both Black and Norway rats occur, but Norway rats are most abundant. In the adjacent, but much drier Ravine du Sud, the opposite is true. It is unfortunate that Norway rats have dispersed to the moist, well-forested mountaintops, such as Pic Macaya, since habitats such as Pic Macaya may have been refuges for small Island Shrews that depended upon the deep pine duff and sphagnum substrates.

House Mouse. The house mouse is common around settlements, but unlike the rat, has not moved out into remote forest habitats.

Domestics. Domestic horses, cows, goats, and (once again) pigs dot the hillsides and fill the valleys alike, and occur in even the most remote districts. The rugged and isolated footpath into the center of Parc National Pic Macaya is often dotted with goat droppings, and goats and sheep roam the dead end valley of the Grande Ravine du Sud in the shadow of Pic Macaya (the closest thing to a wilderness in all of Haiti).

TABLE 10. Introduced Free-Living Mammals Of Haiti

Taxon	Common Name	When Introduced
RODENTIA		
Muroidea		
Rattus *rattus*	Black Rat	1492
Rattus norvegics	Norway Rat	Early 1700s
Mus musculus	House Mouse	Before 1654
Caviidae		
Cavia porcellus	Guinea Pig	Pre-Columbian
CARNIVORA		
Viverridae		
Herpestes javanicus (= H. auropunctatus)	Small Indian Mongoose	1895
Felidae		
Felis silvestris catus	Domestic Cat	1492
Canidae		
Canis familiaris	Domestic Dog	Pre-Columbian
PERISSODACTYLA		
Equidae		
Equus caballus	Horse	1493

Surviving Endemic Mammals

Only 12% of Haiti's endemic land mammals survive today.

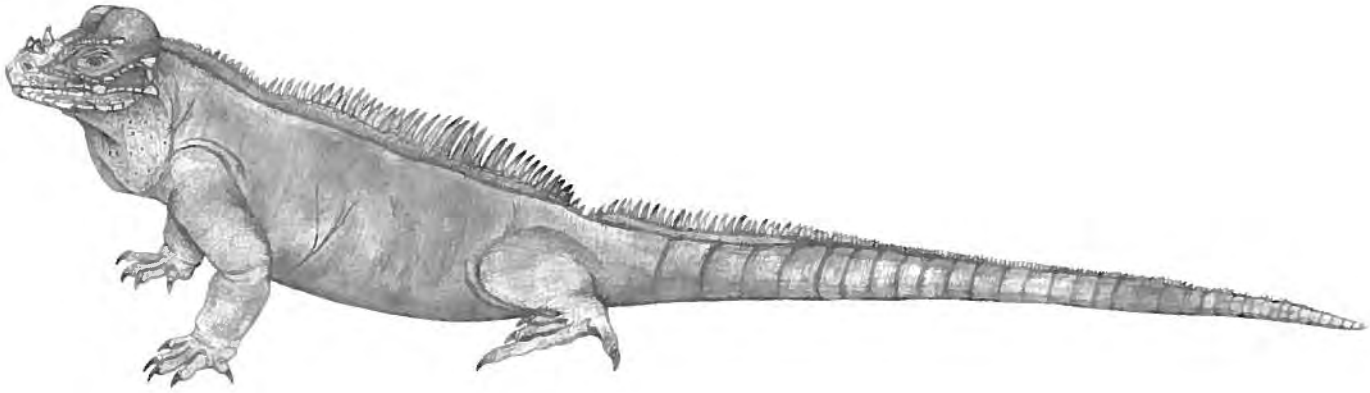
Why?

There are two, and possibly three, surviving endemic terrestrial mammals in the Macaya area today. These native mammals are now extremely difficult to see in the wild, and probably always have been. Even Rabie, who illustrated many rare and unusual animals from Haiti, never portrayed a *Plagiodontia* or *Solenodon*. Very few specimens have been collected during the more than 150 years since the first specimens were discovered and named. In the few areas in the mountains surrounding Pic Macaya where these mammals are locally common, most peasants do not know the animals. Even peasants who say they know the "zagouti" were not sure which was which. In all our years working in Haiti we have found only one peasant who knew *Solenodon* well enough to accuratley describe how it looked and what it ate. This lack of awareness is not so much because the animals are extraordinarily rare, since we have located dozens of each species since in the Macaya area since 1972. It is because both species are extraordinarily secretive. Even knowing exactly where a *Plagiodontia aedium* is living in the rocks does not guarantee that the animal can be seen. Unfortunately, the most common way to see either mammal is after one has been killed by a dog.

When Charles Woods began searching for mammals in the Macaya area of Haiti in 1973, *Plagiodontia aedium* had not been seen alive by a mammalogist for almost 25 years, and no *Solenodon paradoxus* had ever been reported as having been

seen alive in Haiti. We have tried to find out more about the animals by following several strategies. One has been to search for specimens in caves and sinkholes. In investigating caves and sinkholes we were hoping that Barn owls would capture some of the "lost" species for us. Barn owls hunt at night in the region surrounding the caves in which they roost during the day, so by collecting their pellets we have been able to survey the small mammals that they "selected" in a specific region. We hoped that this strategy would be effective in searching for small species, such as Island Shrews, and Indian Hutias. So far this strategy has not been successful in finding any "lost" mammals, even though we have collected owl pellets from hundreds of Barn owls from all over Haiti.

The second strategy we have followed has been to interview peasants in the countryside and at local markets. With the aid of a carefully worked out series of questions, we have interviewed hundreds of peasants from all over Haiti. We also use cards with drawings of a barn owl, owl pellets, a rat, mongoose, *Plagiodontia*, *Solenodon*, and various diagnostic bones to confirm that what a peasant said is what he meant. So far this technique has met with mixed results. We have learned much about the habits of *Plagiodontia* and *Solenodon*, for example, and we were able to discover live *Solenodon* in southwestern Haiti. So one "lost" Haitian mammal has been found this way. We now know that both species occur in a number of habitats in southern Haiti, and we are confident that they are rare or absent from most localities in northern Haiti. But the search strategy has many difficulties. For example, most people living in rural Haiti have a poor grasp of time, and so it has been extraordinarily difficult to document when somebody last saw a "zagouti." For most people in rural Haiti, time is measured by the passage of hurricanes, or significant political events. So the time line in our interviews is very fuzzy.



The Iguana of Haiti, *Cyclura cornuta*, is also known as the "Zagouti" by peasants.

The second problem with interviews is that most people in rural Haiti call three different species by the same name. A "zagouti" is *Solenodon paradoxus*, *Plagidontia aedium*, and the big iguana *Cyclura cornuta*. The problem this can cause is illustrated by the story of the hairless zagouti of Jacmel. In 1977, Charles Woods and his family were living in Jacmel while he was on sabbatical from the University of Vermont. He had spent many months searching the area for information on "zagouties" without much success. One day a group of people arrived at his house across from the market place in the center of Jacmel with a live "zagouti". He was very excited, but when the animal was brought to him it turned out to be a large and very abused iguana. They had found it many kilometers to the east near the town of Belle Anse, and had transported it tied upside down on a long stick born on the shoulders of two men. Woods released the exhausted, but otherwise healthy creature in his courtyard, and sat down to discuss the "zagouti" with the group (which had grown to be quite a crowd by that time). "This was not a zagouti," he said, "because all zagouties have hair." "Oh yes," the spokesman for the group said, "I know that, but this journey had been so long that all of the hair has fallen off of the animal." Then Woods said, "Zagouties have ears, and you can clearly see that this creature does not." "Yes," the spokesman for the group replied, "but the journey was through thick woods, and the ears broke off." He, and the rest of the members of the group had answers for every objection Charles Woods raised. Most of their efforts and replies were designed to make him approve of their gift, and also to convince him that he should pay them for their find. So, the problem was not that they really believed their stories. The problem was that they really did not know the zagouti well enough to recognize one when they saw it, and that they jumped on any large four-legged creature that generally matched the description.

This particular "zagouti" in time became famous throughout Haiti. Charles Woods kept it alive and well-fed in his courtyard in Jacmel. When he took a long field trip to the Dominican Republic in search of lost mammals there, he left the iguana with his friend and colleague Ekke Lemke in Port-au-Prince, who had a big back yard and loved animals. It is Mr. Lemke for whom the La Hotte Hutia (*Rhizoplagiodontia lemkei*) is named. The iguana was large and strong, however, and on November 5, 1977, it escaped from its enclosure and climbed over the garden wall into a neighbor's yard. It caused a sensation in Port-au-Prince. The Lemke's neighbors called the police and fire department. Nobody could recognize the creature, which they decided was some dreadful beast. The emergency was broadcast over the radio, and Ekke's son heard an account of the emergency of the wild beast in Port-au-Prince over his car radio as he drove back to the capital from northern Haiti. Eventually the animal was shot, which made all of us very sad (and angry). However, even that was not the end of the story. The account was carried in a major newspaper in the city. Day by day the accounts in the newspaper became more fanciful: "a soldier had shot the animal as it prowled the downtown streets near the capital;" "the animal was a "baka" (a small demon into which a sorcerer deposits his power);" and "it was wearing dark sun glasses and looked like Francois Duvalier." There are two messages in this amazing finale to the story of the hairless zagouti of Jacmel. One is that very few people in Port-au-Prince recognized an iguana, an endemic species that is common in several districts not too far from the capital. And the second message is that the real and the imagined blend so quickly and so completely in Haiti, and that the imagined so quickly becomes some supernatural beast. The Baka, Cigouave, and Loup-garous all make the search for the real beasts of the Haitian hills more difficult, and more exciting.

The famous "Zagouti" of Port-au-Prince was thought to be a "Baka," and caused great alarm in the city on November 5, 1977.

Hispaniolan Hutia

Plagiodontia aedium

Zagouti

Rat-Cayes

Description. The pelage can vary in color from yellow-brown to dark chocolate brown. The fur is slightly darker in coloration on the shoulders and back than it is on the belly and underside of the legs. It has a large head and a short snout, which gives it the appearance of a dark brown guinea pig with a long tail. The ears are short (22 mm), and barely extend beyond the fur, and its eyes are large and dark. There are many well-developed and long vibrissae around the snout and eyes. The legs are well-developed, but not too long. The front paw has four well-developed digits, which are well clawed, and a very short first digit, or thumb. The hind foot is very large (71 mm), with five well-develped digits with long curved claws. The heal of the foot nearly touches the ground when the hutia walks, so the animal is almost plantigrade. The tail is brown in color, and is long (157 mm; 31% of total length) and naked. The animal uses the tip of the tail as an aid in climbing, and it is slightly prehensile.

Teeth. The dental formula is 1/1 0/0 1/1 3/3. In all West Indian hutias, the premolar tooth is not replaced as the animal grows older. The cheek teeth are evergrowing from soon after birth, and therefore the pattern of the surface of the teeth always looks the same, no matter how old the hutia is. This is also true of *Plagiodontia*. However, in most other ways the four cheek teeth in each toothrow are unique. Most West Indian hutias have a layer of tooth cement on the sides of each molar teeth; *Plagiodontia* do not. Instead, the sides of the teeth are covered with hard, shiny enamel, and the cement is restricted to within the folds of the teeth. These enamel folds, which can be seen on the flat surface of each cheek tooth, are well-developed and pass almost across the entire surface of the tooth. These folds cross the flat surface of each tooth at about a 45 degree angle to the long axis of the body. In most hutias (family Capromyidae), the folds are nearly perpendicular to the body axis. These angled teeth are what gave rise to the generic name of this hutia: *plagios* is the Greek for oblique and *odontos* for tooth.

Body weight. The body weight is quite variable. Since the molar teeth are evergrowing and do not change with age, it is very difficult to determine the age of wild caught specimens. For eight specimens captured in southern Haiti, the average weight was 1,018 grams. In captivity, a very well-fed older individual can become as large as 1400 grams.

Common Names. The Tainos called this small mammal the "hutia" in Arawak. The animal was called "Agouti" by the French, as in Moreau de Saint-Mery (1958:1404) and Descourtilz (1809). In the notes supplied with the specimen collected by Ricord (1826), he used the name "Rat-Cayes" (house rat) for the animal. This was the root of the species name "*aedium*," which appears to come from the Latin *aedem*, meaning a house or a hearth. It is still common in certain districts of Haiti to hear the animals referred to as the "rat-kay." The most commonly-used local name of the animal in Haiti today is "zagouti." This is the Creole pronunciation of the French "les Agoutis".

Hispaniolan Hutia

ENDEMIC

ENDANGERED

The "zagouti" is one of only three surviving endemic land mammals in Haiti. It is well known to the peasants of the Macaya area.

Historical Distribution. Fossils collected in caves and sinkholes indicate that *Plagiodontia aedium* once occurred throughout Haiti, and on Ile de la Gonave. It has never been collected in a cave site in Ile de la Tortue in spite of an intense effort, and we believe that it never occurred there. Moreau de Saint-Mery speaks of having seen an animal by the name "d'agoutis" near Roseaux in southwestern Haiti in April, 1788. We cannot be sure this was a *Plagiodontia aedium*; however, there is little else it could be. The location where the type specimen of *Plagiodontia aedium* was collected by Ricord in 1826 is unknown.

Since specimens were not collected by Rabie, it is likely that it became extinct in northern Haiti before the late 18th century. The one exception may be the far north west, where we have had reports from a few missionaries of an animal living in the mountains south of Mole Saint-Nicolas. This animal is probably the mongoose, but it is possible that *Plagiodontia* still occurs there in the rough mountain terrain. All of the specimens that have been collected since the type specimen in 1826 have come from the southern part of Haiti. A specimen in the Berlin Museum was collected near Jeremie in 1911 by E. Pfizenmayer. Curtiss collected a specimen "near Miragone" in February, 1947. Tate (1948) referred to two specimens received by the New York Zoological Society that were collected in the "mountains of southern Haiti" in 1947. We assume that Curtiss collected these also. Another specimen was collected by Curtiss in July, 1949, from near Miragone, and sent to the Academy of Natural Sciences in Philadelphia. Two specimens collected near Paillant above Miragone were mounted and placed on display at the Faculte d'Agronomie at Damien in Haiti. A specimen collected in 1971 at Paillant near Miragone is now in the Institut Francais d'Haiti in Port-au-Prince.

Present Day Distribution. Since we have not been able to locate any specimens, or find anyone with any knowledge of the species in northern Haiti, we assume that the animal is now extirpated there. All of the recent locations where specimens of *Plagiodontia aedium* have been collected are in southern Haiti. Beginning in 1973, we have collected a number of *Plagiodontia aedium*, all of which are now in the collections of the Florida Museum of Natural History. The locations of these sites are: Alexandre (near Jeremie), Arnaud (between L'Asile and Anse-a-Veau), Beaumont, Bourdon (above Port-au-Prince), Catiche, Camp Perrin, Duchity, Fond Tortue (near Baraderes), Formon, Morne La Visite, Morne Cabaio, Mussotte, Morbette, and Paillant (near Miragone).

The Zagouti was first mentioned by Moreau de Saint-Méry (1797), who describes seeing a mammal in a fallen tree in the mountains near Jérémie.

In the Macaya area, the zagouti is especially common in the broadleaved forest from Portal Formon to west of the Park Headquarters. This forest is located in an area of exposed limestone, and rough limestone hills. As the forest cover in the area of "Bwa Formon" and Bwa Deron" is destroyed, as is now occurring at an alarming rate, the zagouti is disappearing from these areas. The species has not been found in the high mountain areas of Pic Formon and Pic Macaya, probably because there are not sufficient areas of exposed limestone blocks with crevices for the animals to find shelter. The zagouti is still abundant in the foothills of Pic Macaya west of Catiche and west of Duchity and Beaumont.

It is largely terrestrial and lives in limestone crevices. Its distribution appears to be restricted to areas where extensive blocks of hard limestone (karst) are exposed.

Habitat Preference. The sites at which Haitian Hutias have been collected range from near sea level to over 2,200 meters. The common feature of all of these sites is the presence of crevices in rocks. While the Dominican Hutia spends much of its time in trees, and seeks shelter in holes in trees and openings where strangler figs wrap around tree trunks, Haitian Hutias usually seek shelter on the ground. The most commonly-used refuges for the Haitian hutia are crevices in rocks, and openings in the roots of big trees, especially *Didymopanax tremulum* (called "bwa tranble"). There is the reference in Moreau de Saint-Mery of a "agouti" coming out when a tree was cut down, and clearly Haitian hutias will climb up into trees to feed on bark and leaves. However, the critical factor in determining if Haitian Hutias are present in an area is the availability of suitable rock crevices. These hutias can survive even on the edges of towns such a Camp Perrin, or near thickly settled districts with many cats and dogs if rocky areas with many crevices are nearby. The ideal habitat is one where large areas of karst (hard limestone blocks) are exposed, and which are covered with forest vegetation. Very rough and pointed karst, sometimes called "dog-toothed limestone" makes the best habitat.

Food Habits. The Haitian Hutia feeds on many different kinds of plants. These range from plants in peasant gardens where zagouties can be quite a pest. They are especially fond of beans (stem, leaves, and pods), sweet potato plants, "malanga" (*Xanthosoma sagittifolium*), and corn. In a natural site, they will feed largely on the bark of twigs, branches, and the upper trunk of a many plant species. In fact, one of the most reliable indicators of the presence of *Plagiodontia* in an area is a multitude of branches and tree trunks that have patches of bark chewed out of them. One of the favorite barks of *Plagiodontia* is that of the wild avacado, *Persea anomala*. They will also eat the leaves, buds, and fruits of this species. Another is the bark of the wild cheery *Prunus occidentalis*. At 2,200 meters in the Massif de la Selle we found many pine trees (*Pinus occidentalis*) where *Plagiodontia* chewed the bark off of small branches and even around the trunk of large trees. The caecum of *Plagiodontia* is very large, and this rodent seems well-adapted to feeding on leaves and other vegetative parts.

When feeding on the bark of trees, hutias will frequently climb out to the tips of even small branches, and will chew bark off branches all the way from the trunk to the tip of a branch. Hutias especially like the bark of young branches.

The teeth of *Plagiodontia aedium* differ form those of most other hutias, such as those of the genus *Capromys* in Cuba. The incisors are very stout, and not very procumbent (i.e., do not protrude). The very strong incisors and massive cheek teeth with oblique re-entrant folds are likely an adaptation to gouging out and chewing heavy pieces of bark. *Plagiodontia* may be an ecomorph of North American porcupines (Woods and McKeen, 1989), which feed largely on bark, while the Cuban hutias of the genus *Capromys* may be ecomorphs of South American porcupines, which feed largely on leaves and fruits.

The way to know if "Zagouti" live in an area is to look for tree branches that have been chewed, and fecal pellets that look like packed sawdust.

TABLE 11. Plants known to be eaten by Plagiodontia aedium

Scientific Name	Family Name	Creole	Part Eaten
Garden Plants			
Dioscorea alata	Dioscoreaceae	Yam	stem, leaf, tuber
Dolichos lablab	Leguminosae	Pwa nwa	stem, pods
Ipomeoa batatas	Convolvulaceae	Patat	stem, leaf, tuber
Xanthosoma sagittifolium	Araceae	Malanga	leaf, tuber
Zea mays	Gramineae	Mayi	
Trees			
Brunellia comocladifolia	Brunelliaceae	Bwa san	bark
Cecropia peltata	Urticaceae	Bwa twonp/t	bark
Ficus citrifolia	Urticaceae	Figye	bark
Ilex sp	Aquifoliaceae	Ti Kotlet	bark
Persea anomala	Lauraceae	Zaboka mawon	bark*, buds, fruit
Pinus occidentalis	Pinaceae	Bwa pin	bark
Piper sp	Piperacea		bark
Prunus occidentalis	Rosaceae	Amandier	bark*
Prunus myrtifolia	Rosaceae	Amandier	bark
Miconia sp	Melastomaceae	Macrio	bark
Tree that looks like fern (Ekman mentions) :			stem and branches
Other Plants			
Epidendrum nocturnum	Orchidaceae		vegetative parts
Epidendrum jamaicense	Orchidaceae		vegetative parts
Pleurothallis sp	Orchidaceae		vegetative parts
Rhytidophyllum bicolor	Gesnariaceae		stem
Tillandsia sp	Bromeliaceae	?	vegatative parts

Many Haitian peasants living in the mountains know of the "Zagouti" and tell stories about all of the plants that they eat.

Check orchid names

Predators. The original predators on the Haitian Hutia were the Giant Barn Owl (*Tyto ostologa*), and the Hispaniolan Boa (*Epicratis striatus*). The Giant Barn Owl is now extinct, but the abundance of hutia remains in caves confirms that it preyed on *Plagiodontia aedium*. Charles Woods found a man near the town of Arnaud north of l'Asile who said he saw big snake strike, kill, and slowly eat a "zagouti." When they took him to the place where they saw the snake, Woods found the remains of a six foot Hispaniolan Boa with a *Plagiodontia aedium* inside (the man had killed the snake with rocks after watching it eat the zagouti). The only other predator on *Plagiodontia aedium* that we can confirm is the semi-feral

dog. We found bones and teeth of *Plagiodontia* in dog feces collected at three separate locations along the ridge of the Massif de la Selle near Morne la Visite. We suspect that zagouties are killed by cats. Peasants in the Duchity area of southwestern Haiti, where both cats and zagouties are abundant, have reported seeing a cat kill a zagouti. It is possible that large barn owls (*Tyto alba*) also prey on young hutias. Miller (1930:2) found the remains of a young *Isolobodon portoricensis* in "dejecta that appear to be those of a small living barn owl" collected in 1930 near Constanza in the Dominican Republic. We have never found the remains of a *Plagiodontia aedium* in a recent owl pellet, however, even though we have examined thousands from all over Haiti.

Vocalizations. Haitian hutias are very vocal in captivity. When alarmed they make a prolonged, loud nasal whine that sounds like a "hee-haw." An animal will continue to make this sound as long as it is alarmed, which can be as long as several minutes. These hutias also make softer, guttural sounds (mewings and squeaks) when foraging. Haitian hutias are less social than Cuban hutias (*Capromys*), and Jamaican and Bahamian hutias (*Geocapromys*), and as a consequence are less vocal than those species.

Behavior. Haitian hutias are secretive and difficult to get close to, even in captivity. They seek shelter in crevices. They huddle together when two are more animals are kept together in the same cage, and three individuals have been captured in the same crevice in the wild. However, hutias are very particular as to what individuals they associate with, so we assume that most close interactions are usually restricted to family groups. If cornered, these hutias will first try to retreat to a dark corner or hiding place. If that is not possible, they will sit back on their haunches, vocalize, and chatter their teeth. While in this position they will also strike out with their forefeet and attempt to bite anything that comes near.

Hutias drink very little water, so they must get most of their water from eating vegetation. They are able to concentrate their urine at a moderate level.

In addition to regular urine, these hutias also produce concentrated urine that is used to mark rocks and tree trunks. This thick, white substance is often found on rocks near the opening to their hiding places in rock crevices.

These hutias produce fecal pellets that are very characteristic in shape. The pellets are firm, oblong and produced at regular intervals. Pellets are good field character to use as an indication of the presence of hutias. The pellets of *Plagiodontia aedium* are glossy black when first produced, and are approximately 3 mm wide and 10 mm long. The more time hutias spend in an area the more fecal pellets there will be. Hutias also produce softer, ochre-brown pellets, which are usually eaten (caprophagy). Hard pellets can also be eaten. Pellets are eaten by bending over and taking them directly in the mouth as they are produced.

Hutias are very nocturnal, but occasionally can be seen foraging along the edge of a garden in the very early morning hours before the sun is up. This is the time when they are most frequently killed by peasants who have begun work in their gardens early.

Hutias are good climbers, and use their semi-prehensile tail to crawl along even thin branches far from the trunk of a tree. However, they are not excellent climbers, and often appear on the verge of falling.

Reproduction. The species has a low reproductive rate that is associated with gestation periods in excess of four months and a normal litter size of one. The potential longevity of the Hispaniolan Hutia is very long. We know of one female that gave birth when she was at least 16 years old (she was captured in the wild so we do not know her exact age), and lived 18 years. The young is born fully formed at birth, and is able to move about on its own.

Future. *Plagiodontia aedium* has been a rare species in Hispaniola since the early part of the sixteenth century, and our analysis of the relative abundance of species in the fossil record suggests that the species has been uncommon for the last 10,000 years. It has survived in Hispaniola even though many other closely-related native land mammals have become extinct. This secretive and reclusive animal has the potential to survive as a native mammal in Haiti in spite of the threat of predation by dogs, cats, mongoose and various kinds of human disturbances. However, it can only survive in areas where the habitat includes some forest cover and large blocks of limestone. Without this combination of cover and shelter it is impossible for the hutia to survive, even in remote forested areas such as Pic Macaya.

While there may be a need to establish viable captive breeding programs for the species to insure that some individuals survive in case ecological conditions in Haiti continue to decline to the point that *Plagiodontia* becomes extinct, it is much more important to concentrate on the conservation of the species in the wild. It is on the ground in Haiti and not in some foreign zoo or laboratory that the success or failure of the species will be determined. Suitable habitat must be found and preserved in Haiti. With a little help, such as the preservation of suitable habitat along the steep northern escarpment of the national park at Morne la Visite, and the jumbled karst hills along the edge of the Plaine Formon in the Macaya Biosphere Reserve, the Haitian Hutia should be able to survive as part of the natural Haitian ecosystem well into the future.

The zagouti will become extinct in the Macaya area if the "Rak Bwa" forest is allowed to be cut down.

A *Plagiodontia aedium* from Haiti in its natural habitat among giant blocks of exposed limestone.

Hispaniolan Solenodon

Solenodon paradoxus

Nez Longe

Description. The general form of the body is that of a large shrew: round and stout. The long tapering snout is quite extended beyond the nasal bones and bare at the tip, with nostrils opening laterally. The skull is elongated, with a somewhat tubular rostrum. The fore claws are well developed. The eyes are small but the ears are relatively large and visible above pelage. The tail is long and stout, only sparsely haired and almost naked. Females have a single pair of inguinal mammae. In males, the penis is retractable and the testes abdominal.

Body hair is long and coarse dorsally, becoming finer and slightly crinkled on the sides. The sides of the snout are supplied with about a dozen large vibrissae (measuring up to 70 mm), and shorter, coarser hairs than surrounding ones that are tactile as well. One to three vibrissae are also present midway between the eye and the mouth, and on the midline of the chin below the angle of the mouth. Two types of hair are readily distinguished on the back; shorter and finer hairs are abundant, while longer and coarse hairs are scattered and arranged in single rows.

Independent of sex, there is great variation in coloration. The most frequent pattern is black or dark brown on the dorsal surface of the head, the basal half being buff. The black-tipped hairs extend over the mid-dorsal area of the back to the rump and are everywhere intermingled with pale, buff colored hairs, giving a grizzled effect. Ventro-laterally from the median line, there is a transition from black to buff hairs on the sides of the body, and on the forearms a clear buff or cream buff. The color of the sides extend ventrally from the abdominal region to the upper part of the chest where it becomes a deep ferruginous (almost chestnut) over the ventral surface of the throat, upper chest, bases of the fore limbs and dorsally to the sides of the neck. The inguinal region is also ferruginous. There is frequently a whitish nuchal spot. Differences in color patterns are caused by variations in the intensity of the pigments.

Hispaniolan Solenodon

ENDEMIC

ENDANGERED

Teeth. The dental formula is I3/3, C1/1, P3/3, M3/3. This pattern differs from the primitive placental formula only in the absence of one upper and one lower premolar. There is disagreement concerning whether the missing premolar is the P2/2 or the P3/3. The pattern of cusps on the molars is called a "zalambdodont condition" (i.e., triangular upper molar teeth with V-shaped cusps and prominent outer styles). The buccal stylar crest of the upper molars is a feature in which West Indian Insectivores (*Solenodon* and *Nesophontes*) resemble each other and differ from all other insectivores. In *Solenodon*, the deciduous dentition is shed at early age (while Old World zalambdodonts retain the milk teeth until full size is attained). The deciduous P^4 is replaced after the eruption of all three molars, which is unusual for mammals. *Solenodon* is also unique, among Old World zalambdodonts and most other mammals, in that the permanent P^4 is more molariform than its deciduous predecessor. While the canines are small, the permanent I^1 is greatly enlarged and opposed by an enlarged I^2. Thus, the anterior dentition develops into an enlarged pair of upper and lower incisors, opposed in forceps-like fashion, separated from the enlarged P^4 and molars by unicuspid teeth, which is decidedly shrew-like. The permanent I^2 is remarkably specialized in the presence of a deep and rather broad groove. The duct of large submaxillary glands lead to this groove at the base of each I^2. Its function is to conduct toxic saliva into a wound produced on prey, predators, or adversaries.

The generic name is derived from *solenos* = Gr. channel or pipe, and *odontos* = Gr. tooth, in recognition of its deeply grooved second incisor. The specific name is derived from *parodoxos* = Gr. contrary to all expectation.

Body Weight and Measurements. The Hispaniolan Solenodon is one of the largest members of the Insectivora. In breeding adults, weight ranges between 620 and 1166 grams for males and females combined. Total length ranges between 470 and 715 mm. (Ottenwalder, 1991). The population from the Massif de La Hotte is believed to represent a different lineage from the other Hispaniolan populations (Ottenwalder 1991). No weights or external measurements are known from this group of solenodons, but in general they are smaller than most solenodons from Haiti, and closer in body size to populations of solenodon from the southwestern Dominican Republic. An adult female caught alive in 1982 in "a mountain ridge beyond Camp Perrin," in the Massif de la Hotte, had an estimated total length of 470 mm.

Common Names. Both in Haiti and in the Dominican Republic, this rare mammal is generally known with same name used for the native rodent *Plagiodontia aedium*. In addition to "Zagouti," the most commonly used, the species is also locally called "Nez Long."

Historical Distribution. Outside of the southern Peninsula, very little information is known of the past distribution of the species in Haiti. Its presence in northern Haiti is only known from limb bone fragments found in Late Pleistocene deposits of the San Francisco Caves at St. Michel de L'Atalaye. Its previous existence in Ile de la Gonave is suggested by a single molar collected at a cave deposit. It is in southern Haiti, where most past and recent search efforts have taken place, where most records are known. A carcass was reportedly found in the 1930s near Fond Parisien, on the south shore of the Etang Saumatre (Sanderson, 1939). Fossil, subfossil, and post-Columbian remains have been recovered from a number of caves at the Massif de La Hotte and in the Massif de La Selle (at La Visite).

The Hispaniolan Solenodon, the Haitian Hutia, and the big Hispaniolan Iguana (a lizard) are all known by the same common name in Haiti, "Zagouti." This indicates that all three species are uncommon enough to have their common names confused.

Present Day Distribution. Today, the only known surviving population in Haiti is restricted to the Massif de La Hotte. This relictual population is apparently confined to a 8 to 10 km radius from the town of Duchity, a region with dense human populations and highly disturbed forest patches. Although no solid evidence of living *Solenodon* has been established within the Park National Pic Macaya, the possibility exists that *Solenodon*, whose present-day populations are elsewhere characterized by a fragmented distribution (Ottenwalder 1985), might still persist somewhere in the Formon-Macaya area. Frequently, people inhabiting an area where we know populations of *Solenodon* exist are unaware of their presence. Solenodons can exist even in areas long devoted to agriculture and pastoralism. It is also possible that the range of *Solenodon* in southwestern Haiti extends as far north as to the coastal area between Corail and Pestel.

Habitat Preference. So far, recorded collecting sites for *Solenodon* around Duchity are not yet well known. Studies conducted in the Dominican Republic (Ottenwalder 1985) indicate that solenodons occur in limestone areas with different life zones and plant communities; at elevations more often between 500-1,500 meters, but ranging from sea level up to 2,000 meters; usually on steep terrain; and on fine-textured, well-drained, lithic, moderately-permeable, and non-flooding soils. Annual average mean temperature in 15 *Solenodon* localities recorded was 24.8-C. Annual average mean rainfall, for the same locality sample, was 1520.8 mm.

Subtropical moist forest habitats at mid-elevations characterized by hilly terrain, karst topography or rolling plains, with abundant limestone outcrops, and discrete soil accumulations are among the most consistent shared features of *Solenodon* habitats. Limestone topography, perhaps the most uniform environmental element, though not necessarily the best factor to diagnosis presence if used alone, appears to represent the single most important feature to predict persistence of populations. Among other advantages, limestone formations offer abundant solid shelters that provide effective protection against predators, buffer extreme climatic conditions, and contribute a rich mineral source for soil invertebrates.

Food Habits. Solenodons are food generalists and opportunistic predators of the forest floor. They feed on leaf litter and soil macrofauna, primarily arthropods (including groups with chemical defense mechanisms such as scorpions, centipedes, and diplopods), land snails, and small terrestrial vertebrates (lizards, skinks, snakes, frogs, birds) and their eggs.

Predators. Native predators include large Hispaniolan boas (*Epicrates striatus*), and perhaps Stygian (*Asio stygius*) and Barn owls (*Tyto alba*). Pressure from natural predators is presumably low and buffered by the security of their burrows, though they might be likely exposed to predators in foraging trips at early age, and during subadult dispersal. In contrast, predation from exotic mammals, particularly dogs, is one of the known major causes of mortality, and therefore, for their decline. Other introduced carnivores suspected to have considerable negative impact on *Solenodon* are cats and mongooses.

The Hispaniolan Solenodon is the most endangered land mammal in Haiti. We recommend the creation of a Solenodon Wildlife Preserve between Pic Macaya at the town of Duchity.

Behavior. The behavior of *Solenodon* has been described in some detail by Eisenberg and Gould (1966) using captive animals. Although solenodons are strictly nocturnal in activity, they might occasionally wander outside of their burrows for brief periods during daylight hours to defecate, urinate, or scratch. They avoid bright lights, which might explain why they are only observed above ground during the day when it is rainy or cloudy. *Solenodon* digs burrows under limestone boulders, large trees, dead stumps or directly into the ground on slopes. They might also take advantage of existing crevices in large limestone formations or inside hollow stumps on the floor. Nest chambers and tunnels are interconnected under the ground and leaf-litter, forming in some cases an extensive and complex burrow system. They are usually found in family groups of three or just the adult pair alone. Solenodons huddle together during sleep, one crawling over the other. When alone, a solenodon sleeps on its side curled in a semicircle.

During exploration the animal moves slowly, pausing to assume an elongated posture with one forepaw raised off the ground, and sometimes, an upright posture with both forefeet off the ground while the head is moved in all directions.

They move with a slow walk, using a extension limb synchrony; however, they can run surprisingly very fast when disturbed, using a quadrupedal ricochet, with forelimbs and hindlimbs alternately striking the ground. They are poor climbers. Cracks and interfaces are sniffed thoroughly, and the long, flexible snout is inserted in all available niches. Known paths are used in a stereotyped fashion. Solenodons generally flee, if disturbed or startled by a sudden motion or sound; the flight response is in the direction of the burrow. They are, however, out-competed by the much faster introduced carnivores, such as dogs and cats, against which solenodons have few defenses.

The hind feet are used to scratch almost the entire body, while the tongue and teeth are used to clean the flanks. Their demand for water is quite pronounced. In captivity, animals drink extensively after arousal and also after feeding. While searching and capturing food, the animal moves about with its nose to the ground, sniffing and poking it into any crack or under any object. If a prey object is touched with the nose, the animals simultaneously extends its forepaws on either side of the prey while sliding its head forward, and capturing the prey with its mouth. The forepaws are also used to dig in the soil and rotten logs. The prey is located by tactile, olfactory, and auditory stimuli. During foraging, the snout is moved constantly; its great mobility maximizes the search area as the animal moves along. *Solenodon* scent mark with feces and urine. In addition, they have pronounced glandular areas on the ventral, axillar and lateral areas of the body; however, their function in chemical communication is not yet well understood.

Vocalizations. Solenodons produce a diversity of sounds: chewing sounds, digging sounds, walking-runing sounds, puffs (sharp exhalation to clear nasal passages), piffs (explosive variation of "puff" sound), and coughs, which are produced with sudden exhalations through the throat. Five distinct vocalizations have been identified: a) the "twitter," a sound of uncertain significance, is produced during situations of excitement, b) the "chirp" is a single, forceful note given during defensive postures, c) the "soft squeak" is repeated in burst of two or three notes during encounters between familiar animals, d) the "squeal" is a long, high-pitched sound produced during fights, and e) the "click" is a sharp, high-pitched sound produced during exploration of a novel area or when initially encountering a strange animal, and resembles the echolocation pulses of shrews.

The Hispaniolan Solenodon will become extinct in Haiti in the next 20 years unless a major conservation effort is undertaken.

Reproduction. *Solenodon* exhibit a pattern of very low fecundity. The breeding season extend throughout the year. The gestation lasts in excess of 90 days and, as a rule, only one young is born. Females probably average two litters and two young per year. Newborns are large, naked, and require extensive parental care. Sexual maturity is attained between 12-18 months of age. Their low reproductive output is matched to a rather long life span of up to 12 years.

Future. The future looks bleak for Massif de la Hotte *Solenodon* population. Because of its presumed small population size, this isolated population is likely doomed to extinction within the next 20 years, due to: 1) accelerated destruction of the reduced amount of habitat left; 2) heavy predation from exotic carnivores; 3) exploitation for food by Haitian peasants; and 4) intrinsic factors of the species biology (demographic, environmental, and genetic stochasticity). No living populations are known inside protected areas; no captive colony is known to exist anywhere.

Under the present circumstances, aggravated by the lack of any sort of ongoing protection or educational campaigns, timely conservation action would be required to prevent their extinction.

Bats

There are 15 extant species of bats that have been confirmed to have lived in Haiti (and two extinct species). Very little is known about the natural history of these bats. They are difficult to study because of their habits (volant, nocturnal, and difficult to capture without specialized equipment). The most complete studies of bats in Haiti are by Klingener et al. (1978) and Woods (1986). Bats are important in natural ecosystems because they pollinate flowers and flowering shrubs and trees, and because they are excellent dispersers of seeds. Some of the species discussed here are also part of the rare natural patrimony of Haiti because they are endemic to Hispaniola. The bats discussed in this chapter include only the species known to have been encountered in the Macaya area. This group of 13 confirmed species and one likely species (a total of 14) represents almost all of the known bats from Haiti, which is a good indication of how important the natural ecosystem of the Macaya area is to this group.

Annotated List of the Bats of Macaya

Mormoopidae

Sooty Moustached Bat

Pteronotus fulginosus fulginosus

This is a fast flying insect feeding bat. Beetles are its most frequently consumed prey, unlike the following species. It roosts in warm, humid caves, which usually have a single entrance. Koopman (1989) and Silva Taboada (1979) consider this species to be *P. quadridens*, and to be found throughout the Greater Antilles. This species and subspecies occurs in Puerto Rico, Hispaniola and Jamaica. The type specimen is from Port-au-Prince. The species has been collected on the upper slopes of Pic Macaya at 1,250 mebers.

Parnell's Moustached Bat

Pteronotus parnellii pusillus

Endemic Subspecies to Hispaniola

This bat is a fast-flying insect feeder. It feeds mostly on butterflies and moths. It prefers to roost in hot and humid caves, some of which can have more than one entrance. We have captured it in a saddle at 1,250 meters elevation on the north slope of Pic Macaya. It probably hunts for insects much higher up on the slopes of the mountain as well. The species is widespread in the Greater Antilles from Puerto Rico to Cuba, and Mexico, Central America and northern South America. Two subspecies are endemic to Hispaniola. *Pteronotus parnellii pusillus* is found throughout Hispaniola in suitable well-forested areas. A second subspecies, *P. p. gonavensis*, the La Gonave Moustached Bat, is endemic to La Gonave Island. Very few specimens of either subspecies have been collected in Haiti.

Fifteen species of bats have been collected in Haiti. Because they are nocturnal, they are rarely seen, but some species are very common.

Waterhouse's Leaf-nosed Bat

Macrotus waterhousii waterhousii

Leaf-nosed Bat

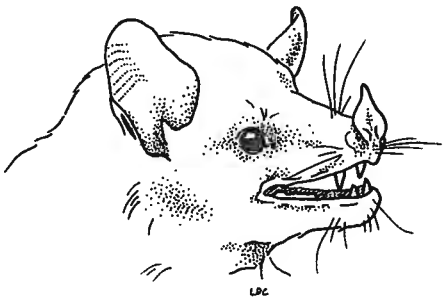
This is one of the most beautiful bats of Haiti.

This large bat hunts large insects, and its presence in a cave can be easily established by the presence of bright green katydid (Orthoptera) wings on the floor of a cave. It feeds almost exclusively on grasshoppers, katydids, butterflies, and moths. It is most common at low to mid elevations, and we have rarely encountered this bat in the high mountains. It usually roosts in the outer areas of caves, often in association with *Artibeus jamacensis*, although it can rarely be found in chambers of deep, warm and humid caves. It will occasionally roost in houses. In the Macaya area it has been collected in the Rak Bois forest near the National Park headquarters at 1,000 meters elevation, and on the eastern slopes of Macaya near Duchity. This subspecies occurs in Hispaniola, the southern Bahamas, and Puerto Rico. The species is widely distributed in the Greater Antilles, south west United States, western Mexico, and the Yucatan Peninsula. The type specimen for the species is from "Haiti."

Leach's Long-tongued Bat

Monophyllus redmani clinedaphus

This small bat is general enough in food habits that it feeds on pollen and nectar from flowers, and on fruit. It has teeth that are still quite tribosectorial, and can also feed on insects. It can, therefore, live in a wide variety of habitats from lowland forests to dense cloud forests in the high mountains. This species is very common in the towering pine forest on Pic Macaya even in January and February. It is the most common bat of the high mountains of Macaya, probably because of its broad food habits. The subspecies occurs in Hispaniola, Cuba, and the southern Bahamas.



Long-Tongued Bat

This is the only bat that occurs in large numbers on the top of Pic Macaya.

Jamaican Fruit-eating Bat

Artibeus jamaicensis jamaicensis

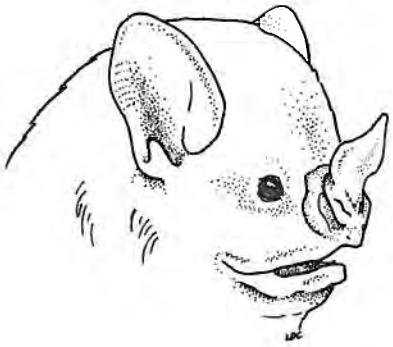
This bat eats mostly fruit, which it transports to its roost to eat. They roost near the mouths of large caves, and the seeds from the fruit they eat or just transport to the caves often sprout as seedlings on the cave floors. Hundreds of these large bats roost in caves all over Haiti, including large caves near Port-au-Prince. These bats are also reported to roost in trees (foliage and cavities in the trunk), and even in houses. They are probably the most common bats of Haiti. They are rarely found in the high mountains, but we have found these fruit-eating bats at elevations as high as 1,000 meters on Plaine Formon in the Massif de la Hotte. In areas of the Dominican Republic, they have been collected at much higher elevations, probably because of the availability of suitable sources of fruit trees. This bat has a wide distribution and occurs on Hispaniola, Jamaica, Puerto Rico, and the Lesser Antilles.

Haitian Fruit-eating Bat

Phyllops haitiensis

Endemic to Hispaniola

This species specializes in eating fruit hard fruit, and has well-developed dentition and strong jaw muscles. It resembles the Jamaican Fruit-Bat, but is browner in coloration, and has a white patch on the shoulder. The Haitian Fruit-eating Bat is combined with *P. falcatus* of Cuba by Koopman (1989). These bats are common in the Macaya area, and have been collected in the Rak Bois forest near the National Park headquarters, as well as along the higher ridges of Formon where it is uncommon. This species is distributed throughout Hispaniola.



Haitian Fruit-Eating Bat

This bat is widely distributed in forested areas of Haiti, and has a big white patch on its shoulder.

Antillean Fruit-eating Bat

Brachyphylla nana

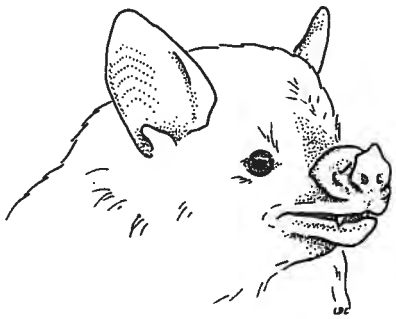
This species feeds mostly on insects and pollen, and only occasionally on fruit. It usually roosts deep inside warm, humid caves, but occasionally it is nearer to the mouth along with *Artibeus* and *Macrotus*. In the Macaya mountains, it occurs at lower elevations. Its distribution includes Hispaniola, Cuba, and the Caicos Islands. The Hispaniolan form may be a distinct species or subspecies from the Cuban form.

Haitian Flower Bat

Phyllonycteris poeyi obtusa

Endemic subspecies to Hispaniola

This bat is a generalist, and is known to feed on fruit, pollen, nectar, and insects. We have found this species in the mountains up to 1,700 meters, but it is not as abundant as *Monophyllus* at higher elevations. It is especially common in the Rak Bois forest at 1,000 meters near the National Park headquarters for Parc Macaya. It always roosts in deep, warm, and humid caves. The Haitian Flower Bat is considered as *P. p. obtusa* by Jones and Carter (1976:30), but not by Silva Taboada (1979) who classifies it as *P. poeyi*, occurring on both Cuba and Hispaniola. The type specimen is from near St. Michel de l'Atalaye in northern Haiti.



Hispaniolan Brown Flower Bat

This bat also feeds on many kinds of foods, and is common in the Macaya area.

Hispaniolan Brown Flower Bat

Erophylla bombifrons santacristobalensis

Endemic subspecies to Hispaniola

This species is also a generalist, and is known to feed on fruit, pollen, nectar, and insects. We have collected it in the Massif de la Hotte up to 1,000 meters, and it is quite common in the Rak Bois forest near the National Park headquarters. The distribution of this subspecies is Hispaniola and Puerto Rico. The distribution of this subspecies is Hispaniola and Puerto Rico according to some investigators, but Hall considers it a distinct subspecies.

Natalidae

Hispaniolan Funnel-eared Bat

Natalus major

Endemic to Hispaniola

This bat is almost totally insectivorous. It roosts in caves. A single specimen was collected in December at 1,000 meters in the Rak Bois forests of Bois Formon near the Parc Macaya headquarters. This is the first recorded specimen from Haiti. Koopman (1989) combines it with *N. stramineus* as *N. s. major*, thus an endemic subspecies.

Vespertilionidae

Hispaniolan Big Brown Bat

Eptesicus fuscus hispaniolae

This bat feeds on insects, which it captures in the early evening hours. Most of the insects it feeds on are beetles, although it will feed on many kinds of flying insects. It usually roosts in caves, but about a quarter of the time it will roost in houses. The caves are usually well-ventilated, and it rarely roosts in the warm and humid interior chambers. It has been found in the high mountains (2,100 meters) in the summer months where many were seen flying over the Riviere Blanche of the Massif de la Selle in the first hour after sunset. Big Brown Bats have never been observed in these mountains during the winter months, however, so they appear to change elevations depending on the season. About fifty individuals of this species were observed flying together over the Riviere Ravine du Sud at 1,040 meters in the Massif de la Selle in both May and January. Big Brown Bats were also collected in the saddle between Pic Formon and Pic Macaya (1,900 meters) in early November. So it may only be the highest mountain areas that are avoided during the winter months. The distribution of this subspecies is Jamaica and Hispaniola. Karl Koopman treats this as a different species, *E. serotinus*.

Because of the great variety of habitats, bats are especially common in the Macaya area.

Small Hairy Tailed Bat

Lasiurus borealis

This rare Hispaniolan bat is considered a separate species by Hall (1981). It is usually found roosting on a branch in a tree rather than in a cave like most species of bats living in Haiti. This subspecies (or species) is distributed throughout Hispaniola, Puerto Rico and the Bahamas.

Molossidae

Haitian Free-tailed Bat

Tadarida brasiliensis constanzae

Endemic to Hispaniola

Free-tailed bats fly very fast, and feed only on insects. It roosts near the mouth of caves, or occasionally in houses. Rarely will it roost in cavities in trees. In caves, it can roost in huge numbers (hundreds or even thousands). It feeds mostly on high-flying insects such as Diptera and Hymenoptera. We have collected it in the mountains of the Massif de la Hotte up to an elevation of 1,250 meters, but the bat probably hunts higher up on the mountain slopes as well.

Haitian Mastiff Bat

Molossus molossus verrilli

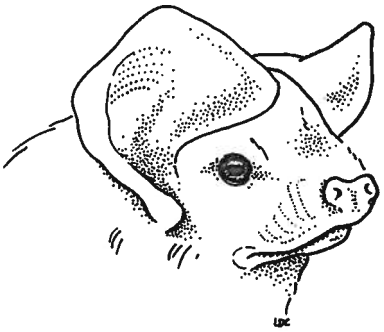
Endemic Subspecies to Hispaniola

Mastiff bats also fly fast, and feed on insects. We have collected it in the moutains of the Massif de la Hotte near Beaumont, but the bat probably hunts higher up in the mountains. The type locality is Petionville. The subspecies is distributed throughout Hispaniola.

Ghosts of the Past: The Fossil Mammals of Haiti

The little information that we had from Oviedo, and the few specimens of *Plagiodontia* (first collected in 1826) and *Solenodon* (first collected in 1832) provided all that was known about the endemic terrestrial mammals of Hispaniola until fossil specimens began to be collected from cave and Indian midden deposits in the early part of this century. William M. Gabb collected a few bones of *Plagiodontia aedium* in 1870 (and saw a live "agouti"), but it was not until the field work of William L. Abbott in 1916 that significant numbers of fossil mammals began to be collected. This collection, as well as the bones collected by Teodore de Booy, Arthur Poole, and W.M. Perrygo were described as new species of Hispaniolan mammals by Gerrit Miller. Work on fossil mammals of Hispaniola continued in the 1970s and 1980s with Clayton Ray and Renato Rimoli working in the Dominican Republic. We have been working on the fossil mammals of both Haiti and the Dominican Republic since 1975 (see Morgan and Woods, 1986; Woods, 1989a, 1989b).

The extinct mammals discussed here were excavated from deposits on the floors of caves. In most cases, the remains of the mammals were originally deposited in the caves by Giant Barn Owls (*Tyto ostologa*), which are now extinct. The owls returned to caves during the day where they roosted and regurgitated "owl pellets" under their roosts. Modern barn owls still do the same thing, and regurgitate the remains of their prey (rats, mice, bats, lizards). Over the years, deep deposits containing the remains of thousands of individual mammals built up in the caves. By carefully excavating these remains it is possible to obtain a record of what animals were living in the area around the caves, as well as their relative abun-



Haitian Free-tailed Bat

This bat flies very fast and travels long distances in search of insects to feed on.

dance. By dating the bones (and associated shells of snails and pieces of carbon) by radiometric techniques (i.e., carbon^{14} analysis), it is possible to determine when the bones were deposited in the cave.

Additional fossil remains have been collected in deep sink holes. Sinkholes differ from caves in that they are deep pit-like holes in limestone deposits, although some are caves in which a section of the roof has fallen in. These sinkholes can function like a giant "pit trap," and provide a fossil record of all of the mammals that fell into the "pit trap" over a long period of time (in Haiti up to 20,000 years, so far). Some of the best sink hole deposits in Haiti are on the Plaine of Formon, and along the Plaine of Durand at 1,000 meters elevation in the center of the Macaya Biosphere Reserve region. Some caves were found high on the slopes of Pic Macaya, and one of the largest and best cave systems in Haiti occurs just outside Camp Perrin in the Valley of the Riviere Grande Ravine de Sud. Therefore, our knowledge of the fossil and recently-extinct mammals of Haiti is extraordinarily complete. The history of mammals is better known there than for any other region of Haiti.

The Small Island Shrews: Nesophontidae

The insectivores of Haiti superficially resemble shrews in morphology, and are divided into two families. Individuals in each family are similar in body form, and show extreme morphological conservatism.

The members of the family Nesophontidae are frequently referred to as the "island shrews," even though they may not be particularly closely related to shrews of the family Soricidae. The name for this family comes from the Greek *nesos* = island, and *phontes* = a murderer, in recognition of their many sharp teeth. All known species are relatively small in body mass, and there is a moderate adaptive radiation.

In Haiti, the three island shrews are probably extinct, although there is evidence that they survived until well into this century. This evidence all comes from nearby areas in the Dominican Republic where the forest cover has been better protected from fragmentation, and the spread of rats may have been slower than in similar mountainous regions of Haiti where peasants have created small gardens even on the highest mountainsides. Herbert W. Krieger found owl pellets with recent-looking skeletal remains of all three species of Hispaniolan *Nesophontes* in them in the spring of 1930. These owl pellets were collected near Constanza (1,212 meters) in the high, remote, pine-covered Cordillera Central of the Dominican Republic. Furthermore, Dr. Clayton Ray of the Smithsonian Institution reported to me in a letter (dated 4 November 1974) that he had searched for *Nesophontes* in the highest and most remote areas of the mountains that he could get to in the Dominican Republic, and that he "did get accounts from seemingly knowledge-able primitive naturalists in the mountains of a tiny rat-like animal, but having a long nose and many, many sharp teeth." This animal usually went by the name of "Rastra" and the two or three interesting accounts agreed in stating that these animals had been seen when the primitive land was being cleared for farming. It sounded as if they had been replaced by European rats as soon as man had moved in with his environment.

Fossil remains of Haitian mammals are most often found in caves and deep sinkholes.

We have found very fresh-looking remains of *Nesophontes hypomicrus* on the surface of rocks at the entrance to a cave at Morne La Visite (2,200 meters) in the Massif de la Selle in 1982, and on rocks at the lip to a cave near sea level at Cabo Rojo in the Dominican Republic near the southern border with Haiti in 1978. So there is strong evidence, and some circumstantial accounts to support that all species of *Nesophontes* survived in Hispaniola until 1930, and that some

individuals of at least one species survived into the 1950s or early 1960s. We hope that a few may still survive in Haiti, and have not yet given up the search.

The one person who has seen these these creatures alive is an old "montero" (a hunter in the woods) from Cuba who reported his observation to Luis Varona of Cuba in 1964. The old man was almost 80 years old, and lived in the mountains near Baracoa (Oriente province). Varona reported that the man said "that when he was a young man, one day, very early in the morning, walking in a jungle in Monte Iberia thick woods (Baracoa) he saw, crossing the trail, a little animal with a long and pointed snout and a long tail, followed by four or five immatures, each one holding in the mouth the tail of the animal before him, and the first one fixed with the mouth to mother's tail, forming a single line or a chain. This man knows very well the "almiqui" (*Solenodon cubanus*) and said that the animal he saw that morning was a very little one, smaller and thinner than the latter. He remembered well the long, pointed snout, like that of the almiqui's and the chained little immatures. The old hunter was a reliable informer, knowing as nobody the region's biota" (letter to me from Varona dated 22 March 1975). This sighting of a live *Nesophontes* in Cuba was made in the 1920s.

All three Haitian Island Shrews occur in the same cave deposits, and so they must have been captured by owls hunting in the same general area. They have been recovered in a wide range of habitats, ranging from near sea level in very dry coastal areas (almost desert like), to upland pine forest above 2,100 meters elevation. When the remains are found in a cave they are very abundant (sometimes several feet thick), but many suitable caves with Barn owls roosting in them will not have any remains of *Nesophontes*. Of the several possible explanations for this inconsistency, we favor an ecological hypothesis. We believe that all three Hispaniolan species inhabited the leaf litter layer of forest communities where they fed on soil invertebrates. Living underground in forested areas, they were not easily preyed on by Barn owls. At times of natural disasters, however, such as hurricanes or fires, and in areas where Indians or colonists were cutting down the forest to make gardens, large areas of habitat would have been opened up, and large numbers of Island shrews could have been preyed on by Barn owls. The original natural predator on *Nesophontes* in deep forest habitats may have been the Stygian Owl (*Asio stygius*). This owl is now very rare as the forest has been reduced in area, and *Nesophontes* eliminated.

We have chosen to call these by the common name Haitian Island Shrews, in spite of their broad distribution throughout Hispaniola, because the type locality of all three species is Saint-Michel de l'Atalaye in Haiti.

The three species of Island shrews found in Haiti are easily separable on the basis of body size.

> *Nesophontes zamicrus* (Miller 1929:7) is the Small Haitian Island Shrew, and the smallest of the Hispaniolan Island Shrews. The name is derived from *za* = Gr. very, *mikros* = Gr. small. Its skeletal remains are very small and delicate. In body size it was close to that of a Smoky Shrew (*Sorex fumeus*) of North America, and we estimate that its mass would have been 8-10 grams.

> *Nesophontes hyponicrus* (Miller 1929:4) is the Haitian Island Shrew, and is the mid-sized Hispaniolan Island Shrew. The name is derived from *hypo* = Gr. less than usual, and *mikros* = Gr. small. It would have been about the same size as a large Short-tailed Shrew (*Blarina brevicauda*) form North America, and we estimate that its mass was 25-30 grams. It was the only Island Shrew known to occur on Ile de la Gonave.

The now-extinct species of Small Island Shrews have only become extinct in the last 50 years, and may still survive in remote areas of Parc National Pic Macaya.

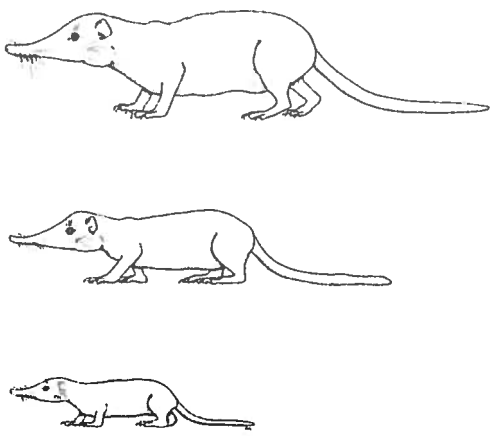
Nesophontes paramicrus (Miller 1929:3) is the Large Haitian Island Shrew, and is the largest Island Shrew found on Hispaniola. The name is derived from *para* = Gr. near, and *mikros* = Gr. small. The range of body size of *N. paramicrus* is almost the same as *N. micrus* from Cuba. The Large Haitian Island Shrew was larger than any shrew from North America, and would have been about the same size as a Hairy-tailed Mole (*Parascalops breweri*) shrew. We estimate that its mass would have been 50-60 grams.

The Giant Island Shrews: Solenodontidae

The family Solenodontidae has only four known species. MacFadden (1980:18) hypothesized that during the late Mesozoic and early Cenozoic, soricomorph insectivores (apternodontids and possibly geolabidids) were distributed throughout North America, Nuclear Central America, and the "proto-Antilles", and that a vicariance event isolated the ancestral soricomorph on the Greater Antilles after the "proto-Antilles" drifted eastward relative to the Americas. MacFadden stated that *Solenodon* and *Nesophontes* are descendants of the Greater Antillean part of the ancient soricomorph distribution, and as such are "island relicts" of a once more widespread radiation of soricomorph insectivores which became extinct elsewhere in the late Oligocene. This indicates that solenodontids are a very ancient group.

Solenodon paradoxus The discussion of this species in the section on recent mammals indicates that this species still survives in Haiti as a "living fossil."

Solenodon marcanoi (Patterson 1962:3). This unusual *Solenodon* was discovered in fossil remains in a cave at Rancho La Guardia in the Dominican Republic a few kilometers from the border with Haiti. This species has shorter, more robust limbs than *S. paradoxus*. Dr. Patterson was impressed with how much this species, which he designated as *Antillogale marcanoi*, resembled the ancient insectivores of the family Apternotdontidae of North America. He remarked that "as far as these teeth are concerned, *Antillogale* could only with difficulty be distinguished generically from *Apternodus*." His explanation was that the solenodontids evolved from relatively unspecialized apternodontids that inhabited the Central American peninsula during the early Tertiary (Eocene or Oligocene). A specimen recovered by a Peace Corps volunteer at a village near the border with Haiti appears to be this species, and thus it is quite likely that *S. marcanoi* survived into the 1970s, and may still be extant. *Solenodon marcanoi*, therefore, is the closest thing in Hispaniola to a living fossil.



The three species of Small Island Shrews from Haiti

Haitian Rodents

The rodents of the West Indies, and of Haiti in particular, have undergone a remarkable radiation, and are morphologically diverse. Mammalian taxa evolving on isolated oceanic islands without competition or predators may not be able to adapt to rapidly-changing conditions, such as the extensive climatic fluctuations of the Pleistocene or sudden competition and/or predation from introduced forms. When local conditions change dramatically, mammals that have evolved

in isolation on remote oceanic islands are especially vulnerable to extinction, which appears to have been the case in all of the mammalian radiations of the West Indies. Even in the Rodentia, where 62 species are known from throughout the region, 77% of the species have become extinct. At least one rodent species is known to have become extinct on every West Indian island where they occurred, with the exception of tiny and remote East Plana Cay in the Bahamas.

The endemic rodents of Haiti are related to the oldest group of rodents of South America, a group that extends back in time at least 26 million years on that continent (Woods, 1982, 1984). These rodents entered the West Indies at a reasonably early date (late Oligocene or early Miocene) and diversified into 14 genera and 54 species, all of which are confined to the Greater Antilles. Some were highly arboreal and clearly occupied niches similar to primates, squirrels and porcupines, while others were very terrestrial and large (Woods and Mckeen, 1989).

In Haiti, at least 13 rodent species from three families and six genera are known to have been present. All of these taxa existed into the period when humans occupied the island during the past 7,000 years. Only one taxon continues to survive. This animal, *Plagiodontia aedium*, is called the "Hutia" in the Dominican Republic and either the "Zagouti" or "Rat Cayes" in Haiti. After the arrival of Amerindians on Hispaniola, 93% of the endemic rodents became extinct, an average loss of one endemic rodent every 583 years. However, since eight (and maybe ten) of these rodents are likely to have still been extant 1,000 yBP, the rate of loss of the endemic rodents was not regular. For the first 6,000 years, the rate of loss would have been one species every 1,500 years. However, for the past 1,000 years the rate increased almost tenfold to a species every 143 years.

The Spiny Rats: Heteropsomyinae

These ideas on the origin and relationships of West Indian echimyids (**family Echimyidae** Miller and Gidley 1918, **subfamily Heteropsomyinae** Anthony 1918:407) are discussed in much greater detail in two of our recent publications (Woods 1989a, 1989b). Our current hypothesis is that there was a direct invasion of eastern Hispaniola or Puerto Rico by an echimyid from South America. Echimyids frequently occur in forests at low elevations and often are found in riparian situations. In general, echimyids are medium-sized and semi-arboreal. Mammals with these characteristics are good candidates to be associated with mats of floating vegetation originating at the mouths of major river systems, and to survive to colonize a distant island. It is reasonable to propose that the founding stock of the West Indian echimyids landed on eastern Hispaniola or Puerto Rico via a form of oversea dispersal.

The endemic mammals of Haiti are all members of ancient groups, and the surviving forms are truly "living fossils."

Haitian Spiny Rat

Brotomys voratus

The Spiny rats from Haiti are all in the genus *Brotomys*. The generic name is derived from *broteos* = Gr. esculent or eatable, and *mys* = Gr. mouse. They are about the same size as *Boromys* from Cuba, and much smaller than any of the heteropsomyines from Puerto Rico. Unlike any other endemic rodents in Haiti the cheek teeth are always rooted, and lack cement within the re-entrant folds or around the shafts. They have never been seen alive by a scientist, nor do any complete specimens exist in the collections of any of the world's museums.

However, there are descriptions of the animal in the writings of Oviedo, who said the Indians called them a "muhoy," and prized their meat above all others. According to Oviedo, they were gray in color and had coarse, spiny fur.

This spiny rat is about the same size as a Norway rat, and may have had similar habits. The remains of this species are very abundant in fossil deposits in owl caves, and in some Indian midden deposits, indicating that they must have been very common at one time. The specific name is derived from *voratus* = Gr. the devouring one. In a collection of owl pellets made by Herbert W. Krieger at Constanza (1,212 meters) in the Cordillera Central of the Dominican Republic in 1930, Gerrit Miller recovered the remains of this species (Miller, 1930:2), so we believe that Hispanioaln Spiny rats were still extant as of that date. This species was extremely common in the Macaya area.

The Haitian Hutias: Capromyidae

The West Indian hutias are all classified together in the **Family Capromyidae.** The name for this group is derived from the Greek *kapros* = a wild boar, and *mys* = mouse. They are large rodents, and are part of an important adaptive radiation of rodents that occurred only in the West Indies.

The hutias that occur in Haiti have been classified into three separate subfamilies because they are so distict from one another. On the much larger island of Cuba, all of the hutias appear to be of the same subfamily, and are fairly similar to one another. How can this be so? The answer appears to be that Hispaniola was the center for the evolution of this group, and so they have been evolving on Hispaniola longer than on any other island in the West Indies. Also, Hispaniola has a long and complex geologic history, and was separated into two, and perhaps three geographically distict regions during the past ten million years. So it is not a surprise that there would have been three sub-radiations of hutias on the island of Hispaniola. As will be seen in the following discussion, the area of Hispaniola with the greatest number of specialized hutias is the Macaya area.

The three subfamilies of hutias on Hispaniola are:

Subfamily *Hexolobodontinae*: The Even-toothed hutias

Subfamily *Plagiodontinae*: The Oblique-toothed Hutias

Subfamily *Isolobodontinae*: The Ring-toothed Hutias

Haitian Spiny Rat

ENDEMIC

EXTINCT

The first, and perhaps most primitive sub-radiation of hutias on Hispaniola, is grouped together as the **Subfamily Hexolobodontinae** (Woods, 1989a:76). In these hutias, the cheek teeth are very tall (= high crowned or hypsodont) in young individuals, and the teeth are open-rooted and evergrowing. In mid-age, however, roots form and the cheek teeth stop growing so that they wear down to become short and prominently rooted. The upper cheek teeth have two re-entrant folds on the inside which lie opposite two re-entrant folds on the outside so as to produce a six-lobed appearance, hence the name *Hexolobodon* (*hex* = six, *lobos* = a lobe, *odontos* = tooth). These upper re-entrant folds, unlike any other hutias in Haiti, are nearly perpendicular to body axis and are covered with moderate amounts of cement. Therefore, the upper cheek teeth of these large rodents are easily distinguished from all other hutias in Haiti because the re-entrant folds are so symmetrical and divide the surface of the teeth up into nearly equal parts, hence the common name of the group--the "Even-toothed hutias".

Even-toothed Hutia

Hexolobodon phenax

The specific name comes from the Greek *phenax* = a cheat or imposter. The remains of this large rodent are not as common as those of *Isolobodon* and *Plagiodontia*, indicating that it may have been one of the first hutias to be significantly reduced in numbers. It survived into the time of the Tainos, however, and may have become extinct about the time of Columbus. These hutias are restricted to Hispaniola and Ile de la Gonave, and are very common in the fossil remains found in sinkholes on the Plaine of Formon in the Pic Macaya area, and in the hills and valleys surrounding Camp Perrin.

La Hotte Even-toothed Hutia

Hexolobodon sp.

This new species of Even-toothed Hutia has several unique features, and so far is know only from Trou Woch Sa Wo near Camp Perrin. This area is isolated from other regions of Haiti, and is the same area where the remains of another native species known to occur only in the Macaya area are found (*Rhizoplagiodontia lemkei*, as described below).

The largest and most diverse group of hutias in Haiti are in the **Subfamily Plagiodontinae** (Ellerman 1940:25). These hutias are characterized by cheek teeth that are nearly horizontal (i.e., occlusal surfaces on the same plane). There is a moderate amount of tooth cement within re-entrant folds, but unlike all other known hutias, no cement surrounds the shafts of the cheek teeth. The enamel surfaces of the cheek teeth are very thick, and the re-entrant folds are oblique (hence the name *Plagiodontia*, *plagios* (Gr.) = oblique, *odontos* (Gr.) = tooth).

This subfamily includes the genus *Plagiodontia*, with four or five species, and the newly described genus *Rhizoplagiodontia* (Woods 1989a), which is found only in the Macaya area. The morphology of the cheek teeth varies from the condition in *Rhizoplagiodontia* in which the roots are open only briefly (in juveniles) and functional hypsodonty in adults is maintained by massive deposits of cement at the base of the alveolus, to the condition in *Plagiodontia araeum* which has completely open-rooted molariforms but has the occlusal surface of the cheek teeth at nearly the same level as the gum line (i.e., low). The most extreme modification in dental morphology in this group is found in *P. velozi* where the completely open-rooted molariform teeth have the occlusal surface far above the gum line. The members of this species-rich group ranged in body size from 500 grams to an estimated 8 kilograms.

There were about 14 endemic species of rodents present in Haiti when Indians first arrived about 7,000 years ago. Only one survives today.

Living Form

Zagouti

Plagiodontia aedium

Cuvier's Hutia

This hutia is now very rare in most parts of its original range. Habitat destruction has exposed it to predation by dogs and other introduced predators, and eliminated its natural sources of food and shelter. During the last decade many areas of remaining natural habitat have been destroyed in both Haiti and the Dominican Republic, and zagouties are now becomming very uncommon in places where they were abundant just a few years ago. Only one young is usually born at a time, and a female usually has only one young each year, so the reproductive potential of this species is very limited. The Hispaniolan Hutia was designated as "indeterminate" in status in the IUCN Red Data Book. The conservation status of the species should be raised to "vulnerable." An in-depth review of its present distribution in the Macaya area should be undertaken as part of the production of a Species Recovery Plan for the Zagouti.

"Zagouti" of Haiti

ENDEMIC

ENDANGERED

Without protection, and the implementation of recommendations in a Species Recovery Plan, this species could become extirpated in the Macaya area within the next decade or two because its present habitat is being rapidly destroyed. As of June 1992, the "natural" habitat that is being destroyed at the most increased rate includes the "Rak Bwa" forests of Bwa Formon and Bwa Durand. Our investigations suggest that it is unlikely that zagouties can survive in the area if these areas of broadleaved forest are cut down. Like its fellow native species discussed in the following section, the zagouti will be lost forever.

Extinct Forms

Zagouti Macaya

La Hotte Hutia

Rhizoplagiodontia lemkei

The name of the genus is derived from *rhizoma* (Gr.) = root, *plagios* (Gr.) = oblique, *odontos* (Gr.) = tooth. The specific name is in honor of our friend and associate Mr. W. E. (Ekke) Lemke of Port-au-Prince, who has assisted in making these studies possible. This hutia is now extinct, but its remains are very abundant in sinkhole deposits on the Plaine Formon near Pic Macaya. Some of these remains are very recent-looking, and the type specimen is a nearly complete skull and both lower jaws (an unusually complete specimen for a fossil). The skull and teeth of this specimen include features that are primitive for capromyids, such as rooted cheek teeth which are not particularly high-crowned, and an extra re-entrant fold on the upper premolar teeth. This hutia bridges the gap between the three subfamilies of hutias on Hispaniola, and provides incontrovertable proof that they are all part of the same radiation. This hutia is also similar to Spiny rats in many features, and as such ties the Spiny rats and hutias together as part of the same radiation of West Indian rodents.

Fossil remains of the endemic La Hotte Zagouti have been collected in Trou Woch Sa Wo near Camp Perrin. Fossil remains have also been collected in two deep sinkholes on the upper Plaine Formon (= Plaine Deron) at sites known as Trouing Jeremie #1 and Trouing Jeremie #5. The La Hotte Hutia was also collected in a deep sink hole on Pic Macaya known as Trouing Lanj Genti #1. This region of the planned Macaya Biosphere Reserve ranges in altitude from 300 meters at Sa Wo to 1,365 meters at Lanj Genti. It is not clear whether the natural distribution of *R. lemkei* included the lowland drier site at Trach Woch Sa Wo or if Giant Barn Owls carried the remains of the rodent to the cave.

The environment of the area where remains of the La Hotte Hutia (or La Hotte Zagouti) are known is characterized by abundant rainfall (exceeding 3,000 mm annually), dense forests, steep ravines, numerous areas of exposed limestone, and the tributaries of four major rivers. The known area of distribution includes the watersheds for the Riviere L'Acul and Riviere Ravine du Sud and extends over an area of 120 square kilometers. The presence of a few remains of *R. lemkei* in Trouing Lan Genti #1 on the north side of the Ravine du Sud and at the edge of a broad plain northeast of the Pic Macaya suggests that *R. lemkei* may have inhabited this plain also. The plain is very similar in geology and ecology to the Plain of Formon and is associated with the Riviere Glace. In the Catiche and Duchity areas of this plain (called "Plaine Martin" near Catiche), *Solenodon paradoxus* and *Plagiodontia aedium* are abundant, and a yet-to-be-described new species of Solenodon also occurs there. Excavations of several caves and sinkholes near Duchity and Beaumont have not indicated the presence of *Rhizoplagiodontia lemkei*. However, based on the similarity of habitat of the region with the Plain of Formon and the presence of *R. lemkei* in Trouing Lang Genti #1 at the western edge of the Plaine Martin and adjacent areas, we predict that *R. lemkei* may also have been found in this area.

La Hotte Hutia

ENDEMIC (to Macaya area)

EXTINCT

Narrow-toothed Hutia

Plagiodontia araeum

The specific name is derived from the Greek *araios* = thin, narrow. It was described on the basis of an upper left premolar tooth. We have collected the remains of many individuals of this species in cave and sinkhole deposits. It is now extinct. This large, heavy-bodied hutia is uncommon in most fossil deposits, and in most parts of the island. It is most common on the high plateau of the Massif de la Selle, where its remains are frequently found in deep sinkholes. We believe that it was a large ground-dwelling herbivore that fed on bark and roots. Its cheek teeth are very wide and open-rooted, but do not emerge far above the jaw (unlike all other hutias). The teeth, therefore, appear short and fat. Its limb bones are heavy and have well-developed processes, indicating that the animal may have been a good digger. This is the same species as described by Rimoli (1976) as *Hyperplagiodontia stenocoronalis*. A form with the same features, but smaller in size occurred on Ile de la Gonave. It is likely that this hutia filled a niche similar to that of a paca (*Agouti paca*). It was an uncommon, but widespread resident of the Macaya region.

Oviedo's Hutia

Plagiodontia velozi

We have named this hutia after Oviedo because we believe that it is the animal Oviedo described as the "quemi." This hutia is very different from the Narrow-toothed Hutia discussed above. Its cheek teeth are very high-crowned and stand far above the jaw. The skull is long and strong. Its limb bones are long and narrow. This animal is common in sinkhole and cave deposits in northern Haiti, but less common in the south, although its remains are found throughout Hispaniola. We believe that this hutia may still survive in remote sections of Hispaniola, such as the western Cordillera Central of the Dominican Republic, and the Sierra de Baoruco. Accounts by campesinos living in these areas of a "comadreja" might possible refer to this animal (Woods et al., 1986). We propose that this animal filled a niche rather like some of the arboreal hutias from Cuba, and that it was a good climber. It was an uncommon, but widespread resident of the Macaya area.

Kitchen Midden Hutia

Plagiodontia ipnaeum

This species is similar in basic morphology to *Plagiodontia aedium hylaeum*, except that it is 25% larger in body size. It includes *P. caletensis* (Rimoli 1976:30), from which it is inseparable. It occurs in both cave and Indian kitchen midden deposits, so it was well known to the Tainos. The specific name is derived from the Greek *ipnos* = an oven or furnace, in recognition of its presence in Indian kitchen middens. This is a significantly larger animal than the "hutia" of Oviedo, but it is not as large as the "quemi," which Oviedo described as the size of a medium-sized hound. The Large Hutia was an important species in northern Haiti up until about the time of Columbus, and must have been prized game for the Indians because of its large body size (3 kilograms) and broad distribution.

The most unique sub-radiation of hutias on Hispaniola is grouped together as the **Subfamily Isolobodontinae** (Woods 1989a:76). The cheek teeth in these hutias are very high-crowned and open-rooted. The tooth cement lies within the re-entrant folds, but in a condition that separates this group from all other hutias; it also surrounds each cheek tooth in distinct rings or bands (hence the common name--the "Ring-toothed Hutias"). The teeth are thus very symmetrical, hence the origin of the name (derived from the Greek *isos* = equal, *lobos* = a lobe, *odontos* = tooth). The enamel structure of cheek teeth is very thin and soft, unlike all other known hutias.

Indian Hutia

Isolobodon portoricensis

The species was still extant in about 1930, because Herbert Krieger collected recent-looking owl pellets near Constanza (1,212 meters) in the Cordillera Central of the Dominican Republic which contained the bones of one very young individual of this species. Very recent-looking remains of this species have been collected in sinkholes in the Formon area and from a cave near Camp Perrin, but no living specimens are known to have been found in Haiti.

The specific name is in recognition of its presence on Puerto Rico, where we now know that it was introduced. The Indians apparently were very familiar with this hutia, since it was probably easy to keep in captivity. The remains of *Isolobodon portoricensis* are very abundant in Indian kitchen midden deposits, and Las Casas reported that Indians had corrals of sticks woven together with vines near their villages where they kept hutias as a ready source of meat. We believe that this hutia is the species eaten by Columbus at Guacanacaric's village in 1492 and by Columbus's crew at Xaragua in 1496.

Mountain Hutia

Isolobodon montanus

This species was originally described under the genus *Aphaetrius* by Miller (1922). It differs from the above species in being larger in size, and having the opposite re-entrant folds on the upper cheek teeth join to divide the tooth into separate front and back sections (i.e., the tooth becomes laminar). In almost all other features, however, this hutia is not separable from *Isolobodon portoricensis*, and it is therefore not appropriate to place them in separate genera.

The teeth of both of the above species have much softer enamel, as well as the unusual pattern of bands of cement around the shafts of the cheek teeth. Plagiodontines and isolobodontines must have had very different food habits. The procumbent incisors and soft enamel indicates to us that isolobodontines were likely to have fed primarily on soft vegetative parts such as leaves, while plagiodontines may have feed primarily on bark and roots.

The Giant Hutia of Haiti

"Giant" Hutias were once found on Jamaica, Hispaniola, Puerto Rico, and the St. Martin Bank. They are considered by many authors to be a distinct family with affinities with either False Pacas (the family Dinomyidae) or Chinchillas (the family Chinchillidae) of South America. Patterson and Wood (1982:512) could not find a close relationship of Giant Hutias with any other known rodent family, however, and assigned them as as *incertae sedis* (which means "of unknown affinity"). Ray (1965) noted many similarities of the Hispaniolan Giant Hutia (*Quimisia gravis*) with the Hispaniolan Hutia or Zagouti (*Plagiodontia aedium*). The main characters separating Giant Hutias from capromyids (hutias) are: 1) the replacement of the deciduous premolar in Giant Hutias (capromyids retain

this tooth throughout life); and 2) the tendency for Giant Hutias to have deeply-cleft re-entrant folds on the molariform teeth that can form laminae (as in dinomyids and chinchillids).

All Giant Hutias are much larger than any known capromyid. Tooth cement is present within the re-entrant folds and on the surrounding surfaces of the cheek teeth. The cheek teeth are high-crowned (hypsodont) but not open-rooted (hypselodont) throughout life. Their teeth are easily distinquished from other hutias. One species of Giant Hutia is known from Haiti.

Hispaniolan Giant Hutia

Quemisia gravis

This species is known from very few specimens. Gerrit Miller believed that the bones he found of this species were what Oviedo was referring to as the "quemi." That was the basis for his name *Quemisia*. However, we believe this species was far too rare to have been well known to the Indians. The specific name is derived from the Latin word *gravis* = heavy. It was about the size of a North American Beaver, and we estimate that its mass would have been about 15 kilograms. It has a massive jaw that is very compact. The femur is very broad, with well-developed processes.

The remains of this species have been recovered from a large cave near Saint-Michel de l'Atalaye, and Cueva de Boca del Infierno near Samana Bay in the Dominican Republic. The specimens that we have collected, including a near perfect jaw, have all come from near the entrances to large caves. We believe that this species was hunted by the paleo-indians, who were also living in these big caves, such as the massive cave complex near Saint-Michel de l'Atalaye. The massive proportions of this species suggest to us that it would not have been a fast runner or good climber, and that it probably would have been easy to locate and kill. The Hispaniolan Giant Hutia was one of the first of Haiti's endemic rodents to be driven to extinction by man. It has not yet been found in the Macaya area, but it is likely that it occurred there.

The Indian Hutia was once the most common land mammal on Haiti. Thousands are present in the "kitchen middens" of Indians. Columbus probably ate this small mammal in 1492. Indian Hutias probably survived in Haiti into this century.

The Giant Ground Sloths: the ghosts of the Cigouave

The West Indian sloths are all members of the **family Megalonychidae**, and probably derived directly from South America. Sloths underwent a remarkable radiation in the West Indies into very diverse forms. Sixteen species have been identified on Cuba, Hispaniola, and Puerto Rico. Some were quite arboreal, strongly resembling tree sloths in size and morphology, while others were large and terrestrial. Presumably all were herbivorous and occupied niches comparable to some of the larger semi-terrestrial lemurs of Madagascar. A simple analysis of the number of taxa supports the hypothesis that sloths dispersed from Cuba (nine species) to Hispaniola (six species), and to Puerto Rico (one species). No sloths have been found on any other islands of the Greater or Lesser Antilles, although they did occur on Ile de la Tortue off the north coast of Haiti, which is separated from Hispaniola by a deep water channel eight kilometers wide.

The status of Ground Sloths at the time of Columbus remains a mystery. They were not mentioned by Oviedo, suggesting that they were extinct by 1492. Miller (1929) believed that they existed well into the time of the Indians. He observed that the sloth remains he collected in caves near Saint-Michel de l'Atalaye were found within two feet of the surface, and that human bones and pottery occurred

at the same level. Miller also observed that sloth bones he collected near the entrance to a cave were mixed with bones of humans and a domestic pig. We have found many sloth bones near the surface of cave deposits, and in the deep sinkholes on the Plaine Formon near Pic Macaya, several sloths were found near the surface. The bones of these sloths, including well-preserved skulls, were associated so that it was possible to recover almost all of the bones of particular individuals. Similar nearly complete sloth skeletons were recovered from deep sinkholes on the plateau of the Massif de la Selle near Morne La Visite.

All of these observations indicate that some sloths in Haiti did not become extinct until about the time of Columbus, and that it is possible that a few individuals (and perhaps even several species), lingered on after Columbus and into the period of the decline of the Indians and the introduction of domestic animals. Another piece of evidence that sloths continued to exist into the time of humans on Hispaniola is the story of the Cigouave and Ciguapa in Haiti and the Dominican Republic. This mythical beast is described in very similar ways in both countries, and appears to resemble a Giant Ground Sloth such as the Big Tortue Ground Sloth. The modern myths must be descended from stories told by the Indians to the early colonists.

It should be noted, however, that there is another explanation for the myth of the Cigouave. The mythical creature also resembles a large owl standing on the ground. In our search for "lost mammals of the Greater Antilles" (Woods et al., 1986), we investigated a story of a Ciguapa in the remote Cordiller Central. After a series of interviews and field work in the area, we concluded that the animal was a Barn owl. In the past, a Giant Barn owl would have looked even more like a Cigouave and Ciguapa. So, as always, the search for the "lost mammals" of Haiti is an elusive one.

The following descriptions of the six Ground Sloths of Hispaniola are not as cohesive as the descriptions of the other mammals of Haiti. The problem is that the two named sloths were described from fossil leg bones. No skulls or jaws were associated with these leg bones at the time of description, so it is not possible to know for certain how these isolated leg bones relate to the numerous skulls that have been collected since. The problem is compounded because sloths are markedly sexually dimorphic, so that male and females can appear to be two separate species. We are still trying to make these associations, and to resolve the question of how many sloths there were on Hispaniola. In the meantime, the following descriptions will give some idea of the scope of the radiation of ground sloths in Haiti.

Large Hispaniolan Ground Sloth

Parocnus serus

The generic name comes from the Greek *para* = near, and *oknos* = sluggish or lazy. The specific name from the Latin *serus* = late. It was described on the basis of a complete femur collected in a cave in the Saint-Francisque region, north west of the town of Saint-Michel de l'Atalaye, Haiti. The femur is much larger than that of the following species, and the anterior (= proximal portion) is much more compressed (i.e., antero-posterior flattened). The femur of *Parocnus* also lacks a lesser trochanter while this structure is apparent in *Synocnus*. Miller compared the femur of this species with that of other species, and estimated that the mass was probably 68 kilograms or more. We have recovered the remains of

sloths with femurs that are similar to this species from the same caves near Saint-Michel, and from rock shelters throughout northern Haiti. Its presence in these rock shelters is likely the result of having been eaten by Indians, perhaps paleo-indians. The remains of this species have not turned up in the deep sinkholes of the Massif de la Selle or Massif de la Hotte. Based on the data available at this time, we are confident that this species became extinct earlier than the following species. It is likely that this form was a large, heavy-bodied, ground-dwelling sloth.

Small Hispaniolan Ground Sloth.

Synocnus comes

This species also was described from a femur collected in a cave located near Saint-Michel de l'Atalaye. The sloth was not that much larger than the Giant Hutia *Quemisia* (about 15 grams). In fact, when we excavated the first complete skull of the animal from a small cave near Miragone, we were initially convinced that it was a rodent. The major features of the skull and the overall body size are very similar to those of the Small Puerto Rican Ground Sloth *Acratocnus odontrigonus*, and Miller's original generic name for the Saint-Michel animal was *Acratocnus*. The Small Hispaniolan Ground Sloth was split off into its own genus by Paula Couto in 1967. The remains of what appears to be this species occur in cave and sinkhole deposits all over Haiti, and it is the most abundant sloth in cave deposits. We believe that it is likely that this species survived in remote relictual habitats such as the Cordillera Central, Massif de la Hotte, and Massif de la Selle until after the arrival of Columbus. The form of the limb bones and moderate body mass indicate that it is probable that this sloth was slightly arboreal.

La Hotte Ground Sloth

Gen. sp A, B and C. New genera and species

This species is a medium-sized ground sloth that appears to be endemic to the La Hotte region. It was about 25 kilograms in mass.

The Monkeys of Haiti: why so few?

Primates in the West Indies underwent a limited radiation. There were two, and possibly three, separate lineages of primates which occurred on Jamaica, Hispaniola, and Cuba. Each lineage may represent a separate invasion of the Antilles, and no genus has more than one known species. The lack of diversity of primates in the Antilles is probably related to the success of sloths and rodents on the islands. Most primate niches appear to have been occupied by sloths, some of which were quite arboreal, and by medium-sized rodents. On Hispaniola, there was at least one species that was similar in mass and many morphological features to tree sloths. The difficulty in establishing the phylogenetic affinities of the primate lineages in the Antilles may be the result of an increase in body size

of West Indian primates. In the case of *Xenothrix* from Jamaica, for example, its possible relationship to callithricids (small-bodied marmosets) may be masked by the effects of allometric growth as the lineage increased in body size (Ford and Morgan, 1986).

Hispaniolan Monkey.

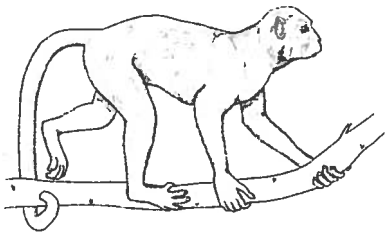
"Saimiri" bernensis

This monkey was named on the basis of a jaw fragment collected at Cueva de Berna near Boca de Yuma in the Dominican Republic. It was originally believed that it was was a Squirrel Monkey. Additional material of this species has now been collected in Haiti at Trou Woch Sa Wo near Camp Perrin (See MacPhee and Woods, 1982), and from a sinkhole on the plateau of the Massif de la Hotte at 2,000 meters. The analysis by Macphee and Woods indicates that this is probably not a Squirrel monkey of the genus *Saimiri*, but rather a monkey much more similar to a South American Capuchin of the genus *Cebus*. It appears as if this form is distinct enough to be given a unique generic name.

The Hispaniolan Monkey probably inhabited well-forested regions, such as the Massif de la Hotte. The deposit at Cueva de Berna dates at 3,860 135 yBP. The bone material in Trou Woch Sa Wo at the same level as the Hispaniolan Monkey dates at 9,550 150 yBP. This monkey appears to have been a widely-dispersed member of the forest ecosystem in Hispaniola. Since no recent-looking material has been collected, and since all of the material so far dated is older than 1,500 yBP, we believe that the Hispaniolan Monkey was hunted to extinction by the paleo-indians that colonized Hispaniola from Central America about 7,000 yBP. They would have come from an area where monkeys were abundant, and were probably experienced hunters.

Patterns and Explanations for the Extinction of Haiti's Mammals

> **"...when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."** (William Beebe)



Hispaniolan Monkey

ENDEMIC

EXTINCT

Why have so many of Haiti's endemic terrestrial mammals become extinct? We have been wondering about this for many years as we have sought ways to conserve the last two terrestrial endemic mammals. The search for a reason for the extinctions is complicated because there were so many different kinds of mammals living on Hispaniola. These mammals varied markedly in body size and life history strategy. However, they occur together in fossil deposits located in regions with very diverse climates and vegetation. As with mammals from many island situations, a large number of the mammals of Haiti may have been generalists rather than specialists. The broad distribution of most species throughout all regions and ecological zones of the island make it even more difficult to pin-point a single factor that played the major role in the extinction Haiti's once impressive repertoire of terrestrial mammals.

Large species dominate the list of Haitian mammals that were present on the island before the arrival of humans. The largest species (over 5 kilograms) represented 48% of the original terrestrial endemics, and 80% of these original mammals were over 1.5 kg (i.e., medium to large mammals). The average estimated body mass of Haiti's endemic terrestrial mammals at the time of Indian contact was 28 kilograms (range .01-320 kg).

The total number, average size, and size class distribution of the endemic terrestrial mammals of Haiti at the time Columbus made contact with Hispaniola in 1492 (5,000-6,000 years after the first Indians) had changed dramatically. Ten endemics survived (60% had become extinct). The average estimated body mass of these remaining mammals had declined 94% to just 1.53 kg. Only one of the surviving endemics was more than 5 kilograms in mass, and 90% of the endemics were small or medium-sized mammals. The range of body mass was .08-4 kilograms, with 40% of the terrestrial mammals being less than 400 grams in mass. During the time of the Indians, the characteristics of Haiti's endemic terrestrial mammals fauna changed from one dominated by large herbivores to one dominated by small to medium-sized insectivores and a few rodents.

This group of ten endemic mammals was largely unaltered during colonial times, although the overall composition of Haiti's mammal fauna changed dramatically with the introduction of dogs, cats, pigs, cows, rats, and mice, all of which spread rapidly to occupy the available niches. At the height of colonial rule in 1775, there would have been 16 free-living mammals (nine of the above endemics and seven introduced species). These nine endemics survived until the 20th Century. During the early 20th Century, however, there was a new wave of extinction of endemics, with all but two or three species becoming extinct. The average body mass of the surviving endemics is 1,200 grams (range 1,000-1,500). All are medium-sized mammals. All of the small mammals of Haiti, which had survived 6,000 years of Indian hunting and habitat alteration, 300 years of colonial exploitation, a bloody and destructive revolutionary war, tremendous habitat destruction as a result of unwise land use practices, and the introduction of more than a dozen non-native mammals, became extinct in the course of the first few decades of the 20th Century.

Why do only 12% of Haiti's original terrestrial mammals survive, and what are some of the specific reasons for the extinction of 88% of the animals present on the island when humans first arrived? The following section explores some of the possible explanations.

The surviving native land mammals of Haiti are all now in danger of becoming extinct.

Indian-Related Causes

Indian Hunting. The earliest Indians of Haiti were the paleo-indians or "Guanahatabeys" (Rouse, 1989). These Indians were descended from Indians living in Central America who used primitive stone tools to kill megaherbivores. Their hunting culture would have been a big threat to the "megaherbivores" of Haiti. If these Indians were experienced hunters of megaherbivores, then they must have had a terrible impact on the ground sloths, giant rodents, and monkeys of Haiti. These big creatures had evolved on Hispaniola without carnivores. They were probably very vulnerable to any hunting, and especially vulnerable to experienced hunters with appropriate tools. We believe that paleo-indians would have utilized the megaherbivores as food, and that they would have reduced the numbers of these animals in Haiti dramatically. These Indians appear to have lived in caves, and to have hunted for their food along the coast and into the interior river valleys. The impact of these Indians would initially have been rather slight, because their numbers would have been low, and many habitats in the high mountains of interior areas would have been avoided because of the dense forest

cover, cold temperatures during the winter months, and high precipitation. However, we know that early Indians eventually penetrated into the Constanza basin of the Cordillera Central in interior Hispaniola (Watts, 1987:50-51), so few areas would have been totally spared the hunting pressure of these early Indians. The abundance of sloths in cave and sinkhole deposits decreases rapidly after about 2,000 yBP. During this same period, large rodents also become less abundant. Watts (1987) believes that these early Indians would have also hunted manatees.

The hunting of endemic mammals by the Tainos that were present on "Hayti" and "Espanola" at the time of Columbus and Oviedo has been well documented. We know from the writings of Oviedo that Indians hunted hutias. Oviedo reported that Indians used dogs to kill hutias, and that hutias had become very rare by the mid 1500s. He went on to report that Spiny Rats were prized as food by the Indians. Both species are common in Indian midden deposits. The remains of several other species of large endemic rodents are also present in Indian midden deposits. Las Casas reported that during the dry season, Indians hunted hutias by driving them out of the open savannas with dogs, groups of Indians, and even fire. They hunted at night by the light of "cocuyos" (lighted *Pyrophore noctiluca*), for it was at night when the animals were really active (Loven, 1935:434). Loven believed that the Indians hunted mainly with dogs, and by "beating-up" hutias rather than by killing the animals with bow and arrow. These hutias, which surely were not *Plagiodontia aedium*, "lived and reproduced in herbaceous vegetation (yerba) and not in the woods, not in burrows and caves, but at the surface of the ground and of them there was an infinite number" (Las Casas, *Apologetica Historia*, Cap. X). The description must be of *Isolobodon portoricensis*, which we know occurred in large numbers in Indian midden deposits of northern Haiti. The Indians must have killed large numbers of these hutias.

The tremendous number of *Isolobodon portoricensis* remains found in Indian kitchen midden deposits all around the island suggest that this animal was even kept in captivity by Tainos, who we also know transported it to Puerto Rico and the Virgin Islands. The Tainos constructed corrals out of poles bound together with intertwining creepers (Loven, 1935:437), and Las Casas (1963:73) reported that these were used to keep hutias in on the Vega Real in Santo Domingo so that meat would always be available. So Tainos must have had a significant impact on the Indian Hutia (*Isolobodon portricensis*), and perhaps the Hispaniolan Spiny rat (*Brotomys voratus*) and Oviedo's hutia (*Plagiodontia velozi*). All of these species continued to survive in low numbers after the arrival of the Spanish and the extinction of the Tainos and their culture in 1540. Therefore, Tainos did not cause the direct extinction of any of these three species during the 1,000 years that their culture dominated "Hayti" (their word for the island). All of the above species may have been significantly reduced in numbers by the presence of 1,000,000 to 3,000,000 Indians on the island.

The first Indians in Haiti were the "Guanahatabeys" who probably hunted most Mega-mammals to extinction.

The large rodents *Hexolobodon phenax* and *Quemisia gravis* were extremely rare during the later years of pre-Columbian Taino culture, and they may have actually been driven to extinction by the rapidly-increasing hunting pressure associated with the increasing masses of Tainos, who must have had a very significant impact on the island as their population peaked. We know, for example, that in addition to "ajes" (a tuber), "caçab1" (cassava bread), and "camarones" (probably Spiny lobsters), that Guacanacaric offered Columbus "caça y otras viandas" (game and other meats). This phrase, as well as Oviedo's opinion that the meat of the "muhoy" was "the food most valued and esteemed by the caciques and chiefs of this island...," indicates that the Tainos hunted wild mammals and valued their meat as food. They cooked the meat of hutias and other small mammals by removing the skin (but not evicerating them), and placing

them in pepper pots. This roasted meat not only was good to eat, but kept well for later occasions (Loven, 1935:438).

Evidence that the Indians had significantly reduced the number of endemic mammals in Haiti by the time the Spanish arrived can be gathered by examining the historical writings of the time and the zoological remains of the first Spanish settlements. The documents of Columbus indicate that the Spanish were surprised by the lack of native mammals on the newly-discovered islands. On November 6, 1492, Columbus wrote that they "saw no four-footed beasts, apart from dogs that do not bark" on Cuba. Expeditions that were sent into the interior of both Cuba and Hispaniola were frequently hungry. Game was very scarce. The early Spanish settlement of Puerto Real was established between 1502 and 1504 on the north coast of Haiti near the present-day city of Cap-Haitien. This city was abandoned in the 1580s because of problems caused by the French and Portuguese. The remains of animals found at the old site of the city should give a good indication of what kinds of animals these early colonists encountered (Reitz, unpublished manuscript). Zooarchaeological analyses of Spanish towns along the coast of Florida from the same period indicate that the remains of wild mammals comprise over six percent of the material, and wild birds an equal proportion (total, 13%). However, at Puerto Real, mammals comprise only 0.6 percent and wild birds 0.3 percent of the animal remains recovered (total, less than 1%).

Clearly, the people living in this Spanish settlement along the north coast of Haiti in the first decades of the 16th century were not encountering, or at least not eating, much wild game. The most likely explanation is that the Indians had so altered the surrounding area by clearing the lowlands for their conucos (mounds) where they grew manioc, sweet potatoes, ajes, canna, peanuts, corn, beans, squashes, fruits, tobacco, cotton, and other crops (Sauer, 1966), that few wild mammals still survived. The Indians maintained these open areas with fire, which they also used to drive the endemic mammals out of the savannas. By the time the Spanish arrived, Indians could have depleted almost all of the native game in northern Haiti, and perhaps many other lowland regions of Hispaniola as well, with the exception of small and secretive species and the Indian Hutia (*Isolobodon portoricensis*), which Indians probably kept in captivity as a domestic food source. The impact of Indian hunting would have been especially severe on the larger endemic terrestrial mammals (i.e., greater than 5 kilograms in mass), which would have been too large to have been killed by introduced predators.

At the time Columbus arrived in Haiti, over one million Indians were present on the island.

We conclude that hunting pressure by Amerindians had a significant negative impact on the endemic terrestrial mammals of Haiti. At the time the first Indians landed on Hispaniola there were 25 species of terrestrial mammals from four different orders (rodents, monkeys, sloths, and insectivores) present in what is now Haiti. Of these, 12 (48%) were larger than 5 kilograms in body mass and could be considered "megaherbivores" in the limited sense of island faunas. They were not only large in size, but also were easy to hunt and kill. The terrestrial mammals of Hispaniola were ecologically naive in that they had evolved without the presence of carnivores or other large terrestrial predators. The paleo-indians would have had an easy time hunting the large ground sloths and giant rodents of the island. These animals decreased dramatically in numbers about 2,000 yBP. Most of the ground sloths appear to have become extinct before the arrival of Tainos in about 600 B.C. A few ground sloths and giant rodents may have survived into the time of Taino culture, especially in the high mountain plateaus such as the Constanza basin of the Cordillera Central of the Dominican Republic and the high plateau-like ridge of the Massif la Selle in southern Haiti.

Since the numbers of these megaherbivores may have been reduced to very low numbers by paleo-indians, they would have been isolated in distribution and

already vulnerable to extinction. The few remaining giant ground sloths could have been killed by the Tainos, who passed along their memories of the creatures along to their ancestors in the myth of the "Cigouave." As Taino numbers increased to over 1,000,000 (and perhaps as high as 4,000,000), the last of the true megaherbivores (*Plagiodontia araeum*, *Quemisia gravis*, and perhaps *Isolobodon montanus* and *Hexalobodon phenax*) would have become extinct, along with the Hispaniolan monkey ("*Saimiri*" *bernensis*).

By the time the first colonists arrived on Hispaniola in 1492, only ten endemic terrestrial mammals were still extant. Eleven of the 12 "megaherbivores," and several medium-sized rodents had become extinct (92%). Before the Indians arrived, 80% of the terrestrial mammals of Hispaniola were of large or medium-body size. At the end of the dominance of Indian culture, 90% of the terrestrial mammals were small or medium size.

Colonial-Related Causes

Hunting by early colonists. It is well known that the early European colonists suffered from a shortage of food, and that many of the early Spanish colonists were on the verge of starvation in the first two decades after the arrival of Columbus (Watts, 1987). Oviedo stated in reference to the "Quemi" that, "There are many persons in this island and in this city who have seen and eaten these animals and who declare that they were good to eat; but in truth, according to what has been said and known about the hardships and deprivations that the first colonists endured in this island it can be presumed that everything that could be eaten must have appeared to them very good and delicious, even when it was not." (Translation of Oviedo by Miller, 1929). So we can assume that the early Spanish colonists would have hunted and killed any large mammals that they encountered.

There were never many Spanish colonists in the early years of "Espanola" compared with the huge numbers of Tainos. However, the Spaniards would have had good weapons, and in their search for gold, they penetrated deep into the Cordillera Central and other mountainous regions of eastern Hispaniola. We are sure that they were excellent and aggressive hunters. Between 1492 and 1697, they could have been partially responsible for the extinction of any megaherbivores that remained. Watts (1987) believes that, except near towns, European impact on the fauna of Hispaniola was less significant than the impact of Indians. However, "near population clusters, the continual shortage of food, and the Spanish predilection for hunting, when put together no doubt meant that some native land animals, notably the hutia and iguana, were removed from selected habitats."

The more intense hunting pressure would have come from the buccaneers. These "Protestant pirates," or as the Spanish called them "los corsarios luteranos" began to make settlements along the north coast of Haiti and on Ile de la Tortue. The buccaneers ate pre-cured (smoked) meat, and they killed cattle, horses, and hogs that ranged throughout Hispaniola and Tortue. They also ate marine mammals and sea turtles. They became very concentrated in northern Haiti in the 1500s. Watts (1987) believes that their ecological impact before 1570 would not have been very great. After 1570, however, the Spanish became much better at protecting the treasure fleets, and buccaneers fell on hard times. They turned cattle into hides, which they sold to traders from Europe. So the buccaneers would have exploited the mammals of northern Haiti for food and commerce. They would have represented a strong hunting force. Any large endemics that survived, especially on Ile de la Tortue, would have probably been eliminated by the buccaneers.

By the time the first colonists arrived on Haiti, 92% of the large native land mammals had become extinct.

So, hunting from early colonists and buccaneers would have had a big potential impact on the few large mammals that survived the Indians. The impact of the Spanish would have been greatest in the Cibao (central Hispaniola) and along the south coast near Santo Domingo. Pressure from the buccaneers would have been greatest in northern Haiti and Ile de la Tortue. In these regions hunting by Europeans should have been the final blow to any surviving large mammals. However, our data (Woods, in press) indicate that of the species of endemic mammals of Haiti that were extant at the time of the arrival of Columbus, only one species (*Plagiodontia velozi*) may have became extinct during the next 300 years (roughly the time of colonial rule). During the early years of the colonial period there would still have been pockets of remote habitat in the Massif de la Hotte in southwest Haiti, the Massif de la Selle in southern Haiti, and the nearby Sierra de Baoruco and Sierra de Neiba in the Dominican Republic. These would have served as the last refugia for some species, but still one would expect that the Spanish and French colonists would have had a much larger negative impact on the endemic mammals than they actually did.

Why did the Spanish and French colonists, unlike the Indians, have such a limited negative impact on the endemic mammals? The answer appears to be that the domestic mammals introduced by the Spanish flourished to the point that they rapidly replaced endemic mammals as "game." Introduced cattle, sheep, goats, horses, and pigs were allowed to roam freely by the Spanish. Horses, sheep, and goats had trouble acclimating to the conditions in Hispaniola (Watts, 1987), and did not increase in numbers rapidly. Cattle and pigs did rapidly increase in numbers, however, and could quickly substitute for some of the extinct large ground sloths and large rodents such as *Quemisia gravis*, *Hexolobodon phenax*, *Plagiodontia araeum*. According to Oviedo (1526), large herds of cattle were common on the island in the early 1500s, with an occasional herd of over 8,000 head.

An indication that this "megaherbivore niche" was unfilled at the time of Spanish colonization is demonstrated by the zooarchaeological analysis of Elizabeth Reitz (unpublished manuscript), who has shown that the introduced Spanish cattle very quickly became larger in size, and remained larger in size than similar cattle introduced into Florida at about the same time. The megaherbivore niche was exploited very successfully by free-ranging cattle. The presence of the free-ranging pigs and cattle would have diverted hunting pressure away from the ten remaining endemic terrestrial mammals of Haiti, and is the primary reason why Spanish and French colonists, and the desperate buccaneers, did not rapidly eliminate the remaining mammals, especially the larger size class 2 forms that documented by Oviedo to be good to eat.

The "niche" of the large native mammals was filled by feral cattle, goats and pigs, which may have saved several species of the remaining native land mammals from becoming extinct from over-hunting.

20th Century Causes

Recent hunting. In some areas of the West Indies there is a strong hunting tradition for native mammals. In Jamaica, for example, a number of people in the countryside know how to hunt for the Jamaican hutia (*Geocapromys brownii*), and hunting platforms have been found in Puerto Rico (Woods et al., 1986). Anthony Curtiss, who collected a specimen of *Plagiodontia aedium* in the Miragone region of Haiti in 1947, wrote the "agouti" "is well known to the country people in the region, who have dogs trained to catch it." The 13 specimens of *Plagiodontia* that were collected near Samana Bay in the Dominican Republic in 1923 by Abbott were obtained from an old man who "caught them with dogs in hollow trees down near a lagoon near sea shore." There is no longer a strong tradition of hunting wild mammals in Haiti today, however, with the possible exception of hunting for feral cats. In all of the years we have been searching for endemic mammals in Haiti we have found only one true hunter. In the traditional

manner of the hutia hunters of Jamaica and Cuba, Selem Auguste of Alexandre (west of Jeremie) used two trained dogs ("Blackie and Jaquiso") to run down and locate "zagouties," and a crow bar to pry open crevice in the rocks where the animals were hiding. Selem was a very efficient hunter, and in two weeks was able to capture six live hutias from the mountains west of Jeremie. These animals became a captive breeding colony of *Plagiodontia aedium* at the University of Vermont. Other experienced hunters such as Selem Auguste were present in the past. However, we are confident that as of 1975, there was almost no hunting for wild mammals being done by Haitian peasants. The "zagouti" is so secretive and difficult to catch that few peasants even know it exists.

Predation by Introduced Carnivores. The original mix of endemic mammals in Hispaniola did not include any mammalian carnivores. The herbivores, therefore, evolved without the threat of predation via another mammal, and developed life history strategies based on selective pressures that did not include predation on the ground other than from the Hispaniolan Boa (*Epicrates striatus*). These mammals, therefore, were very vulnerable to introduced predators. In the case of the megaherbivores, the introduced predators were skilled hunters in the form of paleo-indians, followed by Tainos, Spaniards, and buccaneers. However, these human predators did not cause the extinction of the small herbivores and insectivores. At the time of the arrival of Columbus there were ten endemic terrestrial mammals remaining:

Dogs. We know from the account of the "hutia" in Oviedo that dogs hunted and killed hutias. We have collected dog scat along the ridge of the Massif de la Selle between Morne la Visite (2,170 meters) and Morne Tete Opaque (2,269 meters). Three of these collections of dog scat from different regions along the ridge contained bone fragments from zagouties (*Plagiodontia aedium*). Therefore, we can confirm that dogs living in a semi-feral state along the ridge of Morne la Selle do capture and kill hutias. We have collected the remains of five different specimens of *Solenodon paradoxus* that were killed by dogs in the area between Duchity and Pic Macaya in southwestern Haiti. These observations confirm that dogs can easily capture and kill a 1,500 gram hutia. Dogs have been on the island for at least 500 years, since Oviedo reports that the Indians had barkless dogs when the Spanish explorers first arrived. Since Tainos arrived on Hispaniola about 1,000 years before Columbus, it is likely that dogs have filled a semi-feral carnivore niche in the Haitian ecosystem for 1,000 to 1,500 years. If estimates are correct that there were over 1,000,000 Indians on the island when Columbus arrived (and remember Las Casas estimated 3,000,000), then there could have been an enormous number of dogs also.

Original endemic mammals in Hispaniola did not include carnivores. The herbivores evolved without the threat of predation. These mammals, therefore, were very vulnerable to introduced predators.

Cats. Cats have been on the island of Hispaniola since the arrival of Columbus. Cat remains have been recovered from the probable site of La Navidad (Wing, personal communication) indicating that they were part of the first ill-fated Spanish settlement in 1492. The cat may be an even more efficient predator than the dog. There are many feral cats in Haiti. They are secretive and live in even the most remote habitats. We have collected scat from a cat on the summit of Pic Macaya (2,347 meters). So far we have not found any remains of hutias in cat scat, but cats do prey on lizards, birds, mice, and rats. While it is not possible to document the effect of feral cats on native birds and mammals in Haiti, a study has been done on predation by domestic cats in Britain (Churcher and Lawton, 1989). This study documents that 64% of the wild caught food of domestic cats were small mammals, with the remaining 36% being birds. These British small mammals range in body size from that of the Small Island Shrew to the size of Indian and Hispaniolan Hutias.

Based on this study, it is estimated that 140,000,000 birds and mammals are killed each year in Britain, of which 89,600,000 would be small mammals in the

range of body size of the small mammals of Haiti that survived into this century. If we adjust these figures for the differences in size and relative populations of Britain and Hispaniola, then we estimate that death threat to small mammals in Hispaniola from cats could be 8,064,000, and in Haiti alone 2,688,000. While there are many fewer cats in Haiti than in Britain, the impact of Haitian feral cats on small animals must be much greater than the impact of the domestic cats used in the study by Churcher and Lawton, since their cats were also fed normal meals. Cats could have caused the extinction of many small mammals in Haiti. The negative effect of heavy predation by cats on small mammals in Haiti is compounded because the endemic small mammals of Hispaniola were evolutionarily unprepared for predation by any mammalian carnivore, and because the reproductive rates of most endemic mammals were so low. Like the still extant *Plagiodontia aedium*, which has only one young per year, all of the endemic rodents of Haiti are members of the suborder Hystricognatha which as a group have very low reproductive potential (i.e., few young and very long gestation periods).

An example of cats having driven a West Indian land mammal to extinction can be found in the loss of the Swan Island Hutia (*Geocapromys thoracatus*). This hutia was about the size of *Plagiodontia aedium*, and probably had similar habits. It was last seen on Little Swan Island in the early 1950s. A box of cats was released on the island in the late 1950s (Clough, 1970). By the next time the animals were studied in 1960, no Swan Island Hutias were found alive on the island (Stewart, 1962).

Mongooses. The mongoose was introduced into Haiti in about 1895. The animal has spread to all parts of the countryside. My surveys of the mammals of Haiti indicate that they were not present on the higher ridges of the Massif de la Hotte until after 1977. In 1985, we found scat of a mongoose on the top of Pic Macaya, and we live trapped one just below the summit of Pic Macaya (at 2,200 meters). In 1990, there are many mongooses on the 1,000 meters-high Plain of Formon adjacent to Parc National Pic Macaya in southwestern Haiti, one of the most remote and natural regions of the country. We also observed and live trapped mongooses near Morne La Visite (2,170 meters) along the ridge of the Massif de la Selle. One commonly sees mongooses in the countryside all over Haiti. We do not have any direct evidence of a mongoose killing a *Plagiodontia* or *Solenodon*, but mongooses are hyperactive and aggressive carnivores. They are diurnal, while *Plagiodontia* and *Solenodon* are nearly completely nocturnal, which reduces the impact of mongooses on zagouties. The Small Island Shrews and Hispaniolan Spiny Rat were still extant in Haiti into the 1930s, and probably became extinct in the 1940s or 50s. Since their apparent extinction occurred as the mongoose was expanding its range into the zones where the endemics were last known to exist, there may be a cause and effect relationship.

We have seen zagouties killed by dogs in Haiti.

The Pic Macaya, and Morne la Visite-Tete Opaque area of the Massif de la Selle illustrate how carnivores have become a dangerous threat to endemic mammals (as well as other creatures such as ground nesting birds and burrow nesting Black-capped Petrels). Both areas are very high up in the mountains (each above 2,200 meters), and until recently were isolated and well-forested. It is probable that in both areas there were few dogs and no cats or mongooses until after 1955. People moved into these areas in large numbers in the 1950s and 60s in response to the opening of a sawmill by Societe Haitiano-Americaine de developpement Agricole (SHADA). Some were seeking land to clear for seasonal gardens, and in both areas wood cutters were moving in to cut the giant pines for lumber. The typical sequence of exploitation of these remote areas is: first small openings are cleared in the forest, gardens are planted, ajoupas are built for shelter, domestic animals (first dogs and chickens) are kept at the ajoupas, then better built houses with metal roofs appear.

By the late 1970s, there was regular access to both areas, and along with the access and extensive deforestation came rats and mice. The rats and mice are a good food source for cats. Dogs also roam around at night looking for things to eat. As more and more gardens are built, and more land deforested, dogs and cats are brought in closer and closer contact with the habitat of hutias and any other "lost" mammals that might have still been surviving. It was at this stage of the progression that we collected the zagouti remains in the dog scat. During this same period we would encounter dogs on the steep rocky slope of Morne Cabaio (2,282 meters) near morne la Visite. The dogs were hunting along the edges of gardens right at the edge of rock crevices used by *Plagiodontia* for shelter, and adjacent to steep slopes where Black-capped petrels were nesting in burrows.

We cannot document what impact introduced predators have had on the endemic small mammals of Haiti. We can document that dogs do kill *Plagiodontia*, and will eat them. We can prove that they kill *Solenodon*. Predation is likely to have been one of the important factors in the extinction of Island Shrews (*Nesophontes*) and the Spiny rat (*Brotomy voratus*), since their numbers dropped dramatically following the introduction of the mongoose in 1895. We can be sure that these species of small mammals still survived in moderate numbers until at least 1930 because in that year Herbert W. Krieger collected a series of recent pellets from a Barn owl from a shelter under an overhanging ledge on Monte Culo de Maco ten kilometers southwest of the town of Constanza in the Cordillera Central of the Dominican Republic. The recent-looking Barn owl pellets were filled mostly with the remains of *Rattus rattus*, but also contained the remains of all three species of *Nesophontes*, *Brotomys voratus*, and a young *Isolobodon portoricensis*.

Competition. Because so little is known about the life history of either zagouties, and since most of the mammals of Haiti are known from fossil bones, it is difficult to know enough about a species to be able to discuss the possible consequences of competition. In the cases of the endemic "megaherbivores" it is a mute point, since Indians hunted to extinction 11 of the 12 large endemics known to exist in Haiti. The smaller terrestrial endemic mammals appear to have survived until well into the 20th Century. One species was about the size of rats (300-400 grams), and it is possible that competition with rats directly caused the extinction of the Hispaniolan Spiny Rat (*Brotomys voratus*). However, as noted above, *Brotomys* was considered a delicacy by the Indians, and was frequently hunted with dogs. Hunting and predation from introduced dogs and cats probably took a terrible toll. So it is unlikely that the extinction of the spiny rats in Haiti was caused by competiton alone. Rats and hutias currently occupy the same habitat in many areas of Haiti. It is impossible, based on the available data, to determine if rats are forcing the hutias out of the shared habitat. Over the past 15 years, however, populations of *Rattus* and *Plagiodontia* that we have been studying have coexisted without the extirpation of the hutias. In addition, there are areas near small villages where 10-20 *Plagiodontia aedium* occur, and where the colony appears to have been located and stable for decades. Surely rats must have been found in the same places for decades (even centuries). We do not believe at this time that rats are in direct competition with zagouties.

Cats are extremely damaging and kill millions of small birds, mammals and lizards in Haiti each year.

The three small insectivores of the genus *Nesophontes* are probably now extinct, but were still extant as recently as 1930 (Miller, 1930:2). They were once very abundant, since some caves have the remains of thousands of individuals. However, most caves have the remains of only a few individuals. Something was strange about the habits of these creatures. We now believe that the most logical explanation for this is that they lived in the deep leaf litter under heavy forest cover. Owls had a difficult time catching them except after a fire, or after the clearing of land opened up their habitat, and exposed them to predation. Living in deep leaf litter, especially under pine trees, would have protected them from

predation from most forms, and there are still some very remote areas of the island that have extensive areas of this habitat. They should have been protected enough from predation that they would not have been totally extirpated by predation from cats, dogs, and mongooses. If predation alone was driving these creatures towards extinction, we think a few should still survive today. We have not found them, and we have looked hard (Woods, et al., 1986). Therefore, we think that something else must be responsible for eliminating *Nesophontes* from even the most remote pine forests on the mountain tops of the Massif la Selle and Massif la Hotte. We believe that factor was the Norway rat (*Rattus norvegicus*). Norway rats now occur on the tops of Pic Macaya where they burrow through the deep pine needle covered forest floor. They feed on invertebrates, amphibians, and vegetation. They are very abundant in these high mountain habitats. If *Nesophontes* also depended on this type of habitat, then the spread of *Norway rats* would have caused problems for Island shrews if they were forced to compete for food and shelter in the same limited habitat.

Habitat destruction. When one looks at ecological conditions in Haiti, habitat destruction immediately comes to mind as the probable cause for the extinction of many species. The countryside has been largely deforested, and a process of desertification has set in all over the country. The destruction of the forest cover of the country would have compounded all of the problems faced by the endemic mammals. Less forest cover would have made the megaherbivores, and the monkey more vulnerable to predation. Less forest cover also brings dogs, cats, mongooses, and rats into closer contact with the habitat of endemic mammals, and can lead to predation. Less habitat increases the problems associated with competition. So habitat destruction is a general force that increases the negative impact of many other conditions.

One animal that might have become extinct by habitat destruction is the La Hotte Hutia (*Rhizoplagiodontia lemkei*). This mammal would have been about 800 grams in mass, and occurred in the area between Camp Perrin and the upper plateau to Formon. It is known only from this area. The plateau is now completely deforested with the exception of a narrow band of broadleaf forest growing along the edge of the plateau where large blocks of karst have made agriculture difficult. At the time Erik Ekman first visited the Formon area in 1926, the plateau was still largely forested. Many of the specimens of *Rhizoplagiodontia* we have collected came from sinkholes in the center of the plateau where no forest now occurs. We believe the La Hotte Hutia was an arboreal folivore that lived in the tall trees that grew in the deep soils of the Plaine Formon. The species became extinct when the forest was cut, and introduced predators became abundant. This is only a guess, however, based on the abundance to of the La Hotte Hutia in sinkholes, and the extreme destruction of the habitat in the area surrounding these sinkholes.

By the 1970s, both species of rats occurred on the tops of Haiti's biggest mountains, including Pic Macaya. This eliminated the last refuge for small native species like Island Shrews.

We do have some examples of habitat loss leading to the local extinction of endemic mammals. The most noteworthy example is in the case of *Plagiodontia aedium* along the ridge of the Massif la Selle (discussed above in the section on predation). When we first found *Plagiodontia* living in the area in 1977, we were impressed with how many there were. They were living in crevices in the limestone along the ridge where the karst cap formed steep cliffs. There were few gardens along the ridge, and kilometers of suitable habitat. Between 1977 and 1985, the area changed drastically. Most of the large pine trees along the ridge and adjacent plateau were cut down by a government-sanctioned lumber operation. When the logging operation ended and the sawmill closed in 1980, the peasants who had worked in association with the logging project had to seek other sources of income. Many moved out, but some stayed and made seasonal gardens. Other people moved into the region from the lowlands below the ridge. They came up to the ridge to cut and plant gardens. The forest cover was removed by cutting the larger trees down, and burning the hillsides. The *Plagiodontia*

habitat was more and more fractured into small blocks. It was during this phase (1985) that we found the remains of *Plagiodontia* in dog scat. We also found a dead *Plagiodontia* at the edge of a new garden near its home in a rock crevice on the ridge above. We had been studying this animal for a week, and were stunned to see it dead. It was killed that morning by a peasant clearing brush along the edge of the garden, who had seen the animal in the half light of dawn and slashed at it with his machette. That dead *Plagiodontia* was the last live zagouti we saw in the area. An area with more than 20 zagouties in 1980 is now without any. What had killed them all? Predation killed some of the animals. Competition with humans for space killed at least one, since the peasant did not kill it for food but rather to get the pest out of his garden. But, in the end it was habitat destruction. Habitat destruction is the root of the evil that haunts all of Haiti, and is the driving force behind the extinction of many of the endemic mammals discussed above.

The reason that habitat destruction has been tolerated by government officials and policy makers in Port-au-Prince is not only because of the usual explanations, which are: 1) the government is corrupt, and officials are primarily interested in increasing their own wealth during the brief time they are in a position to milk the system ("pize-suce" or "squeeze and suck"); 2) the elite view a concern for the environment as going back to their roots as peasants or slaves, which that are anxious to erase from their memories; 3) policy makers seldom get into the provinces, which are especially remote because of the bad highway system of the country, and are therefore unaware of the extent of the habitat destruction. The reason also lies in the lack of an understanding or appreciation of the natural fauna of Haiti. A well-educated person in Haiti would have learned about lions, tigers, and even the duck-billed platypus, in school, but would be almost totally unaware of the sloths and monkeys that once live in Haiti, much less the zagouti and nez long that still live there. Culture and education at higher levels in Haiti, have been imported from the Old World and North America. This is even apparent in the beautiful paintings of wild mammals that are for sale in Port-au-Prince. They are spectacular visions of lions, leopards, tigers, elephants, zebras, etc. It is not a surprise that so little effort is being made to conserve the endemic mammals of Haiti when there is such a limited awareness that these mammals even exist.

Concluding Thoughts

To end this review of the mammals of Haiti on a sour note would be most inappropriate, however. The mammals of Haiti have been devastated by the events of the past 500 years, but they are not all gone. Two of the most interesting terrestrial mammals still survive, the "zagouti" and the "nez longe." Manatees still occur along the coast of Haiti, and the bats of the countryside are still abundant. And pigs are being reintroduced to the country. Like so many things in Haiti, where there is a will, there is a way. Currently the French government has a project to breed and distribute "Creole Pigs." These black pigs are bred from Martinique pigs. They have a few of the attributes (and genes) of high-tech pigs, but are small, black, and easy to care for. They look like the pigs the Haitians "lost" in 1983. These pigs are now being distributed back into the Haitian countryside as part of the Macaya Biosphere Reserve Project. The high value that peasants place on these pigs is best illustrated by the events of Hurricane Gilbert which swept through southwestern Haiti in 1988. Many cows, sheep, and goats were killed by the hurricane, and most chickens in the region were blown away. But not one of the newly-distributed pigs was lost. The peasants know that the new Haitian black pig is their hope for the future, and they protected their pigs in every way that they could. This mammal, and its role in the Haitian web of life, might just be the best hope for a stable economic and ecological future in

Deforestation not only eliminates critical habitat for species, but also leads to the spread of dogs, cats, mongooses and rats into an area.

rural Haiti. The reintroduction of the "Creole Pig" is one of the most important strategies around which the Macaya Biosphere Reserve Project is being built. This Beast of the Haitian Hills is the link between the past and the future, the natural and the supernatural, and conservation and survival for man and beast alike.

Summary and Conclusions

1). A large number of endemic terrestrial species from four orders of terrestrial mammals were present in the West Indies (92), with 25 of these species restricted to Hispaniola just before Indians immigrated into the region.

2) The large number of Indians (at least 1,000,000 in Hispaniola alone, and as many as 5,850,000 throughout the West Indies; see Watts, 1987:74) at the time of the arrival of Europeans in 1492 had led to the extinction of all but one (94%) of the large endemic forms ("megaherbivores").

3). Unlike the "Pleistocene overkill" of North America, the loss of the "megaherbivores" in Haiti appears to have been a long slow process of attrition from over exploitation.

4). Medium-sized native mammals in Haiti were only moderately impacted by the activities of the Indians.

5). Small native mammals in Haiti were not impacted by the activities of the Indians, or the presence of the barkless dog.

6). Hunting by French and Spanish colonists, and especially by the buccaneers, did lead to the extinction of the one remaining large herbivore in Haiti, but hunting pressure was mainly concentrated on wild pigs and cattle which prospered in the void left open by the extinction of the native "megaherbivores".

7). The most negative impact on the native mammals of the Haiti was the introduction of non-native species, especially the dog and the cat (and penultimately, the mongoose).

8). Most small mammals (small insectivores and rodents less than 400 grams in mass) survived in Haiti until at least the last 100 years.

9). The extinction of the small native mammals in Haiti was probably not the result of a single factor. The following combination of factors resulted in the rapid loss of the small native Haitian mammals in a brief period of several decades.

The Zagouti may have become extinct in Parc National La Visite during the last decade.

(a). The mongoose played a major role in causing extinctions, since the rate of loss of small mammals accelerated after its introduction in the late 1800s.

(b). Competition from introduced Norway and Black rats was also a contributing factor in causing the extinction of small native species, especially competition from the burrowing Norway Rat (after 1700).

(c). Predation from dogs and cats became more severe (as did all of the preceding factors) following the fragmentation of habitat and the expansion of gardens and habitations into the most remote areas of the mountains, such as in the Macaya area after the Second World War.

(d). The "final niche" that was the most resistant to the many damaging consequences of the human invasion into remote regions of Haiti was that occupied by medium-sized mammals (1,000 to 1,500 grams) which find shelter in rock crevices. This is because medium sized mammals are too large for predation by the mongoose and cats, and at the same time too small to be of great food value to humans. Theyn are also able to use rock crevices for shelter from dogs, and are able to utilize a habitat that is one of the last to be exploited for gardens and fuelwood by humans. In the Macaya area, such conditions are met in the Rak Bois forest along the edge of Plaine Formon and Plaine Durand, as well as the eastern foothills of the Massif de la Hotte between Catiche and Pic Macaya.

The creole pig has been reintroduced into the Macaya area. This strategy may help save habitat and lead to the survival of the remaining endemic land mammals.

TABLE 12

Complete List of the Mammals of Haiti

Taxon	Common Name	Status
EDENTATA		
Megalonychidae		
Parocnus serus	Large Ground Sloth	Extinct Endemic
Synocnus comes	Small Ground Sloth	Extinct Endemic
Gen. sp A	Huge Tortue Ground Sloth	Extinct Endemic
Gen. sp B	Big Tortue Ground Sloth	Extinct Endemic
Gen. sp C	La Hotte Ground Sloth	Extinct Endemic
Gen. sp D	Tree-climbing Ground Sloth	Extinct Endemic
INSECTIVORA		
Solenodontidae		
Solenodon paradoxus	Giant Island Shrew "Nez long"	Endangered Endemic
Solenodon marcanoi	Marcano's Solenodon	Extinct (?) Endemic
Solenodon sp.	La Hotte Solenodon	Unknown Endemic
Nesophontidae		
Nesophontes hypomicrus	Haitian Island Shrew	Extinct Endemic
Nesophontes paramicrus	Big Haitian Island Shrew	Extinct Endemic
Nesophontes zamicrus	Small Haitian Island Shrew	Extinct Endemic
PRIMATES		
Cebidae		
"*Saimiri*" *bernensis*	Hispaniolan Monkey	Extinct Endemic
Callitrichidae (?)		
incertae sedis	Miller's Unknown Monkey	Extinct (?) Endemic (?)
RODENTIA		
Capromyidae		
Plagiodontinae		
Plagiodontia aedium aedium	Haitian Hutia "Zagouti"	Endangered Endemic
Plagiodontia aedium hylaeum	Dominican Hutia "Jutia"	Endangered Endemic
Plagiodontia spelaeum	Small Hutia	Extinct Endemic
Plagiodontia araeum[1]	Narrow-toothed Hutia	Extinct Endemic
Plagiodontia ipnaeum[2]	Large Hutia	Extinct Endemic
Plagiodontia velozi	Oviedo's Hutia "Quemi" or "Comadreja"	Extinct Endemic
Rhizoplagiodontia lemkei	La Hotte Hutia	Extinct Endemic
Isolobodontinae		
Isolobodon portoricensis[3]	Indian Hutia	Extinct Endemic
Isolobodon montanus	Mountain Hutia	Extinct Endemic
Hexolobodontinae		
Hexolobodon phenax[4]	Even-toothed Hutia	Extinct Endemic
Hexolobodon sp	La Hotte Hexolobodon	Extinct Endemic

Taxon	Common Name	Status
Family *incertae sedis*		
Heptaxodontinae		
Quemisia gravis	Hispaniolan Giant Hutia "Quemi"(See above)	Extinct Endemic
Echimyidae		
Heteropsomyinae		
Brotomys voratus	Hispaniolan Spiny Rat "Muhoy"	Extinct Endemic
Brotomys contractus	Saint-Michel Spiny Rat	Extinct Endemic
Caviidae		
Cavia porcellus	Guinea Pig "Kochondenn"	Domestic Introduced
Muroidea		
Rattus rattus	Black Rat	Very Common Introduced
Rattus norvegicus	Norway Rat	Common Introduced
Mus musculus	House Mouse "Sourit"	Common Introduced
CARNIVORA		
Viverridae		
Herpestes javanicus[5]	Small Indian Mongoose "Woulong"	Common Introduced
Felidae		
Felis silvestris catus	Feral Cat "Chat Mawon"	Common Introduced
Canidae		
Canis familiaris	Domestic Dog "Chen"	Common Introduced
PINNIPEDIA		
Phocidae		
Monachus tropicalis	West Indian Monk Seal	Endangered or Extinct West Indies
SIRENIA		
Trichechidae		
Trichechus manatus	Manatee	Rare Caribbean Basin
CETACEA		
Delphinidae		
Globicephala macrorhynchus	Short-finned Pilot Whale	Rare
Tursiops truncatus	Atlantic Bottlenosed Dolphin	Rare
Stenella plagiodon	Atlantic Spotted Dolphin	Rare
Delphinus delphis	Common Dolphin	Rare
Steno bredanensis	Rough-toothed Dolphin	Rare
Physeteridae		
Physeter ma crocephalus	Sperm Whale	Rare

Taxon	Common Name	Status	
CHIROPTERA			
Noctilionidae			
Noctilio leporinus mastivus	Greater Bulldog Bat	Uncommon	GA,LA,CA,Mx
Mormoopidae			
Pteronotus (Chilonycteris) fulginosus fulginosus[6]	Sooty Moustached Bat	Uncommon	H,Ja,PR
Pteronotus (Phyllodia) parnellii pusillus	Parnell's Moustached Bat	Uncommon	Endemic
Pteronotus (Phyllodia) parnellii gonavensis	La Gonave Moustached Bat	Extinct	Endemic
Mormoops blainvillei	Antillean Ghost-faced Bat		
Mormoops megalophylla	Large Ghost-faced Bat	Extinct	NA,CA,WI
Phyllostomidae			
Macrotus waterhousii waterhousii	Waterhouse's Leaf-nosed Bat	Common	H,sBa,PR
Monophyllus redmani clinedaphus	Leach's Long-tongued Bat	Common	H,sBa,Cu
Artibeus jamaicensis jamaicensis	Jamaican Fruit-eating Bat	Common	H,Ja,PR,LA
Phyllops haitiensis[7]	Haitian Fruit-eating Bat	Common	Endemic
Brachyphylla nana	Antillean Fruit-eating Bat	Uncommon	H,Cu,Caicos
Phyllonycteris poeyi obtusa	Haitian flower Bat	Uncommon	Endemic
Erophylla bombifrons santacristobalensis	Hispaniolan Brown Flower Bat	Uncommon	H,PR
Natalidae			
Natalus major[8]	Hispaniolan Funnel-eared Bat	Uncommon	Endemic
Natalis (Chilonatalus) micropus micropus	Small-footed Funnel-eared Bat	Uncommon	H,Ja,Ba
Vespertilionidae			
Eptesicus fuscus hispaniolae[9]	Hispaniolan Big Brown Bat	Common	H,Ja
Lasiurus borealis minor[10]	Small Hairy-tailed Bat	Uncommon	H,Ba,PR
Molossidae			
Tadarida brasiliensis constanzae	Haitian Free-tailed Bat	Common	Endemic
Tadarida macrotis[11]	Big Free-tailed Bat	Uncommon	NA,Mx,GA
Molossus molossus verrilli	Hispaniolan Pallas Mastiff Bat	Uncommon	Endemic

[1] Includes *Hyperplagiodontia stenocoronalsis*
[2] Includes *Plagiodontia caletensis*
[3] Includes *Ithyodontia levir*
[4] Includes *Hexalobodon poolei*
[5] (= *Herpestes auropunctatus*)
[6] (Koopman, 1989) = *Pteronotus quadridens*
[7] (Koopman, 1989) = *Phyllops falcatus* of Cuba + *P. haitiensis*
[8] (Koopman, 1989) = *Natalis stramineus*
[9] (Koopman, 1989) = *Eptesicus serotinus*
[10] (Griffiths & Klingener = *Lasiurus minor*
[11] (Koopman, 1989) = *Nyctinomops macrotis*

CHAPTER VI

SPECIES RECOVERY PLANS

Introduction

This chapter presents "Species Recovery Plans" for three endangered species in Haiti. The first and most important recovery plan is for the "living fossil" of Haiti, the Giant Island Shrew of the genus *Solenodon*. This genus represents the most endangered, and the most important remaining terrestrial mammal in Haiti, and is one of the most significant parts of the natural patrimony of the country. The extinction of Solenodons in Haiti would not only be a tragedy for Haiti, but a loss of one of the most unusual and important mammals in the world. These animals are well known to scientists and natural resource specialists all over the world.

The other species recovery plans are for two bird species. The Black-capped Petrel nests in the high montane forests of the Pic Macaya, and along the high steep ridge of the Massif de la Selle. The species is extinct almost everywhere else in its original range in the West Indies, so the two populations in Haiti are of enormous importance. Since these birds nest in exactly the same habitat that is critical for the generation of water for the downslope watersheds, and are threatened by the same phenomena that lead to massive soil erosion and the loss of water in springs, streams and rivers, their status is a good indication of the status of steep mountain slopes and nearly vertical cliffs in the mountains of Haiti. The other bird species for which a recovery plan is presented is the White-winged Warbler, the rarest and most endangered bird in Haiti. This species is found in montane forests. In a real sense, the White-winged Warbler is an indicator species

for biodiversity in the mountains of Haiti. When and if this species becomes extinct, then it could be argued that the montane community of plants and animals is only one step behind, along with the soil and water conservation potential of the country as a whole. So, the White-winged Warbler is one of the species we think should be carefully monitored and protected. As goes the White-winged Warbler, so goes Haiti.

The three species recovery plans presented in this chapter are the beginning of a series of species recovery plans that will be written for endangered plants and animals throughout Haiti, but with an emphasis on areas like Macaya. The concept of species recovery plans is discussed in detail in *Stewardship Plan for the National Parks and Natural Areas of Haiti* (Woods, Sergile and Ottenwalder, 1992). All species recovery plans follow a standard format, and need to include very specific information. There may be some overlap of information between the discussions in sections of these recovery plans and the in-depth discussions of birds and mammals in Chapters IV and V.

Solenodon Recovery Plan

Summary

The Massif de La Hotte *Solenodon* Recovery Plan outlines steps for recovery of *Solenodon paradoxus* throughout its historical range in the Macaya-Duchity region. Fossil evidence suggest that *Solenodon* was widely distributed in south-western Haiti. At present, the future looks bleak for Massif de la Hotte population. This species is likely doomed to extinction within the next few decades due to: 1) accelerated destruction of the reduced amount of habitat available; 2) heavy predation from exotic carnivores; 3) exploitation for food by Haitian peasants; 4) increasing reduction of range and isolation; and 5) a small population size, compounding intrinsic factors in the biology of the species (demographic, environmental, and genetic stochasticity). No living populations are known inside protected areas, nor is a captive colony known to exist anywhere. Under the present circumstances, aggravated by the lack of programs to protect the species in Haiti and of educational campaigns that might call attention in Haiti to the plight of the animal, timely conservation action will be required to prevent their extinction.

The goals for the Massif de La Hotte *Solenodon* Recovery Plan are to:

(1) Determine the location of existing populations and their habitats;

(2) Establish a wildlife reserve to protect and secure a viable population of Massif de La Hotte Solenodons, and a portion of their habitat in the Duchity area; and

(3) Reduce mortality due to predation by humans and exotic mammals.

The goal is to improve the status of Solenodon in southern Haiti from Endangered to threatened within 15 years.

The general objective of this conservation action plan is to reduce the status of the Haitian *Solenodon* from "Endangered" to "Threatened" within a 15-year period. Lack of available information on this secretive nocturnal mammal precludes formulation of a quantitative recovery level. Therefore, it is suggested that a comprehensive population survey and ecological study of the species be conducted prior to defining a recovery level for this endemic West Indian insectivore.

Introduction

Solenodons (Mammalia: Insectivora: Solenodontidae) are endemic to the Greater Antilles and are the most ancient representatives among the known native mammals of the West Indies. They are true "living fossils." In their radiation, West Indian insectivores attained two genera and at least 12 species, of which all but two forms are now extinct. The genus *Solenodon*, restricted to the islands of Cuba and Hispaniola, contains the only extant members of the group in the region: *Solenodon cubanus* in Cuba, and *S. paradoxus* in Haiti and the Dominican Republic (Hispaniola). Their surviving populations are relictual in distribution, and have been considered threatened for many years. In fact, the Hispaniolan Solenodon was considered extinct at the time Verril (1907) visited Santo Domingo, where he obtained three specimens after a five-month search. Similarly, the Cuban Solenodon was also believed extinct (Harper, 1945; Crandall, Bridges, 1958) until its rediscovery during the 1970s (Silva Taboada, 1974; Varona, 1974, 1980, 1983).

As early as 1942, the two species were already included in the first inventory of endangered mammals, *Extinct and Vanishing mammals of the Western Hemisphere*, published by the American Committee for International Wild Life Protection (Allen 1942). *Solenodon paradoxus* and *S. cubanus* have been consistently listed as endangered by IUCN since 1966 (IUCN Mammal Red Data Book, 1966-1978; Thornback and Jenkins, 1982). They have been listed for protection under the USFWS's Endangered Species Act (ESA) since 1970 (Estes and Sessions,1983; USFWS, 1987).

Solenodon have been considered the rarest and most endangered of all insectivores (Poduschka, 1977), and both species were included by Thornback (1983) among the mammal species with higher priorities for needed action to prevent extinction. More recently, the Cuban and Hispaniolan Solenodons were selected among the 1986 IUCN/Species Survival Commmission's "Top Twelve" list of endangered animals of the world (IUCN/SSC *Species*, 1987; ITSES, 1987). For an update of their conservation status see Ottenwalder (1985, 1991).

The Hispaniolan Solenodon (*S. paradoxus*) has been recently found to comprise up to three geographic populations throughout the Dominican Republic and Haiti, as a result of geographic isolation due to island fragmentation and further subspeciation (Ottenwalder, 1991).

The results of this study suggest that the population from the Massif de la Hotte might represent a separate lineage from the closely-related populations of northern Hispaniola and southwestern Dominican Republic. Furthermore, the population from La Hotte, southwestern Haiti, is also the only known surviving population of *Solenodon* in Haiti today (Ottenwalder, 1991).

Solenodon is considered one of the most endangered mammals in the world by most authorities.

Description

In Haiti, *Solenodon* is generally known by the name "Zagouti" (most commonly used), but might also be called "Nez Long" (locally). It is important to point out that the endemic rodent *Plagiodontia aedium* is also known as the "Zagouti."

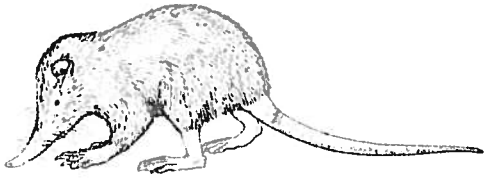
The population from the Massif de La Hotte has been distinguished from the other Hispaniolan (and Cuban) populations in cranial, dental, and post-cranial characters (Ottenwalder, 1991). According to the measurements analyzed is this study, the southwestern Haiti population is closely related, but not identical, to the slightly smaller populations from southwestern Dominican Republic, and to the larger populations from northern Dominican Republic (= North Hispaniola). A detailed description and comparison of the different Hispaniolan

populations will be published elsewhere (Ottenwalder, MS). The range of genetic distances separating the three geographic populations, which appear to occur allopatrically, is yet unknown.

Live individuals of the Haitian population have not been available for examination and description of external features. However, overall appearance other than size (i.e., coloration), is probably similar for all surviving Hispaniolan populations. No other Hispaniolan mammal, native or introduced, could be confused with, or resembles *Solenodon*. Solenodons are among the largest members of the Insectivora. In breeding adults, weights range between 620 and 1,166 grams for males and females combined. Total length range between 470 and 715 mm. The population from the Massif de La Hotte, which might represent a different lineage from the other Hispaniolan populations (Ottenwalder, 1991), and for which no weights or external measurements are known, is expected to be in the lower range of mass and body length, closer in proportions to populations from the southwestern Dominican Republic.

The general form of the body is that of a large shrew--round and stout. The long tapering snout is quite extended beyond the nasal bones and bare at the tip, with nostrils opening laterally. The skull is elongated, with a somewhat tubular rostrum. The foreclaws are well developed, and comprise part of the animal's burrowing adaptations. The eyes are small, the ears are relatively large, but visible above the pelage. The tail is long and stout, only sparsely haired and almost naked. Sexes are not be readily distinguished by the untrained observer. In females, the mammae--a single pair--have an inguinal position. In males, the penis is retractable and the testes abdominal.

While the canines are small, the first upper incisor is greatly enlarged and is opposed by the also enlarged second lower incisor. Thus, the anterior dentition is composed of an enlarged pair of upper and lower incisors, opposed in forceps-like fashion. These teeth are separated from the enlarged last premolar and molars by unicuspid teeth, a feature which is decidedly shrew-like. The second lower incisor is remarkably specialized by the presence of a deep and rather broad groove, at the base of which ends the duct of the large submaxillary glands. The function of this groove is to conduct toxic saliva into a wound on prey, predators, or adversaries.



The smaller Solenodon from the Massif de la Hotte might be a new species, distinct from the larger *Solenodon paradoxus*.

The body hair is long and coarse dorsally, becoming finer and slightly crinkled on the sides. The sides of the snout have about a dozen large vibrissae (measuring up to 70 mm), and and shorter, coarser surrounding hairs that are tactile as well. One to three vibrissae are also present midway between the eye and the mouth, and on the midline of the chin below the angle of the mouth. Two types of hair are readily distinguished on the back: shorter and finer hairs are abundant, while longer and coarse hairs are scattered and arranged in single rows.

Color varies from buff to blackish or reddish, usually black or dark brown on the dorsal surface of the head, while the ventral surface is buff colored. A whitish nuchal spot is frequently present. The black-tipped hairs extend over the mid-dorsal area of the back to the rump and are intermingled with pale, buff-colored hairs, giving a grizzled effect. Ventro-laterally from the median line, there is a transition from black to buff hairs on the sides of the body, and on the forearms the color varies from a clear buff to a cream buff. The color on the sides extends ventrally from the abdominal region to the upper part of the chest, where it passes into a deep ferruginous color, almost chestnut, over the ventral surface of the throat, upper chest, bases of the forelimbs and dorsally to the sides of the neck. The inguinal region is also ferruginous in color. Individual variations in color patterns are mainly due to variations in the intensity of the pigments.

Life History

Activity patterns. Solenodons are decidedly nocturnal, and only occasionally crepuscular or diurnal in activity (Ottenwalder, 1991). Peasants have reported encountering Solenodons at times during daylight hours.

Habitat. There is little information on the habitat of Solenodons in Haiti. In the Dominican Republic, they are found in limestone areas with different life zones and plant communities; at elevations more often between 500-1,500 meters but ranging from sea level up to 2,000 meters; usually on steep terrain; and on fine-textured, well-drained, lithic, moderately permeable, and non-flooding soils.

Annual average mean temperature in 15 *Solenodon* localities recorded was 24.8^0 C. Annual average mean rainfall, for the same locality sample, was 1520.8 mm (Ottenwalder, 1985). Subtropical moist forest habitats at mid elevations characterized by hilly terrain, karst topography or rolling plains, with abundant limestone outcrops, and discrete soil accumulations are among the most consistent shared features of *Solenodon* habitats.

Limestone topography, perhaps the most uniform environmental element, though not necessarily the best factor to diagnose presence if used alone, appears to represent the single most important feature that can be used to predict persistence of populations. Among other advantages, limestone formations offer abundant solid shelters that provide effective protection against predators, buffer extreme climatic conditions, and contribute a rich mineral source for soil invertebrates.

Feeding habits. Solenodons are food generalists and opportunistic predators of the forest floor. They feed on leaf litter and soil macrofauna, primarily arthropods (including groups with chemical defense mechanisms such as scorpions, centipedes, and diplopods), land snails, and small terrestrial vertebrates (lizards, skinks, snakes, frogs, birds) and their eggs.

Predation. Native predators include large Hispaniolan boas (*Epicrates striatus*), and perhaps Stygian (*Asio stygius*) and Barn owls (*Tyto alba*). Pressure from natural predators is presumably low and buffered by the security of their burrows, though they might be likely exposed to predators in foraging trips at early age, and during subadult dispersal. In contrast, predation from exotic mammals, particularly dogs, is one of the known major causes of mortality, and therefore, for their decline. Other introduced carnivores suspected to have considerable negative impact on *Solenodon* are cats and mongooses.

Limestone topography, especially karst, is very important to Solenodons, and is the single most important feature that can be used to predict the presence of this species.

Behavior. The behavior of *Solenodon* was described in some detail by Eisenberg and Gould (1966) using captive animals. Although Solenodons are strictly nocturnal in activity, they might occasionally wander outside of their burrows for brief periods during daylight hours to defecate, urinate, or scratch. They avoid bright lights, which might explain why they are only observed above ground during the day when it is rainy or cloudy. *Solenodon* digs burrows under limestone boulders, large trees, dead stumps or directly into the ground on slopes. They might also take advantage of existing crevices in large limestone formations or inside hollow stumps on the floor. Nest chambers and tunnels are interconnected under the ground and leaf litter, forming in some cases an extensive and complex burrow system. They are usually found in family groups of three, or just the adult pair alone. Solenodons huddle together during sleep, one crawling over the other. When alone, a Solenodon sleeps on its side curled in a semicircle.

During exploration, the animal moves slowly, pausing to assume an elongated posture with one forepaw raised off the ground, and sometimes, an upright posture with both forefeet off the ground while the head is moved in all directions. They move with a slow walk, using a extension limb synchrony, however they can

run surprisingly very fast when disturbed, using a quadrupedal ricochet, with forelimbs and hindlimbs alternately striking the ground. They are poor climbers. Known paths are used in a stereotypical fashion. Solenodons generally flee if disturbed or startled by a sudden motion or sound; the flight response is in the direction of the borrow. They are, however, out-competed by the much faster introduced carnivores, such as dogs and cats, against which Solenodons have few defenses.

The hind feet are used to scratch almost the entire body, while the tongue and teeth are used to clean the flanks. Their demand for water is quite pronounced. In captivity, animals drink extensively after arousal and also after feeding. While searching and capturing food, the animal moves about with its nose to the ground, sniffing and poking it into any crack or under any object. Cracks and interfaces are sniffed thoroughly, and the long, flexible snout is inserted in all available niches. If a prey object is touched with the nose, the animals simultaneously extends its forepaws on either side of the prey while sliding its head forward, and capturing the prey with its mouth. The forepaws are also used to dig in the soil and rotten logs. The prey is located by tactile, olfactory, and auditory stimuli. During foraging, the snout is moved constantly; its great mobility maximizes the search area as the animal moves along. *Solenodon* scent mark with feces and urine. In addition, they have pronounced glandular areas on the ventral, axillar and lateral areas of the body; however, their function in chemical communication is not yet well understood.

Vocalizations. Solenodons produce a diversity of sounds: chewing sounds, digging sounds, walking-runing sounds, puffs (sharp exhalation to clear nasal passages), piffs (explosive variation of "puff" sound), and coughs, which are produced with sudden exhalations through the throat. Five distinct vocalizations have been identified: a) the "twitter," a sound of uncertain significance, is produced during situations of excitement, b) the "chirp" is a single, forceful note given during defensive postures, c) the "soft squeak" is repeated in burst of two or three notes during encounters between familiar animals, d) the "squeal" is a long, high-pitched sound produced during fights, and e) the "click" is a sharp, high-pitched sound produced during exploration of a novel area or when initially encountering a strange animal; it resembles the echolocation pulses of shrews.

Reproduction. *Solenodon* exhibit a pattern of very low fecundity. The breeding season extends throughout the year. The gestation lasts in excess of 90 days and, as a rule, only one young is born. Females probably average two litters and two young per year. Newborns are large, naked, and require extensive parental care. Sexual maturity is attained between 12-18 months of age. The low reproductive output is matched to a rather long life span of up to 12 years.

Solenodons can live as long as 12 years. Females have a single young, and can breed twice each year.

Status and Distribution

Fossil and Historical

Little information is known of the past distribution of *Solenodon* in Haiti (Woods, 1975, 1981, 1986; Ottenwalder, 1985, 1991), probably because the animal was never common or attained high densities. At least some of the museum specimens collected in the 1800s and early 1900s, labelled as of "Haiti," "Santo Domingo," or "Hispaniola," must have originated from Haitian territory.

Northern Haiti. Its previous presence in northern Haiti is only known from a few limb bone fragments found in a Late Pleistocene caves deposit in San Francisco, St. Michel de L'Atalaye (FLMNH-VP Collection). In Gonave Island (probably more related zoogeographically to southern than northern Haiti), its

previous existence is suggested by a single lower molar collected at a Late Quaternary cave deposit (FLMNH-VP).

Southern Haiti. It is in southern Haiti where most past and recent search efforts have taken place, and from where most past records are known. Fossil, subfossil, and post-Columbian remains have been recovered from several caves in the Massif de La Hotte and in La Visite, Massif de La Selle (Woods, 1986, 1989; Ottenwalder, 1991; FLMNH-VP Collection). A carcass was reportedly found by Sanderson (1939) in 1937 near Fonds Parisiens, on the south shore of the Etang Saumatre. Although a rather marginal habitat for *S. paradoxus*, the locality is at the foothills of the northern slopes of the Massif de La Selle, where *Solenodon* was known to occur at higher elevations in the recent past.

Present: (1975-1992)

After searches in the 1970s covering "all regions" of the country, *Solenodon* was considered by Woods (1981) "functionally extinct in most of Haiti." There is no data on *Solenodon* numbers, and no censuses have ever been conducted. Woods (1982) found it "widespread in the mountains of southern Haiti," but later estimated (Woods, 1983) that "fewer than 100 individuals survived" (in the remote mountains of southern Haiti), concluding it was in imminent danger of becoming extinct. Results of these surveys, including the fresh remains of about 35 animals and reports of observations, indicate that today the only known surviving population in Haiti is restricted to the northeastern portion of the Massif de La Hotte, on the southwestern end of the country.

Massif de La Hotte's vestigial population is apparently confined to a 5-10 mile radius around the town of Duchity, a region with dense human populations and highly disturbed remaining forest patches, including Catiche and Plaine Martin to the south, Raymond and Cadet to the southwest, and Durand to the north. Although no evidence of living populations has been established in Macaya, the possibility exists that *Solenodon*, whose present-day populations are elsewhere characterized by a fragmented distribution (Ottenwalder, 1985) might still persist somewhere in the Formon-Macaya area. *Solenodon* is also apparently extirpated in the Massif de La Selle. More often, people inhabiting an area with persisting *Solenodon* populations are unaware of their existence, even if the area has long been under exploitation for agriculture and pastoralism. It is also possible that their range in the Duchity region extends as far north as to the coastal area between Corail and Pestel.

The Solenodons of the Macaya region may be restricted to a 5-10 mile radius around the town of Duchity.

Causes for Decline

Habitat destruction, predation by dogs, and presumably other exotic predators such as cats and mongooses, and indiscriminate killing and exploitation for food by man are the primary causes for the extirpation and decline of *Solenodon* populations in Haiti.

The situation of *Solenodon* in the Massif de La Hotte, intrinsically aggravated by its own relictual condition, is not different. Despite the isolation of the Duchity area, the human population is high, and depends on traditional agriculture and forest harvest methods. Here, Solenodons are killed and eaten when encountered, by both people and by feral dogs. Signs of cooking and cutting blades are noticeable in the bones of animals examined from that area. Because of the low densities of Solenodons, exploitation for food in the Duchity area is likely only opportunistic rather than a sustained hunting activity. Hunting methods used by Haitian peasants include the use of dogs for detecting and capturing animals

during nocturnal activity, the use of smoke in potential burrows during the day, and more commonly, the killing of the animals by peasants with sticks or rocks any time they are seen.

Conservation Efforts

Legislation. In Haiti, *Solenodon* is not protected by any legislation, and native mammals are not covered by existing wildlife regulations. The manatee (*Trichechus manatus*), the zagouti (*Plagiodontia aedium*), and *Solenodon* were mentioned in a list of about 50 animal species considered "threatened and in need of protection in Haiti," prepared by the Ministry of Agriculture (MARNDR), but this list has not been granted legal consideration. Furthermore, The Haitian Ministry of Agriculture has suffered great institutional instability during the past administration. As a result, its role as the government wildlife authority and wildlife enforcement agency appears to be presently in much disarray. Despite any well-intentioned efforts, effective enforcement by the government wildlife office in Haiti is hampered by insufficient material and human resources, a reflection of the poor political support natural resource management policies have in the country.

Protected Areas. No living populations are known inside protected areas in Haiti. Pic Macaya has been considered one of the strongholds of *Solenodon* in Haiti (Woods, 1982). However, no extant populations have yet been found inside the current boundaries of either one of the two existing and/or proposed protected areas of southern Haiti: National Park Pic Macaya, and National Park La Visite (Woods, 1986). In the Macaya region, the most likely *Solenodon* habitats have been already devastated (i.e., Les Platons 635 meters, Sous Bois 970 meters). To a lesser extent, the same is true for the Duchity region (i.e., Catiche, Plaine Martin) (see photograph, page 174).

An imposing number of human disturbances, incompatible with the national park criteria, threaten the integrity of existing habitats and wildlife inside protected areas in Haiti (Table 13) (Ottenwalder, 1991). Some fragments of the highland (usually pine-dominated) vegetation communities, are still at a stage of recovery. However, a great portion of the lower-lying broadleaved forest zones, which are of greatest importance to *Solenodon*, have been destroyed or altered.

No live Solenodons have ever been found within the present boundaries of Parc National Pic Macaya, so it is very important to expand the park to include the area where Solenodons are known to occur near Duchity.

Slash and burn, steep-slope crops farming, fuel wood harvesting, and free-ranging livestock ranching have cleared the natural vegetation off mountain slopes. Deliberate burning has damaged an extensive area of pine forest on the north slopes of Pic Macaya; several years after the fire, this area shows little sign of regeneration. Continued disturbance hinders the recovery and regeneration of cleared areas. The high elevation habitats left inside the parks had remained relatively undisturbed until the early 1960s because of their remoteness and lack of access roads. However, several new roads that lead into the Formon Plateau and Des Barrieres areas are now in use or are under construction from Les Platons, Duchity and Beaumont.

Problem Analysis and Recovery Strategies

Successful recovery of *Solenodon* requires resolution of problems at a number of levels, beginning with their effective detection in the wild. As often happens in conservation biology and wildlife management, uncertainty pervades the recovery process but should not impede it (Soule, 1986). Decision-making can be improved and uncertainty reduced by modeling the variability surrounding complex decisions (risk assessment), designing actions as experiments (to identify

casual relationships), using available natural history data (including knowledgeable individuals and extensive literature reviews), identifying cumulative effects of activities (Orians et al., 1986), and considering the cost-effectiveness of alternative recovery options. Strategies which offer the most solid conservation action, sustained stability over time, and lowest future maintenance cost should be given the highest priority.

Finding and Monitoring Solenodons

The difficulties of conducting field work in Haiti have been pointed out by a number of researchers. Adequate planning should be made in advance to prevent obstacles to the program. The ongoing University of Florida's Macaya Biosphere Reserve Project, now continuing with financial assistance from the MacArthur Foundation, offers an excellent infra-structure for the development and implementation of the recovery plan.

Some guidelines for conducting *Solenodon* searches, developed during surveys conducted in the Dominican Republic between 1973-1982, were described by Ottenwalder (1985). These methods should be utilized and refined. Saturation-extensive ground-truth surveys are extremely useful during the initial stages of the search. The use of interviews in areas suspected (or not) to support populations of Solenodons, is fundamental for the surveys, and their contribution should not be underestimated. Reconnaissance of every single site from where specimens and confirmed or unconfirmed reports are known should be carried out. Detailed observations on vegetation cover, topography, geomorphology, soil characteristics and limestone features are important.

Looking for rare species such as *Solenodon* is time consuming, and although search techniques have improved, low-intensity methods for verifying their presence have not been developed. The use of scent attractants and fecal analysis may be useful. Depending on local densities, trapping with live bait could be relatively successful. On the other hand, the use of high frequency detectors (receivers) and recording (vocalizations) playback, might prove feasible. The larger the number of *Solenodon* populations discovered in the Massif de La Hotte, the higher the chances of gathering biological data, and the better the genetic stock. The latter aspect is especially important if a healthy founder population is eventually needed.

Monitoring of newly discovered *Solenodon* populations will be extremely important for gathering mortality data. Night censuses, mark-recapture, forage signs-tracking, and radiotelemetry are some of the alternatives, but are also manpower-intensive. Non-invasive models to generate foraging tracks population estimates should be attempted.

The Macaya area may be the last area in Haiti where Solenodons still occur.

Habitat

Habitat destruction has had an important influence on *Solenodon* endangerment, and one of the major problems for the long-term conservation of Solenodons in Haiti would be habitat vulnerability to human disturbance. Forest patches with Solenodon populations might be burned, exploited for forest products, and planted by peasants without warning. This problem has been observed for a period of over 15 years in a number of areas in the Dominican Republic, including two study sites at the early stages of research development (Ottenwalder, unpubl.). Protection, and research investments and efforts should be concentrated in areas where habitat is secure and land use activities can be predicted.

As also shown in these studies, the ecological range of *Solenodon* habitats should not be underestimated. Despite the common belief that *Solenodon* occurs solely in undisturbed communities, survey efforts should include an adequate sample of the habitat types available in the area.

A regional inventory of available and potential *Solenodon* habitats is essential. Without a regional inventory, the cumulative effects of control projects cannot be known and, therefore, rational approaches to protecting appropriate habitat cannot be formulated.

Although the active search for Solenodons in the wild would improve the prospects for finding and maintaining wild populations, the allocation of available resources for *Solenodon* recovery to locating and protecting suitable habitat should receive the maximum level of priority.

Diseases and parasites

There is no information concerning the influence of diseases and parasites on the population ecology of *Solenodon*. An effort should be developed to build up our knowledge in this obscure aspect of their biology. With a population already seriously reduced in range and, therefore, presumably also in numbers, the possibility always exists that catastrophic epizootic diseases could have profound effects on isolated wild populations.

Small population size

Although numbers of *Solenodon* in the Duchity region are unknown, available information suggests that their densities are very low. During a 20-year period, between 1973 and early 1992, a permanent search effort has yielded the remains of 35 individuals from Duchity and surrounding areas: a rate of about 1.8 Solenodons recorded per year. During the same time interval in the same areas, remains of at least 104 (5.5/year) Hispaniolan Hutias (*Plagiodontia aedium*) were secured using identical search methods and efforts. These data suggest a ratio of almost three *Plagiodontia* for each *Solenodon* record. *P. aedium*, the only other surviving terrestrial mammal in Hispaniola, and one of the most endangered endemic capromyid rodents of the West Indies, is also very rare in the Massif de La Hotte and elsewhere throughout its range in Haiti and the Dominican Republic. Used as an index of relative abundance, in view of the lack of other data, this information indeed suggests very low densities for *Solenodon* in the Duchity area.

More research is necessary in order to determine how many Solenodons survive in the Macaya area.

At very low population numbers, any one of several intrinsic (part of species biology) or extrinsic (influenced by the external environment) factors can lead to extinction (Soule and Simberloff, 1986). These factors include: 1) demographic stochasticity (changes in fitness or survival of population subgroups); 2) environmental stochasticity (diseases, changes in predator or competitor densities, too many predators, parasites, or competitors) of which catastrophes (fire, hurricanes) are one extreme case; and 3) the effects of inbreeding and the loss of genetic variation through drift (genetic stochasticity) (Shaffer, 1981; Soule, 1987).

Many extinctions occur because species are driven inexorably to lower numbers. Populations that can potentially increase in numbers, or at least have the potential to remain unchanged, might not seem obvious candidates for extinction. But, under the appropriate circumstances, such as small population size, we might observe local extinctions, at least. Available information suggests that in Haiti, *Solenodon* have gone through a number of local extinctions since the arrival of western man and their dogs, and that it is now restricted to one region in the

Massif de La Hotte, its last stronghold in the whole country. Furthermore, and as shown elsewhere, the chance of extinction increases as population sizes decline and as populations become increasingly isolated. Considering both that the species now occupies only a small fraction of its former range, and MacArthur and Wilson's (1967) implications concerning selective forces acting upon island communities, several important questions concerning the survival of Solenodons should be raised:

a) how much longer (length of time) they will be able to persist?

b) how small a population size would be the minimum viable for the species below which it would be doomed?

c) which factors make the species more or less prone to extinction?

Species population responses to stochastic events have been summarized as resilience (ability to recover from declines resulting from random variation in normal birth and death events and environmental perturbations measured as return time) and fitness (having appropriate sets of genes to maintain normal fecundity and viability under the prevailing environmental circumstances). Beyond this, a population's long-term survival potential is related to its adaptability, or its ability to evolve. The latter two concerns are determined by the presence of sufficient genetic variation, or heterozygosity. For Pimm (1991), population responses also involve persistence (the degree to which changes in the density of one species affects the density of other species measured as time), and resistance (measure of the demographic consequences when a variable is permanently changed).

According to Gilpin and Soule (1986), populations must be large enough to accommodate variations in their demography and environment that tend to draw them toward extinction in the short term, as well as large enough to preserve existing heterozygosity and provide the potential for species evolution. Population sizes necessary to avoid extinction based on viability analysis of these causes differ and, therefore, provide a range of management strategies for *Solenodon* recovery. Recovery could be accomplished by managing a single *Solenodon* population (i.e., Massif de La Hotte, Haiti) or managing many small *Solenodon* populations (i.e., Haiti plus southwestern and northern Dominican Republic) as a single "metapopulation" (Levins, 1970). It is generally agree that populations require an effective size of 500 breeding individuals to retain genetic heterozygosity sufficient for evolution (Franklin, 1980; Frankel and Soule, 1981). N_e is the size of an ideal population that loses genetic diversity at the same rate as a particular real population. The ideal population is one in which all individuals mate randomly, each sex has equal numbers, the number of young produced by individuals are Poisson distributed, and there are no overlapping generations (Frankel and Soule, 1981). Departures from N_e are multiplicative, and, as a result, the census population (N) usually must be larger to maintain an N_e of a given size.

Lack of information concerning population size and genetic variation for any of the known surviving populations of *Solenodon* in the wild, however, prevents estimation of N_e/N ratios, evaluation of genetic variation, and numbers needed for persistence over a given period of time or modeling time to extinction.

In undeveloped countries such as Haiti and the Dominican Republic, law enforcement is poor, and the implementation of conservation programs is difficult and, at best, achieved only slowly. A metapopulation management approach (not to include outbreeding) would be desirable to maximize retention of genetic diversity, and to compensate for time lags and ineffective protection.

RECOVERY

Objectives

To ensure immediate survival of the Haitian *Solenodon* by:

(1) Establishing the location of existing populations and their habitats;

(2) Establishment of a wildlife reserve to protect and to secure a viable population of Massif de La Hotte Solenodons, and a portion of their habitat in the Duchity area; and

(3) Reducing mortality due to predation by humans and by exotic mammals.

The general objective of the conservation action plan is to reduce the status of the Haitian *Solenodon* from Endangered to Threatened within a 15-year period. Lack of available information on this secretive nocturnal mammal precludes formulation of a quantitative recovery level. Therefore, it is suggested that a comprehensive population survey and ecological study of the species be conducted prior to defining a recovery level for this endemic West Indian insectivore. In the meantime, we suggest that recovery be defined in terms of:

a) maintenance of a stable or growing wild population of the La Hotte *Solenodon* at selected locations during a 5- to 10-year period (required viable population level to be quantified or defined later using results from population surveys);

b) acquisition of land containing *Solenodon* populations for the creation of a *Solenodon* protected area;

c) halt the indiscriminate killing and hunting of *Solenodon* by peasants using educational methods and existing protective legislation;

d) effective control or, if possible, eradication of exotic predators found to be a threat to *Solenodon* in selected areas; and

e) development of captive breeding and translocation protocols, since such strategies will be likely required and necessary in further stages of the recovery plan.

Stepdown Outline

1. Determine the status and distribution of present populations and their habitats.

   1.1. Update and compile all existing data.

   1.2. Carry out surveys to determine the presence or absence of extant populations.

   1.3. Survey known populations to determine distribution and density.

   1.4. Conduct periodic surveys to determine population trends and/or seasonality.

   1.5. Evaluate habitat extent and status.

1.6. Assess additional management strategies from data.

2. Protect and enhance the existing populations and protect and manage habitats.

2.1. Acquire and protect habitat.

211. Extend the boundaries of existing protected areas and acquire additional habitat.

212. Protect habitat.

2.2. Develop educational programs.

2.3. Develop cohesive protection strategies with local jurisdictions, authorities, influential groups and community leaders.

2.4. Determine the effects of exotic predators on *Solenodon* populations, and reduce or control their numbers inside the boundaries of protected areas.

2.5. Develop law enforcement activities whenever feasible.

3. Develop research and management programs for *Solenodon* populations and habitats.

3.1. Research protocols.

3.2. Determine habitat structure and requirements.

3.3. Determine feeding ecology.

3.4. Determine movements and behavior.

3.5. Determine reproductive ecology.

3.6. Develop a genetic profile of the La Hotte population.

361. Evaluate the genetic diversity and the prognosis for long-term viability of the La Hotte population.

362. Evaluate the phylogenetic relationships of any additional Hispaniolan populations.

4. Determine the need and feasibility for the establishment of captive breeding programs in Haiti and/or elsewhere.

4.1. Develop protocols and a methodology for captive breeding.

4.2. Evaluate populations for potential sources of "founders."

Recovery Narrative

1. **Determine status of present population and habitat.** It is essential for an effective recovery plan that the status, distribution and abundance of the population and its habitat be determined.

1.1. **Update and compile all existing data.** Compile all existing historical and recent data, including published and unpublished observations, interviews with older peasants, and temporal trends in population/habitat change.

1.2. Carry out surveys to determine the presence or absence of extant populations. Surveys should be carried out in the Massif de la Hotte to determine the presence or absence of extant populations. In particular, a thorough survey of the remaining areas with vegetation cover within a 20-kilometer radius of Duchity should be a priority, and is needed to provide more reliable information on distribution. If possible, surveys should also be conducted in the Massif de la Selle, particularly Morne d' Enfer, to determine whether *Solenodoh* still survive or if it has been extirpated in that range.

1.3. Survey known populations to determine distribution and density. A survey of known populations is needed to develop an estimate of the total La Hotte *Solenodon* population. Distribution will be determined by extensive day and night searches, examination of likely daytime refugia, foraging tracks, feces, etc., and interviews of peasants living in the surrounding areas. Methods to estimate population density should be developed. Solenodons are not caught in traps easily, so that standard techniques such as capture-marking-release-recapture studies are not useful. Combined results of all sources of data can be used to estimate total population, or at least to generate an index of relative abundance.

1.4. Conduct periodic surveys to determine population trends and/or seasonality. Periodic surveys of the same habitat and study sites are needed to determine population trends. Increasing numbers could yield animals for captive breeding and translocation programs. Decreasing numbers would alert researchers of the need to identify and correct adverse circumstances in the environment.

1.5. Evaluate habitat extent and status. The integrity of the habitat is crucial to the maintenance of viable populations. Inventory of the remaining habitat and assessment of its status is a priority.

1.6. Assess additional management strategies from data. Analyze available data to determine if other management activities that which be beneficial should be implemented.

2.Protect and enhance existing populations and protect and manage habitats. With only a relictual, isolated population of Solenodons known to survive, it is essential that their reduced numbers and habitats are carefully protected and managed to secure their continued existence.

2.1. Acquire and protect habitat. Loss of habitat has been identified as a major factor in the decline of Solenodons. The most important effort in the recovery of Solenodons must be directed at protecting their habitat. Increasing and maintaining available habitat is essential to their survival.

211. Extend the boundaries of existing protected areas and acquire additional habitat.

Establishment of a protected area for the La Hotte *Solenodon* should be an essential component for any long-term conservation strategy aimed at the survival of the species in Haiti. Acquire only secure sites where adequate protection can be maintained.

A major program objective of the Pic Macaya National Park and Macaya Biosphere Reserve should be to expand the current boundaries to include existing areas of relatively undisturbed forests, to assure that adequate habitat will be available for watershed protection, and for the future survival of native plant communities and wildlife.

A corridor of broadleaved forest fragments should be established between Pic Macaya and the Duchity-Plaine Martin-Catiche region, to connect the known range of extant *Solenodon* populations in the region, and to include areas with potential for persisting populations.

Acquisition of additional land in the Duchity-Plaine Martin-Catiche area, the only region in Haiti known to support surviving populations, for the purposes of establishing a *Solenodon* reserve is a priority of the recovery plan.

The establishment of a "**Solenodon Wildlife Reserve**" is of critical importance for a) the immediate protection of present-day surviving populations, b) the preservation and restoration of a portion of the last samples of natural habitat remaining with existing populations, and c) for the long-term preservation of adequate and suitable habitat which would be required for eventual translocation efforts in the future.

The protected area selection should be based on three basic criteria: the confirmed existence of populations, habitat requirements, and the degree of threat of destruction from development. Detailed information on the habitat in Haiti is lacking. Instead, the best available knowledge of what represents "optimal Solenodon habitat," should be adopted. Upon selection of potential areas, a list of public and privately owned lands in acquisition priority order should be developed to assure effective utilization of land acquisition funds. Securing large blocks of land is preferred. Smaller tracts would be of marginal value if surrounding areas were developed in the future. To improve habitat quality and to simplify management and enforcement of widely dispersed land, emphasis should be on purchasing, or trading for, small isolated tracts of land-habitat adjacent to larger parts of the intended reserve.

Ideally, an autonomous government institution should be responsible for the management and administration of the reserve and the other protected areas of Haiti. The development of local conservation groups should be an intrinsic part of the development of the protected area itself. Involvement of local community leaders in this role would be highly desirable. The participation of local NGO's in the process of conservation and management of protected areas in Haiti, along with the government, should be encouraged and strengthened.

212. Protect habitat.

Human disturbances and degradation of habitat are detrimental to *Solenodon* and to other wildlife. Habitat must be protected from these adverse impacts.

A plan emphasizing the preservation of vital habitat and the reduction of damage to resources by development activities must be developed for the Duchity area. Therefore, its protection would require that all land practices must be considered in light of their effect on Solenodons and other wildlife. For instance, soil quality (an important factor of the habitat because of the feeding and burrowing habits of *Solenodon*), is being reduced by grazing livestock, which cause soil compaction.

The acquired (reserve) land would be the only protected area for *Solenodon* in Haiti and should be maintained as such. Public access should be limited so as to minimize disturbance to habitat and wildlife. Constant supervision should be required to accomplish this task. The

erection of fences along the perimeter would be a critical factor to identify its boundaries and to delimit the extent of the area being protected, as well as to deter trespassing by peasants and livestock. Signs in Creole should be posted extensively along the perimeter to inform the public about the function and purposes of the reserve.

A fire management plan should be developed for the core vegetated zones in anticipation of an emergency due to accidents, vandalism or natural causes.

2.2. Develop educational programs Within the known range of *Solenodon* in the Duchity area, a reflex response to sighting of an animal is to kill and often eat it. Educational programs are needed among the rural population in selected areas within the range of *Solenodon*. The campaign should include schools, broadcast media, appearances at public service meetings, and posters.

The public should be made aware of the harmless nature and endangered status of *Solenodon*. A series of information/education efforts acquainting the public with the appearance of the animal, its habits, and endangered status would result in reduced human-induced mortality and increased reporting of incidental encounters. For instance, the campaign should illustrate and demonstrate the fact that Solenodons do not eat "malanga" and other "viande" in their gardens, but rather eat the "bugs" that plague the viande. The campaign should emphasize, promote and project a positive image of *Solenodon*.

2.3. Develop cohesive protection strategy with local jurisdictions, authorities, influential groups and community leaders.

In the jurisdictions involved, a cohesive recovery plan effort should be coordinated and developed locally with government delegates, church representatives and community leaders.

2.4. Determine the effects of exotic predators on Solenodons, and reduce and/or control their threats inside the boundaries of protected areas.

Information concerning *Solenodon*-predator interactions is needed. Threats from introduced mammalian predators should be analyzed and determined. Populations of exotics should be controlled or eliminated inside protected areas supporting *Solenodon* populations.

241. The influence of mongooses, feral dogs and cats on *Solenodon* populations and their habitats should be determined by establishing predator-free control zones in areas presently occupied by these exotics.

242. Control programs, to reduce or eradicate feral dogs, cats and mongooses, as necessary and feasible, should be developed using grids of live traps and other appropriate, *Solenodon*-safe methods. These areas

should be fenced and monitored for continued absence of these predators.

2.5 Develop law enforcement activities whenever feasible. It is essential that known causes of mortality are minimized to prevent further reduction of population size, and therefore, decrease the chances of relatively short-term extinction. Existing *Solenodon* populations need to be protected from indiscriminate killing and subsistence hunting. Any form of human disturbance, to the animal or to the habitat, should be prevented by protective legislation and active enforcement of these regulations.

Provided with a strong public relations component, enforcement of protective legislation inside protected areas should be carried out by wardens of the Haitian park service (Parcs Haiti), with the assistance of local authorities. "Preventive enforcement," might be the best strategy considering the weakness of the local justice infrastructure and a lack of a tradition of wildlife stewardship in the region.

3. **Develop research and management programs for *Solenodon* populations and habitats.** Basic natural history information on the Massif de La Hotte *Solenodon* and its habitat is lacking and is needed for effective management.

3.1. **Research protocols.** The endangered status of *Solenodon* imposes constraints on the choice of research techniques available to gather ecological data. The use of traumatic and invasive methods should not be attempted unless expertise in its application is available. A protocol should be developed for all procedures requiring the trapping, capture, handling, and tranquilizing of the animals.

Whenever possible, salvaged dog and/or human-kills should be immediately preserved as whole (anatomical) specimens in 100% ethanol for further examination of reproductive condition, analysis of stomach contents, parasites, diseases, and other post-mortem evaluations. Preservation of body tissues would also prove useful for genetic studies.

3.2. **Determine habitat structure and requirements.** Habitat descriptions and habitat selection and use should be determined by intensive quantitative studies of areas supporting seemingly moderate and "high" (or higher) populations of *Solenodon*.

3.3. **Determine feeding ecology.** Feeding ecology and prey species should be determined by several methods, including fecal analysis, quantification of relative abundance and seasonal availability of potential prey, inventory of soil macrofauna (both vertebrates and invertebrates), and, if feasible, direct observation using night vision devices.

3.4. **Determine movements and behavior.** Home range, daily movements patterns, and general activity and behavior should be determined by radiotelemetry and observation of marked animals.

3.5. **Determine reproductive ecology.** Reproductive ecology should be investigated by examination of free-living animals to determine seasonal presence and habitat preference of pregnant females in the population. These observations should be supplemented by observations recorded under captive conditions.

3.6. **Develop a genetic profile of the La Hotte population.** Because of the crucial implications for conservation biology and management, an investigation of the genetic variability of the *Solenodon* population in the Massif de la Hotte is a priority.

361. **Evaluate genetic diversity and prognosis for long-term viability of La Hotte population.** Genetic variability of the La Hotte population should be assessed using blood, tissue, and saliva electrophoretic evaluations and other techniques.

362. Evaluate phylogenetic relationships of additional Hispaniolan population. Similar analyses of other Hispaniolan populations of *Solenodon* should also be carried out for comparative purposes, to evaluate the amount of genetic (and geographic) variation among and between the Massif de la Hotte, the Barahona Peninsula and the North-

ern Hispaniola populations. The use of restriction-site variation techniques using high-molecular DNA would be desirable for this assessment. Restriction-site data would be also useful to investigate the phylogenetic relationships of the Solenodontidae within the Insectivora.

4. **Determine needs and feasibility for the establishment of captive breeding programs in Haiti and/or elsewhere.** Present numbers in the wild are likely very low. Should the population become suddenly affected by stochastic events, population size might drop to critical levels. Hurricanes, for instance, are frequent in Hispaniola, and 90% of them occur in the south coast, where the Massif de La Hotte is located. Considering the low productivity of *Solenodon* (under hypothetically ideal conditions, a maximum 18-20 offpring/female in a lifetime, assuming two young per year during 9-10 years), and removing mortality due to parasites, diseases and predators, chances for recovery to viable levels would take a long time. Recovery would be successful only if it were not aggravated by the effects of the "bottleneck" caused by such low population numbers, or subjected to some environmental catastrophe such as a hurricane or major forest fire. Long-term success would require a successful maintenance program for the resulting "founder" population. Captive breeding programs should be planned carefully in view of the slow growth and poor adaptability of Solenodons to captive conditions. Zoological parks or other institutions with the required infrastructure to develop a successful captive breeding program are lacking in Haiti. Potential recipients of animals for captive propagation should be found elsewhere, at least during the initial stages of the development of the captive breeding program.

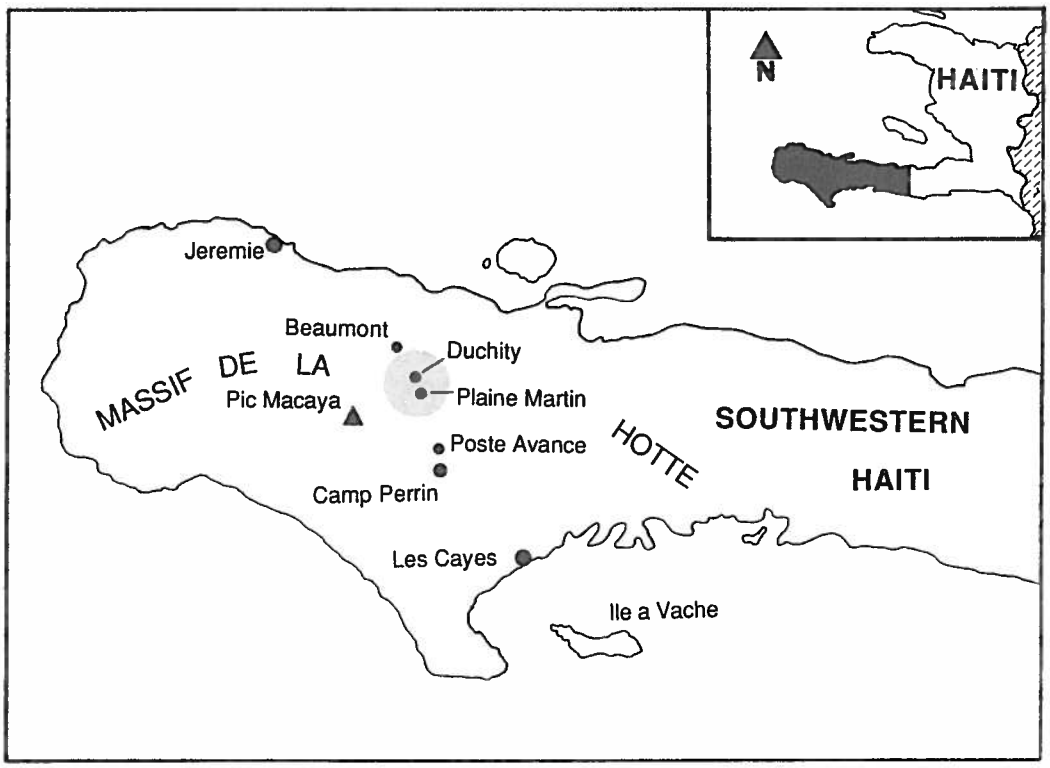
   4.1. **Develop protocols and methodology for captive breeding.** Until now, all efforts to establish viable populations of *Solenodon* in captivity have failed. Mortality has been high and only one captive-bred young has ever been recorded. Techniques and protocols for captive propagation should be developed as soon as possible.

   4.2. **Evaluate populations and sites for potential sources of founders.** Potential sources of the founder population needed for captive propagation should be identified using the information gathered from habitat and population surveys.

Devastated Solenodon habitat in the region of Duchity, Massif de la Hotte, southwestern Haiti.

Table 13.
Threats to *Solenodon* population and their habitats in the Duchity region, Massif de La Hotte.

RANK	ACTIVITY
1	Habitat loss
	Shifting cultivation
	Plantation agriculture
	Soil erosion
	Fire
	Charcoal production
	Livestock grazing
	Unplanned colonization
	Unlawful logging
	River and dam impoundment
	Commercial logging
2	Exotics
	Predation
	Competition for food
	Diseases and parasites (possible)
3	Human predation
	Unlawful capture and killing
	Subsistence hunting



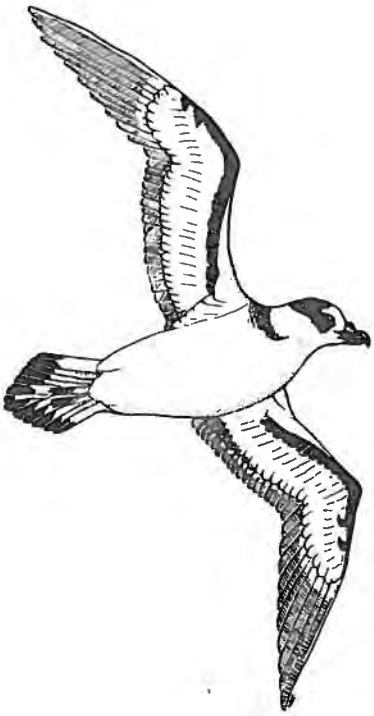
Map showing present range of Solenodon in Haiti.

BLACK-CAPPED PETREL RECOVERY PLAN

Introduction

The Black-capped petrel, *Pterodroma hasitata*, is the only gadfly petrel known to breed in the West Indies. It was formerly widespread in the region, breeding in the mountains of Jamaica, Guadeloupe, and Dominica but is now restricted to the highlands of Hispaniola and Cuba. The Jamaica Petrel, generally considered a melanistic race of *P. hasitata* and last known to breed in Jamaica in 1890, is now thought to be extinct. In Hispaniola breeding colonies are known in Haiti (in Massif de La Selle and Massif de La Hotte), and in the Dominican Republic (in Loma de Toro, Sierra de Baoruco; Bond, 1982), whereas in eastern Cuba, a breeding colony has been reported from Monte la Bruja, an inaccessible site, between Uvero and Ocujal, on the southern coastal slopes of Sierra Maestra (Bond, 1978; Garrido, 1985), where four specimens were collected.

Today, *P. hasitata* is believed extirpated in Jamaica, Guadeloupe, and Dominica (and perhaps also in Martinique). Following its decline in the Lesser Antilles, the Black-capped petrel was once thought to be extinct (Bent, 1922) before the discovery of yet unknown breeding colonies in Hispaniola. It is listed as threatened throughout its range by ICBP (King, 1978-79; Collar and Andrew, 1988), and is considered locally endangered in Haiti (Wingate, 1964; Woods and Ottenwalder, 1986), the Dominican Republic (Ottenwalder, 1973; Ottenwalder and Vargas, 1978; Stockton de Dod, 1987), and Cuba (Garrido, 1985). Mountfort (1988) included it among the rare bird species of the world. In Haiti, the peasants call the petrel "Chatte Huant," a name they also utilize to refer to owls and goatsuckers.



Like the three Western North Atlantic petrel populations (Hispaniolan-Cuban petrel, Jamaican petrel, and Bermuda petrel), the two closest petrel populations from the tropical Pacific Ocean have experienced population declines related to human activities: the Galapagos Dark-rumped petrel (*P. phaeopygia phaeopygia*), and the Hawaiian Dark-rumped petrel (*P. phaeopygia sandwichensis*).

The Black-capped petrel, also known as Diablotin and/or West Indian petrel, ranges at sea in the Caribbean and Western North Atlantic from about 36-N (Tropic of Cancer) south to seas off eastern Brazil, rarely to the Atlantic coast of North America from Maine to Florida, although regular off North Carolina (AOU, 1983). The pelagic distribution of the species largely follows the Gulf Stream off the eastern United States (Haney, 1987), overlapping in range with the closely related and also endangered Bermuda Petrel (*P. cahow*).

Taxonomy

The extant Black-capped petrel populations from Hispaniola and Cuba are currently regarded as *Pterodroma hasitata hasitata* (AOU, 1983; Imber, 1985). The possible extinct, dark form that bred on Jamaica (*Pterodroma hasitata caribbaea*) has been regarded by some to represent a distinct species, the Jamaican Petrel (*Pterodroma caribbaea*). *P. hasitata* and *P. cahow* constitute a superspecies (AOU 1983), but are sometimes considered conspecific (Palmer, 1962). In a recent taxonomic review of *Pterodroma*, Imber (1985) confirmed *hasitata* and *cahow* as distinct species.

Description

The black-capped petrel is a medium to large petrel about 35-46 cm (14-18 in) in length, with a wingspan of approximately 89-102 cm (Harrison, 1983). On the head, the plumage is brownish-black in the cap, eye and nape, with the hindneck and remaining parts white. The upperparts are mostly brownish, shading to blackish on the lower back; with white on the rump and upper tail-covers forming

a prominent broad band over the base of the tail. The tail is brownish-black. The underparts are mostly white except for a narrow dark collar on the sides of the breast (extending from the mantle), and blackish feather tips on thighs. The upper wing is brownish-black, with the primaries and secondaries being slightly darker. The underwing is mainly white, with irregular blackish margins, tip and short diagonal bar of variable width and length extending inwards across coverts. The bill is black, the iris blackish-brown, the legs and feet are whitish-flesh, and the webs distally black. In its "dark phase," and apart from the white at the base of the tail, it is entirely dusky. The white upper tail covers are an excellent field mark for identification. Sexes alike. Juveniles and adults alike.

Black-capped petrels can be distinguished from two similar species that occur within its range (Harrison, 1983). Individuals of *P. hasitata* in typical plumage are easily separated from Bermuda Petrels (*P. cahow*) by the white hindcollar and the broad white band over the rump. Great Shearwaters (*Puffinus gravis*) have superficial resemblance to *P. hasitata*, but differ in distinctly different flight and jizz; less white on hindneck and rump; longer, more slender bill; upper parts coloration; and, if present, a diagnostic dark smudge on belly.

Historical Range

A specimen believed to have been collected about 1835 in Haiti (specific locality unknown) represents the earliest confirmed report known of the species from Hispaniola (Wetmore and Swales, 1931). However, an account given by Moreau de Saint-Mery concerning an unknown bird recorded by three frenchmen in Pic la Selle on February 1, 1788 ["hollow cries heard from eight in the evening to one in the morning", and "feathers resembling those of a swan"], interpreted by Wetmore and Swales (1931) to refer to *Tyto ostologa*, may actually represent *P. hasitata* (Bond, 1987). Rabie's painting of the Diablotin, dated 1778 and labelled "Au Cap" [= Cap-Haitien], suggests that the species may have ranged as far as the north coast during the last century, and perhaps that colonies may have existed in the coastal slopes of the Massif du Nord mountains. The 100 birds observed plus the 5 captured in 1928 in Moca, Dominican Republic, (Moltoni, 1929; Wetmore and Swales, 1931; Wetmore, 1932, 1939) give additional support to the possibility that Black-capped petrels occurred in coastal north Hispaniola until the recent past.

The first confirmed record from Haiti consisted of a fledging captured in 1938 on the streets of Port-au-Prince (Wetmore, 1939). Between 1951 and 1961, collection of five additional petrels in or near Port-au-Prince, and one from For + t de Pins near Mont des Commissaires, in the Massif de la Selle, lead to the discovery of 11 breeding colonies in that mountain range in 1963 (Wingate, 1964). Eight of the colonies discovered by Wingate were located on the north, inland slopes of the Massif, to the north of the peaks La Visite, Cabaio, and Tete Opaque, whereas two were found north of Pic La Selle and Dubois. One colony was on the south, sea side, southwest of Casse Dent.

The Black-capped petrel was once thought to be extinct before the discovery of breeding colonies in Hispaniola.

Present Distribution

Little is known about sizes, locations, and seasons of petrel breeding colonies. Only three of the five Black-capped petrel colonies discovered by Wingate (1964) in La Visite-Tete Opaque ridges were found by Woods and Ottenwalder (1986) to be active during surveys conducted in the winters of 1982 through 1985, one on Morne La Visite, and two on Tete Opaque. They concluded that there may be fewer colonies of the species in this particular area, now declared a national park.

In the Massif de la Hotte, where petrel colonies were unknown, Woods and Ottenwalder (1986) reported a breeding colony on the south facing cliffs of Pic Macaya above 2,000 meters elevation, and a second possible colony on the northwest face of Pic Formon. Earlier efforts to locate petrel colonies in La Hotte had failed; C.A. Woods in the north slope of Pic Macaya in 1975, and D. Wingate and P. Paryski in the south slopes of Pic Formon in 1982 (Woods and Ottenwalder, 1986). The new Haitian colony was located west of the ridge connecting Pic Formon with Pic Macaya.

The only other colonies known from elsewhere in Hispaniola were discovered in 1981 in Loma de Toro, Sierra de Baoruco, in the Dominican Republic, about half a mile from the Haitian border near the eastern end of the Massif de la Selle. At this site, nests were said to be accessible, but none were found (Bond, 1982).

Off southwestern Hispaniola, Wiley and Ottenwalder (1990) recorded a small group of Black-capped petrels off northeast of Isla Beata on 28 July 1977, five birds off west of Punta Lanza, I. Beata, on 21 October 1978, and three petrels off near Alto Velo Island on 22 October 1978. Fishermen interviewed at that time indicated Black-capped petrels nested in the cliffs of Cabo Falso, Dominican Republic. The presumed colony at Cabo Falso has not been verified, though it may not pertain to this species as the highest elevation in the Cabo Falso area is only 112 meters.

Status

During the past two decades, Black-capped petrels have been recorded regularly in some offshore areas of South Carolina, Georgia, and Florida (Lee, 1977; Lee and Booth, 1979) apparently the petrels' primary non-breeding grounds (Clapp et al., 1982). These records, with peak numbers observed in spring and fall when the species moves from or to breeding colonies, have regarded petrels as rare but regular summer visitors. Nearly all sightings have been along the edge of the Gulf Stream, and several along the continental slope on days the Stream was farther to the east than normal (Lee and Booth, 1979). These observations have raised questions concerning the population status of *P. hasitata*, whether or not it should be considered a threatened species.

In 1936, Wingate (1964) estimated 50 birds at each one of the 11 breeding colonies discovered in the Massif de la Selle. "On authority of Wetmore (1932)", he assumed in Hispaniola the existence of 40 colonies with a rough total population estimate of 4,000 Black-capped petrels. However, in the areas surveyed inside the boundaries of La Visite National Parks, Woods and Ottenwalder (1986) estimated that the number of petrel colonies may have declined from five to two. Although the number of birds detected by vocalizations during these searches was relatively high, the species is considered under threatened conditions in its breeding habitat.

In 1986, a new breeding colony of Black-capped Petrels was discovered on the south-facing cliffs of Pic Macaya.

Habitat

Available information of the breeding habitat of Black-capped petrels in Haiti have been given primarily by Wingate (1964). More recently, valuable information about the distribution, habitat selection, and ecology of the petrels at sea have been known for the first time through studies by Lee et al. (1977, 1979, 1981, 1984) and Haney (1986, 1987).

Breeding habitat. The nesting habitat of Black-capped petrels in Haiti is confined to steep, virtually inaccessible areas (Wingate, 1964). All colonies

located by Wingate were found on 500 meter-high forested cliffs above 1,300 meters altitude; most between 1,500 and 2,000 meters. Proximity to the sea is not essential, and all but one were on the inland side of cliffs, presumably because of availability of suitable habitat. Colonies occurred only on vegetated slopes, and where sufficient soil cover exists for burrowing; which suggests the need for forested cliffs where the vegetation functions as stabilizer of boulders, rocks, soil, and humus (Wingate, 1964). Vegetation cover is abundant but not densly closed, allowing enough space for petrels access to the ground.

Feeding grounds. Recent studies indicate that the pelagic distribution of Black-capped petrel is most influenced by the Gulf Stream and other warm water masses between 10- and 40-N latitude (Haney, 1987). The primary marine habitat of the petrel off North Carolina lies seaward of the continental shelf break (200 meters isobath), an area including, but not limited to, the Gulf Stream (Lee, 1984). Off Florida, petrels occur over shallower depths and closer to land than farther north off Georgia and South Carolina. This pattern has suggested that Gulf Stream meandering and topographically-induced current deflection influence petrel distribution between Florida and North Carolina. Black-capped petrels return to the breeding colonies about November and depart about May, dispersing to adjacent seas along the western edge of the Gulf Stream north of Cape Hatteras (Lee and Booth, 1979), Virginia and Maryland, and S to NE Brazil (Clapp et al., 1982; Harrison, 1983).

Locally, petrel distribution is influenced by the presence of upwelling associated with Gulf Stream eddies and the mesas, ridges, and hills on the Blake Plateau (Haney, 1987). At these locations, petrels have been primarily observed in or near internal wave crests resulting from topographic turbulence created by the current over steep undersea ridges and peaks. Unstable meanders induce upwellings and cause local increases of marine organisms (Lee et al., 1981). Off northern Georgia and southern South Carolina, petrels were found to be significantly more abundant, where upwelling is more frequent, persistent and extensive. Food prey may be presumably higher in upstream upwelling sites, because of the transport and concentration of marine organisms. Haney (1987) also concluded that sea surface temperature and depth alone do not adequately characterize the petrel's marine habitat.

Life History

Food and Feeding Behavior

The stomach of one specimen examined by Wingate (1964) contained remains of cephalopod beaks and lenses. Haney (1987) found squid beaks, fish bones and lenses, whole squids (of 25 to 70 mm in length), and a 40 mm planehead filefish (*Monocanthus hispidus*) in the stomachs of three Black-capped petrels collected off Georgia. Other contents included small pieces of petroleum residue, small feathers, paper, and, perhaps of incidental ingestion, *Sargassum* algal blades. Haney (1986) noted that the presence of *Monocanthus* together with algal material suggest that Black-capped petrels forages on *Sargassum*-associated fauna.

Colonies of Black-capped Petrels occur only on vegetated slopes, and where sufficient soil cover exists for burrowing.

Black-capped petrel feeding bouts occur generally in flocks, which usually include other species. They may scavenge discarded waste only when natural foods are not abundant or reliable, and do not rely exclusively on olfaction for locating food sources (Haney, 1987). They spent little time on the water surface and apparently are not adapted for diving (Clapp et al., 1982). Petrels have been observed during aerial "flushing" and chasing of flying fish, and diving 3-4 meters from the air to, but not beneath, the water surface at a angle of 45-60- (Haney, 1987), a behavior that resembles surface plunging by gulls.

At sea, Black-capped petrels have been recorded active during all daylight hours, with peaks at early morning and evening (Haney, 1987). Limited information is available concerning their activity at night, but petrels have been observed flying, though not feeding after dark. According to Imber (1985), *Pterodroma* exploit diel vertically-migrating, meso-pelagic nekton, which selects for crepuscular or nocturnal feeding. Birds normally remain well out to sea, occurring inshore or on land only when sick or storm-driven (Clapp et al., 1982).

Petrels appear to be dependent upon wind velocities of 4 knots or higher for foraging and dispersal (Haney, 1987). At winds of 6 knots petrels may sometimes spring directly into the air from the water surface (Harrison, 1983), whereas in lower winds they run along the ocean surface for 2-4 meters before taking flight. The low wing loadings of Black-capped petrels allows for efficient gliding (Warham, 1977) but not sustained flapping flight, thus, the species is dependent on wind for long-distance foraging and dispersal within its oligotrophic environment (Haney, 1987). The Black-capped petrel is the only seabird present all year in the Gulf Stream, a current system with surface waters of very low productivity. As expected for gadfly petrels (*Pterodroma sp.*) in general (Imber, 1985), it appears that the behavioral and structural adaptations of Black-capped petrels have enabled effective exploitation of ocean niches where prey are widely dispersed.

Reproduction

Little is known of the breeding biology of the Black-capped petrel (*P. hasitata*) in Haiti, where according to Wingate (1964), "the actual nests of all of them [breeding colonies] were inaccessible to any but professional climbers". However, their breeding schedule, activity, and vocalizations are very similar to those of the closely-related Bermuda petrel, *P. cahow* (Wingate, 1964).

Black-capped petrels are nocturnal at breeding sites, and breeders presumably return to the same site each year. Nesting takes place during the winter months, probably between October and May. They may arrive at the colony sites in Haiti (and Dominican Republic) beginning during late September and continuing until November. Wingate (1964) was told by Haitian peasants living nearest to the colonies that the birds can be heard from early November to mid-May. Peak breeding occurs in late December, January and February. The nest is located in burrows or crevices on high mountains cliffs (see Nesting Habitat). Eggs are laid mostly during January and February. A single white egg is laid. The young are fledged in the spring and vocalizations are no longer heard after late April.

Nesting takes place during the winter months. Eggs are laid mostly during January and February. A single white egg is laid.

The breeding of Bermuda petrels (*P. cahow*) have been summarized in detail by Palmer (1962). Breeders arrive late October and begin burrowing and transportation of nest plant material until early November, when nest building activity reaches a peak. Activity decreases after mid-November until birds are absent altogether for two weeks in late December, prior to egg-laying. An aerial display, in which the pair flies close together one behind the other vocalizing noisily, takes place about December. The female returns to lay a single egg about January. Incubation lasts for 51-54 days. Both parents participate equally, taking turns on eggs for 8-14 day periods without visitation or relief. Hatching occur from 25 February to 5 March. Eggshells are trampled into nests. Young are brooded the first 1-2 days, then are left alone during daylight hours. During development, the chick is visited by one or occasionally by both parents on average of 3 nights out of 4. The feeding pattern is erratic, with parental absence up to five days. Occasionally during the first two weeks a parent remains in the burrow all day, usually until 2-3 A.M.

The chicks grow fast during the first 8 weeks, at which time they attain the rough proportions of adult birds. Feather sheaths appear at 40 days and are shed at about 60 days, but the body still covered in long flowing down. Head and body feathers develop by 70 days. The young are fully feathered and 80% free of down at 90-95 days. Adults abandon chicks during the last days of May, at which time the young begin excursions outside of burrow after dark to exercise and to peck at loose objects. Young might wander 20 feet from burrow, climbing rock-faces and vegetation. Young usually depart by flying directly to sea from the highest point near the burrow, at 90-100 days. The period between last feeding and departure is variable, usually 4-10 days. No birds return to the breeding grounds for about 4-5 months.

Available data suggest a similar cycle and timing for *P. hasitata* in the mountain tops of Hispaniola (Palmer, 1962). The duration of the fledgling period in procellariids is dependent in body mass (Imber, 1985). In medium-sized petrels (ca. 270-330 g), such as *P. cahow*, the fledgling is attained after 90-100 days (Imber, 1985; Wingate, 1964). A fledging female *P. hasitata* (with traces of down) found alive in the northern foothills of Sierra de Baoruco at Cabral weighted 278 g. (Ottenwalder and Vargas, 1979). In Haiti, Wingate (1964) recorded 3 fledglings of Black-capped petrels on June 1961 (Port-au-Prince), 1 July 1961 (Port-au-Prince), and "summer of 1957" (Foret de Pins, Massif de la Selle). Wetmore and Swales (1931) reported one fledgling "not long out of the nest" on 30 June 1938 (Port-au-Prince), and Ottenwalder and Vargas (1979) recorded another on 15 June 1979 (Cabral, Sierra de Baoruco, Dominican Republic). All five fledglings, probably at the onset of their post-breeding dispersal, appear to have lost orientation during the night due to light attraction from cities (Port-au-Prince, Cabral) or from Sen-sel-like fires (at logging camp of Foret de Pins). While in their breeding grounds, petrels fly by night and only exceptionally during daylight.

During the winter breeding season (Nov.-Feb.), Black-capped petrels present in waters of the Gulf Stream off the southeastern coasts of the United States, may not yet be reproductively mature, or may be non-breeding adults that fail to return to their breeding grounds (Clapp et al., 1982; Haney, 1987). However breeding *Pterodroma* may range up to a few thousand kilometers from nesting sites Warham *et al.* (1977), and Clapp *et al.* (1982) noted that breeding birds could disperse the 800 miles from Haiti between incubation shifts.

Predation, Diseases, and Parasites

No information is available concerning parasites and diseases on Black-capped petrels.

Native predators. There are no data about the native predators of the Diablotin on Hispaniola. Wingate (1964) claimed that the native Hispaniolan Palm crows (*Corvus palmarum*), would probably attack and kill any petrel caught out during daylight. Since they are not fast fliers, but gliders that take advantage of fast winds currents, petrels would certainly be easy prey of any of the common diurnal raptors found in the mountains of Hispaniola unless favorable winds are available. The Red-tailed hawk in quite common in both la Selle and la Hotte. The native Hispaniolan barn owls (*Tyto alba*, *T. glaucop*), Short-eared owl (*Asio flammeus*), and boas (*Epicrates striatus*) are probably potential predators of both adults and fledglings. *Tyto alba* has been identified as one the predators of the endangered Newell's Manx shearwater on Hawaii (Byrd and Telfer, 1980), and *Asio flammeus* of the endangered dark-rumped petrel in the Galapagos Islands (Harris, 1970).

Mongooses, rats, dogs and cats may be limiting Petrel numbers at their breeding colonies.

Introduced predators. The effects of exotic mammals on Black-capped petrels in Hispaniola is unknown. In Haiti, the mongoose (*Herpestes auropunctatus*) has

been considered a potential factor in reducing petrel numbers in la Selle (Bond, 1942; Wingate, 1964). Woods and Ottenwalder (1986) also felt mongooses, rats, dogs, and cats may be limiting petrel numbers at their breeding colonies.

Introduced mammals, both feral and wild, have been repeatedly blamed since historical times for the partial decline of petrel populations elsewhere (see Greenway, 1967): the mongoose in Jamaica (Palmer, 1962); the mongoose, dogs, and cats in the Lesser Antilles (Bent, 1922; Greenway, 1967); rats (*Rattus rattus* and *R. norvegicus*), and pigs in Bermuda (Murphy and Mowbray 1951); black rats (*R. rattus*), cats, dogs, and pigs in Galapagos (Harris, 1970; Coulter et al., 1982); and, the mongoose, rats (*Rattus* spp.), cats, dogs, and pigs, in Hawaii (Munro, 1944; King and Gould, 1967; Larson, 1967). Livestock, notably goats, burros, and cattle, were also condemned by Coulter et al. (1982) as responsible for limiting petrel numbers by degrading petrel breeding habitat and ground nesting burrows in Galapagos.

Despite these claims, the impact of exotics on petrel populations is not yet well understood, in part due to the paucity of studies (see Bell and Keith, 1983). Wingate (1964) found no evidence that rats represented a serious threat to Bermuda petrels, and suggested rats were unlikely to be a significant predator of Black-capped petrels in their breeding colonies in the mountains of Haiti. The nesting habitat of Hispaniolan petrels is usually located on steep, virtually inaccessible cliffs, above 1,500 meters elevation. In contrast, the nesting sites of the Bermuda and Galapagos petrel populations are found at low elevations, and their burrows are build on the ground or close to it. Eggs, chicks, and incubating adults of ground-nesting populations are, therefore, more vulnerable and accessible to predators.

The mongoose was considered by Wingate (1964) a potential predator of the petrel in Haiti, but minimized its predatory role because none was observed during his surveys in la Selle. However, the mongoose have been found to be common in both la Selle and la Hotte (Woods, 1985), and although a poor climber, it may be a threat to the petrel in certain colonies. Black rats and cats also common in these areas.

Programs for rat and/or mongoose control have been recommended and implemented to protect petrel and seabird colonies in Bermuda (Murphy and Mowbray, 1951), in Galapagos (Coulter et al., 1982; Bell and Keith, 1983), and in Hawaii (Keith et al., 1985, 1987)

Clearing of the vegetation by grazing, logging, and fires decreases the value of remaining nesting habitat and increases the susceptibility of petrels to predators.

Reasons for Decline and Present Threats

Since colonial times, original Black-capped petrel populations were severely exploited for food by man in the Lesser Antillean islands of Guadeloupe, Dominica, and Martinique (Bent, 1922), in Bermuda (Murphy and Mowbray, 1951), and probably also in Jamaica. Human consumption and habitat destruction have been major factors in their decline elsewhere. Clearing of the vegetation by grazing, logging, and fires decreased the value of remaining nesting habitat and increased the susceptibility of petrels to predators. Petrel predation has been increased with the introduction of exotic mammals. Finally, environmental pollution has also exposed gadfly petrels to potentially hazardous chemicals such as DDT (Wurster and Wingate, 1968; King and Lancer, 1973), and petroleum residues (Haney, 1987).

In Haiti, human disturbance, exploitation for food, "Sen-sel" fires, forest fires, and introduced mammals have been considered important factors influencing the reproduction and survival of the population at the Morne la Selle (Wingate, 1964) and Morne la Hotte (Ottenwalder and Woods, 1986) breeding grounds.

An additional factor that may be limiting population breeding and growth in Hispaniolan petrels, may be attraction to artificial lights. Coastal cities, resorts, hotels, stadiums, streets, increasing urbanization, and other sources of man-made lighting, have resulted in important losses for other seabird species that normally fly to and from their nests overland only after dark (USFWS, 1983), particularly if these are fledglings birds. Newell's manx shearwater fledglings appear to be particularly attracted to lights. It has been suggested that this attraction may be related to the bioluminiscence of their pelagic food supply or a natural tendency to find the ocean from the reflection of the moon and starlight from the water's surface (USFWS, 1983). Artificial lights affect birds in the same way "Sen-sel" or forest fires would; petrels become confused and may suffer temporary night blindness. They would fly into obstructions such as trees, utility poles, wires, and buildings, and fall to the ground.

All five Back-capped petrel fledglings records known from Haiti and the Dominican Republic (Wingate, 1964; Wetmore, 1931; Ottenwalder and Vargas, 1978; see Reproduction section) were probably at the onset of their post-breeding dispersal, and appear to have lost orientation during the night due to light attraction from cities (3 Port-au-Prince, 1 Cabral) or from mountain fires (1 at logging camp of Foret de Pins). All them were reportedly found or caught during June.

Other potential threats to the petrels and their breeding colonies in Haiti include soil erosion and subsequent land slides as a result of deforestation due to wood harvest and fires on their actual nesting sites. As fuelwood becomes increasingly scarce and/or exhausted in traditional areas, exploitation of wood and other forest products in remote, steeper slopes, previously considered inaccessible would eventually happen.

The possibility of natural disasters, such as hurricanes and landslides, in petrel colonies is not remote. In fact, Noble (1916) related the sudden extirpation of a breeding colony of Black-capped petrels in Guadeloupe by a landslide caused by the great earthquake of 1847 on that island, as a result of which the whole mountain slope of the Soufriere in which the petrels bred had collapsed and fallen into a valley (see also Bent, 1922). Stranded and dead petrels of this species have often been reported as a result of hurricanes and storms (Wetmore, 1932; Bond, 1968). Hurricanes are frequent in Hispaniola, and more than 90% of them hit and/or enter the island along the south coasts; where the Massif of la Hotte, Massif de la Selle, and Sierra de Baoruco, and all known petrel colonies in Hispaniola, are located. Earthquakes in the Greater Antilles, and even volcanic activity in the Lesser Antilles, are to some extent predictable in ecological time. In addition to habitat suitability, the relatively high frequency of hurricanes that affect Hispaniola might be a factor in the site selection of breeding colonies by petrels. Why almost all petrel breeding colonies are found on the north, inland-facing cliffs of mountains, is possibly related to the fact that the majority of cyclones and tropical storms that touch or pass near Hispaniola, do so along the south coasts of Haiti and the Dominican Republic.

Conservation Measures Taken

The cutting, transport, and selling of wood is regulated by legislation passed by the Haitian Government in 1955 and 1962. Hunting was regulated and nine categories of birds were protected by a decree enacted in 1971 (ratifying the recommendations of the Convention for the Protection of Nature and Wildlife Preservation in the Western Hemisphere), but it is unclear whether the Black-capped petrel is listed or not. Unfortunately, none of this legislation is known to be effective or enforced. A decree passed in 1983 created the first natural

protected areas in Haiti: Parc National La Visite in the Massif de La Selle, and Parc National Pic Macaya in the Massif de La Hotte. A management plan is being implemented only for the Pic Macaya National Park (to be eventually proposed as a biosphere reserve), with the support of USAID and the MacArthur Foundation. Human population pressure inside the parks and continued political instability in Haiti, represent the major challenges for the future of protected areas in this country.

RECOVERY

Recovery Objective

The primary objective of this recovery plan is to restore the Southern Haiti Black-capped petrel to a stable, secure and self sustaining status throughout its historic range allowing the reclassification of the species from endangered to threatened. Criteria for fulfilling the objective are:

(1) attainment of a free-living, stable, and self-sustaining standing population which demonstrates stability and self-sustenance for at least 10 continuous years, and

(2) providing the habitat required to support the petrel population

The natural history and status of the *P. hasitata* is poorly known. In order to attain the recovery plan objective, data is needed on the ecology and life history of the Black-capped petrel, particularly on numbers, habitat requirements, mortality, reproductive potential, and population genetics. Until adequate information is available upon which to establish a specific population goal, the species should be considered recovered after attainment of an annual average of 400 breeding pairs in la Selle and 200 pairs in la Hotte for a ten-year period, and assurance of long-term protection of the essential habitat needed to sustain these populations. In this recovery plan, emphasis has been placed in obtaining basic data on the natural history of the species and on habitat protection.

Stepdown Outline

1. Determine status of the population

   1.1 Survey population abundance.

   1.2 Document current distribution.

   1.3 Identify possible causes of decline, potential threats, and limiting and mortality factors.

2. Determine status of the habitat and habitat requirements

   2.1 Document distribution, situation and amount of remaining habitat

   2.2 Determine habitat requirements for the species

3. Protect and enhance the population and its habitat

   3.1 Protect habitat from any further human disturbance inside existing protected areas

   3.2 Manage degraded habitat for restoration

   3.3 Promote species and habitat preservation through public education

4. Conduct natural history studies

4.1 Investigate the reproductive ecology

4.2 Investigate the feeding habits

5. Monitor recovery of the population and assess additional management strategies from available data.

Recovery Narrative

1. **Determine status of the population.** Recovery of the Black-capped petrel will require quantification of current population levels and trends, geographic distribution, and limiting factors.

1.1 **Establish population abundance.** Little information concerning population densities of Black-capped petrels has been known since their discovery. Present numbers are unknown, though it is suspected that numbers are declining. Information about their abundance is essential to determine the present status of the species as well as to determine future goals and priorities for recovery.

1.2 **Document current distribution.** An inventory of the past and present breeding colonies of Black-capped petrels should be carried out. The present range of the species in the Massifs of la Selle and la Hotte should be determined so that these areas can be managed and protected against habitat modification and disturbance. Surveys should also be carried out in La Visite National Park, and Morne La Selle, to determine whether or not the number of previously known colonies of the species in this protected area and mountain range is declining. It is of great concern that a management plan is developed and implemented for Parc National La Visite.

1.3 **Identify possible causes of decline, potential threats, and limiting and mortality factors.** Possible causes of decline should be identified. The role of potential predators, competitors, parasites, and diseases should be analyzed. The impact of human disturbance on the habitat of Black-capped petrels should be analyzed as well. Efforts should emphasize the identification of which particular factors are currently limiting population size.

2. **Determine status of the habitat and habitat requirements.** Information concerning the distribution, extent, and situation of the habitat is fundamental to the recovery plan. Furthermore, the habitat needs to be characterized in order to determine the areas that are essential to the Black-capped petrel for breeding that should be preserved.

2.1 **Document distribution, situation, and amount of remaining habitat.** Information concerning the present situation of the habitat, including disturbance levels, successional stage of plant communities, potential threats, and vulnerability of these cliff communities should be one of the priorities of the recovery plan.

2.2 **Determine habitat requirements for the species.** The structure of habitats supporting Black-capped petrels should be investigated so as to develop a physical and biotic profile. Habitat selection and use should then be determined from both available data on species productivity and habitat assessments.

3. **Protect and enhance the population and its habitat.** In Haiti, the single most important strategy to the Black-capped petrel recovery plan is to assure protection of adequate portions of habitat for the species. It is unrealistic to expect achievement of recovery plan goals if habitat cannot be preserved over the long term. Increasing and maintaining habitat is essential to the survival of the species.

   3.1 **Protect habitat from any further human disturbance inside existing protected areas.** Existing colonies of Black-capped petrels should be protected promptly. Habitat destruction or modification within both National Parks should be prevented. Surveillance by park wardens should be increased in Parc National Pic Macaya, and started in Parc National La Visite. Buffer zones around critical nesting and feeding areas should be delineated and managed accordingly. The most feasible means should be adopted to secure essential habitat outside existing or proposed protected areas within the historic and presently reduced range of the Black-capped petrel. New colonies discovered near the present park boundaries should be incorporated and protected immediately.

   Woods and Ottenwalder (1986) made the following recommendations for the protection of Black-capped petrels inside the boundaries of protected areas: a) no fires be allowed on the peaks of the mountains, b) elimination of all dogs and cats, c) no gardens or trails be allowed anywhere on the north face (Nan Nway) of the Massifs, d) no gardens or fires be allowed in a buffer zone that extends down to an elevation of at least 1,400 meters elevation below the cliffs within each park, e) study the effect of rats and mongooses on the petrels, and f) removal of sheep and goats from both parks.

   3.2 **Manage degraded habitat for restoration.** Remaining habitats should be immediately managed for restoration and natural regeneration. Methods for how habitat alterations and/or direct human disturbance can be reversed should be determined.

   3.3 **Promote species and habitat preservation through public education.** Develop educational campaigns concerning the endangered status of the Black-capped petrel and its habitat in the national parks of Haiti.

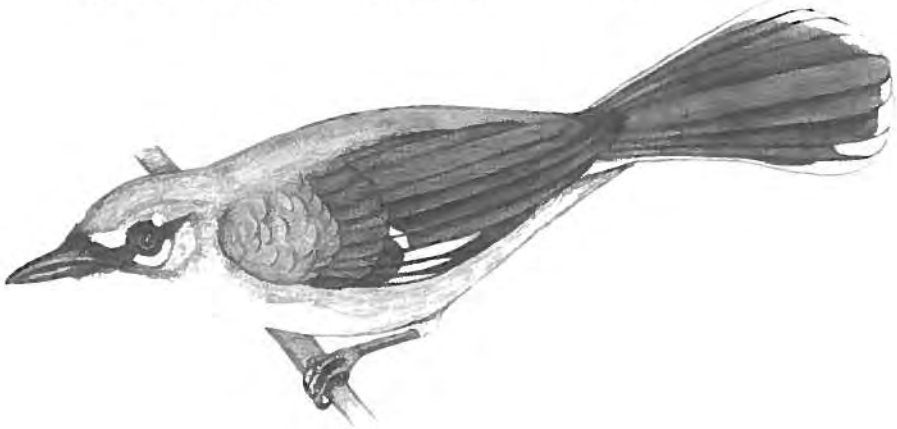
4. **Conduct natural history studies.** Little is known of the natural history of Hispaniolan petrels. Information about their reproduction and ecology is fundamental to the success of the recovery plan.

   4.1 **Investigate the reproductive ecology.** Studies of the breeding season, nesting, incubation, parental care, fledging period, young survivorship, dispersal and attainment of sexual maturity are essential for determining growth rates, and critical periods when the species is most vulnerable to disturbance.

   4.2 **Investigate the feeding habits.** Foods habits should be determined. Basic food items need to be known to provide for the possibility of habitat management to maintain and enhance food prey, and to determine if food availability is a limiting factor of population growth or dispersal.

5. **Monitor recovery of the population and assess additional management strategies from available data.** Regular monitoring of the population, both at sea and at nesting areas, is needed to assess general population trends and the effects of management options. Additional management strategies should be implemented from available data generated by field studies.

WHITE-WINGED WARBLER RECOVERY PLAN



Introduction

The White-winged warbler, *Xenoligea montana*, is listed as threatened by ICBP (King, 1978-1979; Collar and Andrew, 1988), and among the rare bird species of the world (Mountfort, 1988). In Haiti, the species has been considered at great risk of habitat loss (Woods and Ottenwalder, 1983), and endangered and locally extirpated (Woods and Ottenwalder, 1986). In Dominican Republic, the species has been listed as endangered by Ottenwalder (1973), and vulnerable by Stockton de Dod (1987).

Taxonomy

X. montana is endemic to Hispaniola and is one of the few endemic species of warblers of the West Indies.

It was originally described as *Microligea montana* by Chapman in 1917 from the Cordillera Central of Dominican Republic. Bond (1967, 1968) created the subgenus *Xenoligea* for the species based on its unique characteristicss among the 'Geothlypeae' (sensu Ridgway, 1902; which include the more arboreal, "*Dendroica*-like" *Geothlypis*, *Microligea*, *Teretistris*, and *Leucopeza*). Although given generic status thereafter (In Paynter, 1968), *Xenoligea* is sometimes merged with *Microligea*, but *montana* appears to have thraupine affinities while the Ground warbler, *Microligea palustris* (another Hispaniolan endemic warbler), seems to be paruline and possibly close to *Dendroica*. However, behavioral and genetic affinities between *Microligea* and the tanagers have also been suggested (McDonald, 1987). Nevertheless, both *Microligea* and *Xenoligea* are currently placed within the Parulidae (AOU, 1983).

The White-winged Warbler is the most endangered species of bird in Haiti.

Description

The White-winged warbler is about 5.7 inches (14.3 cm) in total length. It resembles the Ground warbler, *M. palustris* (also known as Green-tailed ground warbler and Gray-breasted ground warbler), in overall size and dorsal coloration. In both, the pileum, hindneck, sides of head, and extreme upper back are slate-grey, the remaining upperparts being green. *Xenoligea* is distinguished from *Microligea* by the following characteristics: the tail is slate-grey, the outer rectrices blackish and tipped with white, the outer margins of the primaries are white (producing a prominent white streak on wing), with a white stripe from bill to above eye and a white spot below eye (Wetmore and Swales, 1931; Bond, 1957, 1985). The underparts are white, turning greyish on the sides and flanks. The bill is also thicker, the plumage less fluffy, and the body appears more robust than that of *M. palustris* (Wetmore and Swales, 1931). The white wing marking is

striking and serves as an excellent field mark for identification. Males and females are similar in appearance.

The White-winged warbler, sometimes referred in the literature also as White-winged Ground warbler and Chapman's Ground warbler, is locally known in Haiti with the names "Ti chit kat je" and "Petit quatre-yeux".

Historical Range

White-winged warblers are unknown from most of Haiti. Historically, they appear to have been restricted to the southern peninsula, were the species was apparently common and more widely distributed early in the century. In January 1928, Bond (1928) reported the species on Morne La Selle "as about as common as *Macroligea palustris*," and Wetmore and Lincoln (1933) found the White-winged warbler to be "fairly common" in the rain forest of Pic Macaya in April, 1931.

In the Massif de La Hotte, *Xenoligea* have been collected or recorded on a few occasions in the past: 3 birds in "La Hotte" on June 1917 (Wetmore and Swales, 1931), and 6 birds on Pic Macaya in April, 1931 (Wetmore and Lincoln, 1933). In La Selle, Wetmore and Swales (1931) collected 2 birds and observed a third individual in two days at the Jardins Bois Pin in April, 1927, whereas, in January, 1928, Bond (1928) found the species in "small numbers" on Morne Malanga (one male was collected in the Crete a Piquants group of mountains), and on Morne Tranchant, were one bird was taken.

No additional sight records and localities are known of the species from elsewhere in Haiti.

Present Distribution

Recent sightings of the White-winged warbler in the Massif de La Hotte were recorded in January, 1973 at Ridge Formon, and in January, 1977 at Ridge Macaya (Woods and Ottenwalder, 1983). Only two birds were positively sighted at Formon, during daily four-hour (6:30-10:30AM) censuses along transects between 2-10 January 1983 (Ottenwalder, field notes). None were observed by Ottenwalder at the Formon Plateau on 12-13 April 1992, at two forest patches checked close nearby northeast and west of the Macaya park headquarters.

Historically, White-winged warblers have been restricted to the southern peninsula of Haiti.

In La Visite, Massif de La Selle, one bird was netted in May 1975 (Woods and Ottenwalder 1983). No White-winged warblers were recorded on La Visite during 18 hours (six-hours/day; 6:00AM-12:OOM) of transect censuses during three consecutive days (19-21) December 1982 (Ottenwalder, field notes).

Woods and Ottenwalder (1986) reported *Xenoligea* to be very rare and endangered in Macaya, and possible extirpated in La Visite National Park. All the known areas within the historical distribution of de species on the Massif de La Selle (Morne Malanga, Crete a Piquants, and Morne Tranchant; see Bond, 1928), are now severely deforested. No records of the species, recent or historical, are known from anywhere else in Haiti.

Status of the Species

Today, the White-winged warbler is the most endangered species of bird in Haiti. No confirmed observations are known from Morne La Visite since the mid-1970s, and the population appears to be very low in La Hotte, where the only

remaining Haitian population is likely isolated. The status of the extant population inside protected areas is probably critically endangered. No current conservation, research or management programs exist for the species in Haiti. No individual White-winged warblers is known to exist in captivity anywhere, and no individuals of the species have ever been known to have been maintained in captivity.

Habitat

Specific habitat requirements for the White-winged warbler are unclear. The species occupy the forest undergrowth and adjacent thickets of the higher mountain regions of Hispaniola. In fact, the type locality, Monte Tina, is 2,200 meters in elevation. The species is primarily found at elevations above 1,200 meters (1,300-1,800 meters in Pic Macaya, Wetmore and Lincoln, 1933; ca. 1,800 meters in Formon-Macaya, Woods and Ottenwalder, 1986; 1,200 meters, Stockton de Dod, 1981), but it may also occur at lower elevations (350 meters, Stockton de Dod, 1987, Ottenwalder, pers. obs.), where favorable habitats may also exist as a result of gradients in temperature and rainfall created by the physiographic diversity available in the large mountain ranges of Hispaniola. White-winged warblers utilize several plant communities, such as pine and mixed pine-broadleaved forests, but are more often found in broadleaved vegetation, including dense stands, low trees, open thickets, edges of clearings, or shrubbery either alone or as an understory (Wetmore and Lincoln, 1933; Woods and Ottenwalder, 1986; Stockton de Dod, 1987).

Life History

Very little is known about the natural history of the White-winged warbler.

Among New World warblers, West Indian endemics appear to share several common patterns. The strong tendency toward monomorphy observed in the endemic species does not occur among forms that are conspecific with North American warblers. Patterns of monomorphy (endemics) and dimorphy (non-endemics) suggest that monomorphy is associated with permanent residency but it is not quickly attained over evolutionary time. All species have small clutches with open nests and protracted seasons, presumably related to concealment as a response to predator avoidance (Morse, 1989).

Nesting

Virtually nothing is known about the reproductive biology of White-winged warblers. In fact, nests and eggs have not yet been categorically identified and described. Furthermore, the extent of the breeding season is still uncertain. Wetmore and Swales (1931) recorded one young molting into first fall plumage on early June in the Massif de La Hotte. Woods and Ottenwalder (1986) proposed the breeding season to be April-May. Nest may be expected to be open, and either globular or cup-shaped. Eggs may be greenish or bluish; however, Wetmore and Swales (1931) were shown on La Selle a nest with two "plain, creamy-white eggs without markings" reputed to be of *Xenoligea*.

White-winged warblers occupy the forest undergrowth and adjacent thickets of the higher mountain regions of Hispaniola.

Food and Feeding behavior

X. montana is found alone, in pairs or in mixed flocks with other species. Low chattering calls are the only known vocalizations in White-winged warblers. It

appears more active and ranges higher and in more open thickets in the undergrowth than *M. palustris* (Wetmore and Swales, 1931). It does not forage as near the ground as *Microligea*, which suggest niche partitioning may allow for coexistence. However, it has been observed in mixed feeding flocks with Ground warblers and Flat-billed vireos, *Vireo nanus* (In Collar and Madrono, MS). Wetmore and Swales (1931) observed that White-wing warblers forage rather actively among branches and creepers in a manner that combines the habits of warblers and vireos. Little is known about their diet, which includes insects and seeds. Seeds of the Cuba tree (*Trema micrantha*) reportedly represent an important food source for *Xenoligea* in Sierra de Baoruco (Dominican Republic) (Stockton de Dod, 1987).

Predation, Diseases and Parasites

No information is known about mortality due to predation and diseases. Barn owls (*Tyto alba* and *T. glaucops*), diurnal raptors (*Buteo* and *Accipiter*), and Hispaniolan boas (*Epicrates striatus*), are potential predators of White-winged warblers. It is possible that feral cats, mongooses, and rats may be heavily preying on ground and near-ground dwelling birds such as *Xenoligea* and other low-nesting species.

Reasons for Decline and Present Threats

Habitat destruction appears to be the major cause of decline of the White-winged warbler in Haiti. However, White-winged warblers appear also to be absent in some areas were seemingly favorable habitat is still available. Additional factors, though secondary in importance, are possibly involved in their reduction in numbers, but these are unknown. White-winged warblers appear to be a species of low resilience, whose population levels are very sensitive to habitat disturbance.

Conservation Measures Taken

The cutting, transport, and selling of wood is regulated by legislation passed by the Haitian Government in 1955 and 1962. Hunting was regulated and nine categories of birds were protected by a decree enacted in 1971 (ratifying the recommendations of the Convention for the Protection of Nature and Wildlife Preservation in the Western Hemisphere), but it is unclear whether the White-winged warbler is listed or not. Unfortunately, none of this legislation is known to be effective or enforced.

White-winged warblers appear to be a species whose population levels are very sensitive to habitat disturbance.

A decree passed in 1983 created the first natural protected areas in Haiti: La Visite National Park in the Massif de La Selle, and Pic Macaya National Park in the Massif de La Hotte. A management plan is being implemented only for the Pic Macaya National Park (to be eventually proposed as a biosphere reserve), with the support of USAID and the MacArthur Foundation. Human population pressure inside the parks and continued political instability in Haiti represent the major challenges for the future of protected areas in this country.

White-winged warblers appear to be very rare and endangered in the park Pic Macaya, and they may have been already extirpated in La Visite National Park.

RECOVERY

Recovery Objective

The primary objective of this recovery plan is to restore the Southern Haitian White-winged warbler to a stable, secure and self sustaining status throughout its historic range allowing the reclassification of the species from endangered to threatened. Criteria for fulfilling the objective are:

(1) attainment of a free-living, stable, and self-sustaining standing population which demonstrates stability and self-sustenance for at least 10 continuous years, and

(2) providing the habitat required to support the population.

The natural history and status of the *X. montana* is poorly known. In order to attain the recovery plan objectives, data is needed on the ecology and life history of the White-winged warbler, particularly on numbers, habitat requirements, mortality, reproductive potential, and population genetics. Until adequate information is available upon which to establish a specific population goal, the species should be considered recovered after attainment of an annual average of 600 breeding pairs for a ten-year period, and assurance of long-term protection of the essential habitat needed to sustain these populations. In this recovery plan, emphasis has been placed on habitat protection and on obtaining basic data on population size and natural history of the species.

Stepdown Outline

1. Determine status of the population

   1.1 Survey population abundance.

   1.2 Document current distribution.

   1.3 Identify possible causes of decline, potential threats, and limiting and mortality factors.

2. Determine status of the habitat and habitat requirements

   2.1 Document distribution, status, and extent of remaining habitat

   2.2 Determine habitat requirements for the species

3. Protect and enhance the population and its habitat

   3.1 Protect habitat from any further human disturbance inside existing protected areas

   3.2 Manage degraded habitat for restoration

   3.3 Promote species and habitat preservation through public education

4. Conduct natural history studies

   4.1 Investigate the reproductive ecology

   4.2 Investigate the feeding habits

   4.3 Evaluate the genetic variability of the population

5. Monitor recovery of the population and assess additional management strategies from available data.

6. Establish captive breeding if available evidence indicates that the White-winged warbler may become extinct in the wild.

Recovery Narrative

1. **Determine status of the population.** Recovery of the White-winged warbler will require quantification of current population levels and trends, geographic distribution, and limiting factors.

   1.1 **Establish population abundance.** Little information concerning population densities, and even sight records, of White-winged warblers have been known since their discovery. Present numbers are unknown, though it is suspected that population densities are very low. Information about their abundance is essential to determine the present status of the species as well as to determine future goals and priorities for recovery.

   1.2 **Document current distribution.** The present range of the White-winged warbler in the Massif de La Hotte should be determined so that this area can be managed and protected against habitat modification and disturbance. Surveys should also be carried out in La Visite National Park to determine if the species has indeed been extirpated in this protected area and mountain range. It is of great concern that a management plan is developed and implemented for La Visite National Park.

   1.3 **Identify possible causes of decline, potential threats, and limiting and mortality factors.** Possible causes of decline should be identified. The role of potential predators, competitors, parasites, and diseases should be analyzed. The impact of human disturbance on the habitat of White-winged warblers should be analyzed as well. Efforts should emphasize the identification of factors which are currently limiting population size.

2. **Determine status of the habitat and habitat requirements.** Information concerning the distribution, extent, and situation of the habitat is fundamental to the recovery plan. Furthermore, the habitat needs to be characterized in order to determine plant communities which are essential to the White-winged warbler and should be preserved.

   2.1 **Document distribution, situation, and amount of remaining habitat.** An inventory of the habitats in areas known to support populations of White-winged warblers should be carried out. Information concerning the present situation of the habitat, including disturbance levels, successional stage of plant communities, potential threats, and size of forest fragment should be one of the priorities of the recovery plan.

   2.2 **Determine habitat requirements for the species.** The structure of habitats supporting White-winged warblers should be investigated so as to develop a physical and biotic profile. Habitat selection and use should then be determined from both available data on species productivity and habitat assessments.

3. **Protect and enhance the population and its habitat.** In Haiti, the single most important strategy to the White-winged warbler recovery plan is to assure protection of adequate portions of habitat for the species. It is unrealistic to expect achievement of recovery plan goals if habitat can not be preserved over the long term. Increasing and maintaining habitat is essential to the survival of the species.

3.1 Protect habitat from any further human disturbance inside existing protected areas. The remaining small population of White-winged warbler should be protected promptly. Habitat destruction or modification within the National Parks should be prevented. Surveillance by park warden should be increased in Parc National Pic Macaya, and started in Parc National La Visite. Buffer zones around critical nesting and feeding areas should be delineated and managed accordingly. The most feasible means should be adopted to secure essential habitat outside existing or proposed protected areas within the historic and presently reduced range of the White-winged warbler. New areas around the present habitat should be incorporated and protected immediately.

Woods and Ottenwalder (1986) recommended the habitats on the cliffs of La Visite between Morne La Visite and Tete Opaque must be preserved. They stressed that the area west of Morne La Visite connecting this ridge and Morne d'Enfer (including it), must be incorporated into the park. This area, and that on the plateau of the massif to the south of the park, have extensive areas of the habitat where White-winged warblers are found, and it is the type of habitat that has been eliminated, negatively affecting the parks' endemic wildlife. The broadleaved forest in the Morne d'Enfer has been preserved because the area is difficult to reach as a result of steep cliffs that surround the mountain which can only be reached by a narrow, rocky connecting ridge or by a steep climb from below.

3.2 Manage degraded habitat for restoration. Remaining habitats should be immediately managed for restoration and natural regeneration. Methods for how habitat alterations and/or direct human disturbance can be reversed should be determined.

3.3 Promote species and habitat preservation through public education. Develop educational campaigns concerning the endangered status of the White-winged warbler and its habitat in the national parks of Haiti.

4. Conduct natural history studies. Virtually nothing is known of the natural history of *Xenoligea*. Information about their reproduction and ecology is fundamental to the success of the recovery plan.

4.1 Investigate the reproductive ecology. Studies of the breeding season, nesting, clutch size, hatching period, parental care, fledging period, young survivorship, dispersal and attainment of sexual maturity are essential for determining growth rates, and critical periods when the species is most vulnerable to disturbance.

4.2 Investigate the feeding habits. Foods habits should be determined. Basic food items need to be known in order to provide for habitat management to maintain and enhance food prey, and to determine if food availability a limiting factor to the population growth or dispersal.

4.3 Evaluate the genetic variability of the population. Evaluation of the genetic diversity of *Xenoligea* should be one of the priorities of the recovery plan. Should the surveys indicate that very low numbers remain in the wild, the development of population dynamics and minimum viable population models will be essential to guide the recovery of the White-winged warbler. At present, the information required for the development of these models, life history and genetic data, is completely non-existent.

5. **Monitor recovery of the population and assess additional management strategies from available data.** Regular monitoring of the population is needed to assess general population trends and the effects of management options. Additional management strategies should be implemented from available data generated by field studies.

6. **Establish captive breeding if available evidence indicates that the White-winged warbler may become extinct in the wild.** It is unknown how many White-winged warblers may survive in the wild, but numbers are presumably low. If numbers and/or distribution continue to decline in the wild, it is essential that one or more captive breeding populations be established to preserve the genetic stock of the species. Birds should be taken from the wild to establish captive breeding populations only if the species if nearing extinction.

Solenodon paradoxus

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