STEWARDSHIP PLAN FOR THE NATIONAL PARKS AND NATURAL AREAS OF HAITI

by
Charles A. Woods
Florence E. Sergile
Jose Alberto Ottenwalder

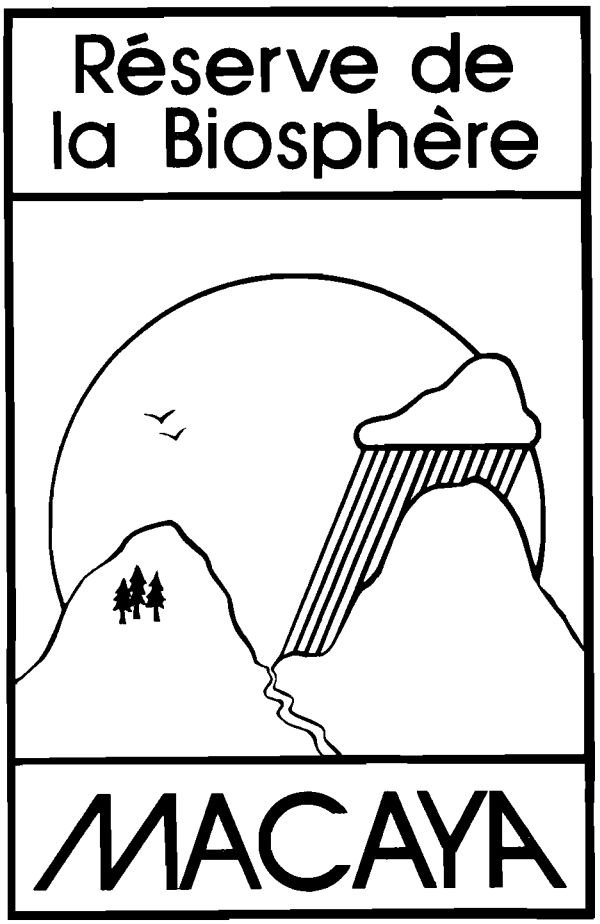


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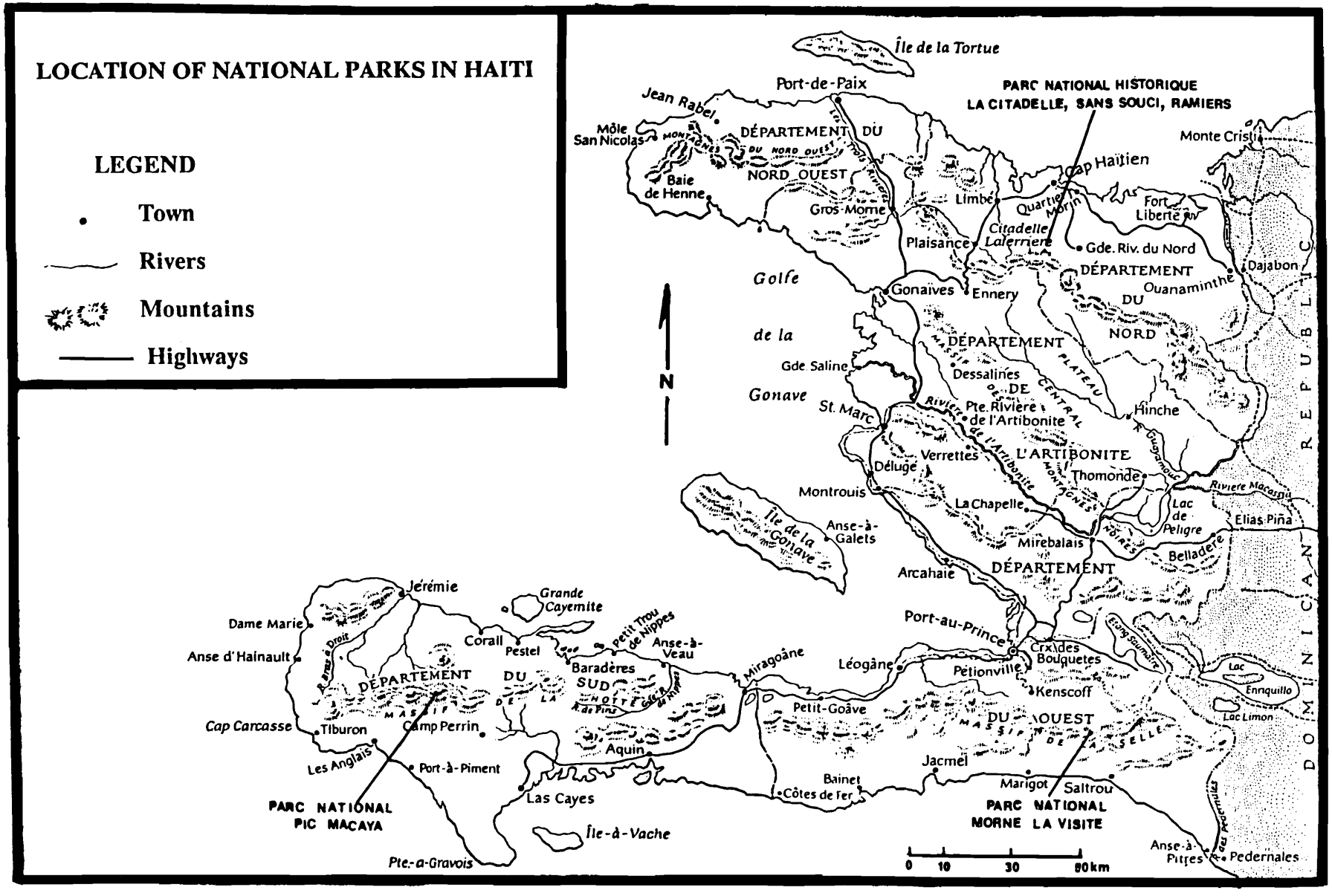
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LOCATION OF NATIONAL PARKS IN HAITI
LEGEND
Town
Rivers
Mountains
Highways
Île de la Tortue
Port-de-Paix
PARC NATIONAL HISTORIQUE
LA CITADELLE, SANS SOUCI, RAMIERS
Jean Rabel
Môle San Nicolas
DÉPARTEMENT DU NORD OUEST
NORD OUEST
Baie de Henne
Gros-Morne
Limbé
Cap Haïtien
Quartier Morin
Fort Liberté
Monte Cristi
Plaisance
Citadelle Laferrière
Gde. Riv. du Nord
Dajabon
DÉPARTEMENT DU NORD
Ouanaminthe
Golfe de la Gonave
Gonaïves
Ennery
Gde Saline
DÉPARTEMENT DE L'ARTIBONITE
Dessalines
St. Marc
Pte. Rivière de l'Artibonite
Hinche
Verrettes
Thomonde
Déluge
Montrouis
La Chapelle
Lac de Peligre
Elias Piña
Île de la Gonâve
Anse-à-Galets
Mirebalais
Belladère
Arcahaie
DÉPARTEMENT
Jérémie
Grande Cayemite
Dame Marie
Corail
Pestel
Petit Trou de Nippes
Anse-à-Veau
Port-au-Prince
Anse d'Hainault
Baradères
Miragoâne
Léogâne
Pétionville
Croix des Bouquets
Kenscoff
DÉPARTEMENT DU SUD
Cap Carcasse
Tiburon
Camp Perrin
Petit-Goâve
DU OUEST
Lac Enriquillo
Lac Limon
Aquin
Les Anglais
Port-à-Piment
Jacmel
Bainet
Côtes de Fer
Marigot
Saltrou
PARC NATIONAL PIC MACAYA
Las Cayes
Île-à-Vache
PARC NATIONAL MORNE LA VISITE
Pte.-a-Gravois
Anse-à-Pitres
Pedernales
0 10 30 80km
N
DOMINICAN REPUBLIC

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: 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 parts of the plan presented here can be implemented.

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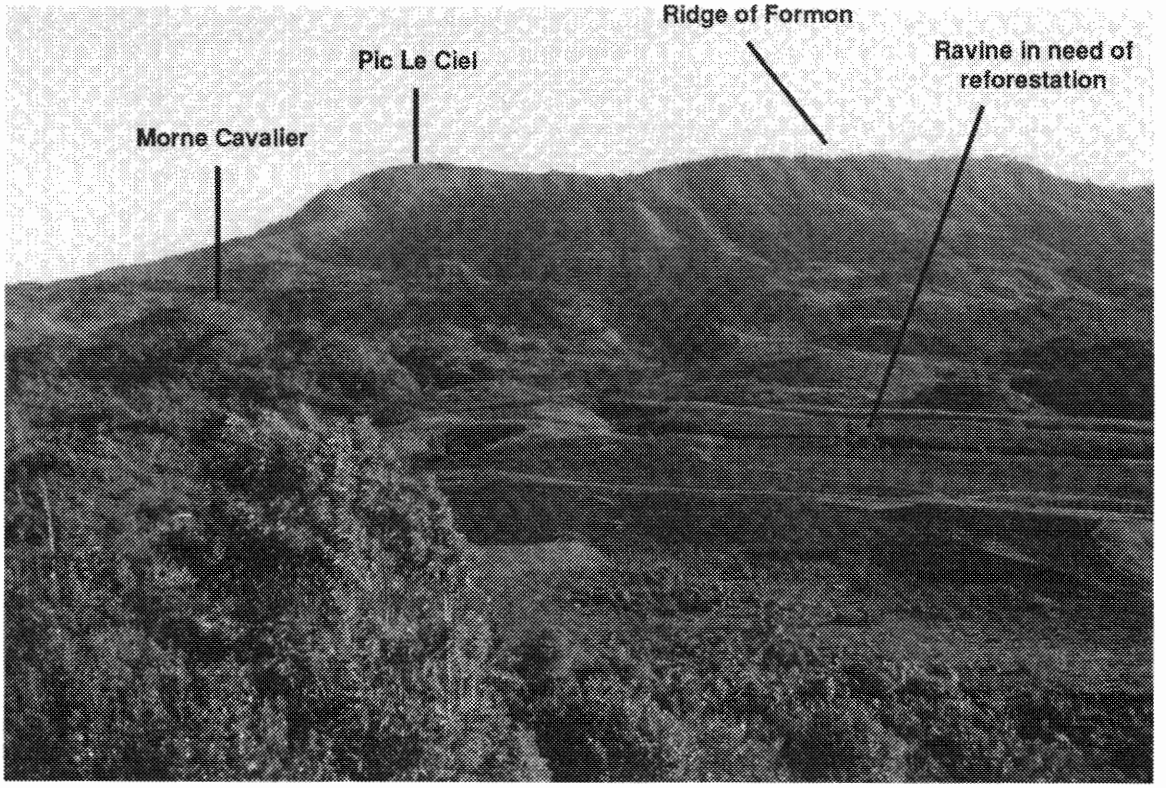
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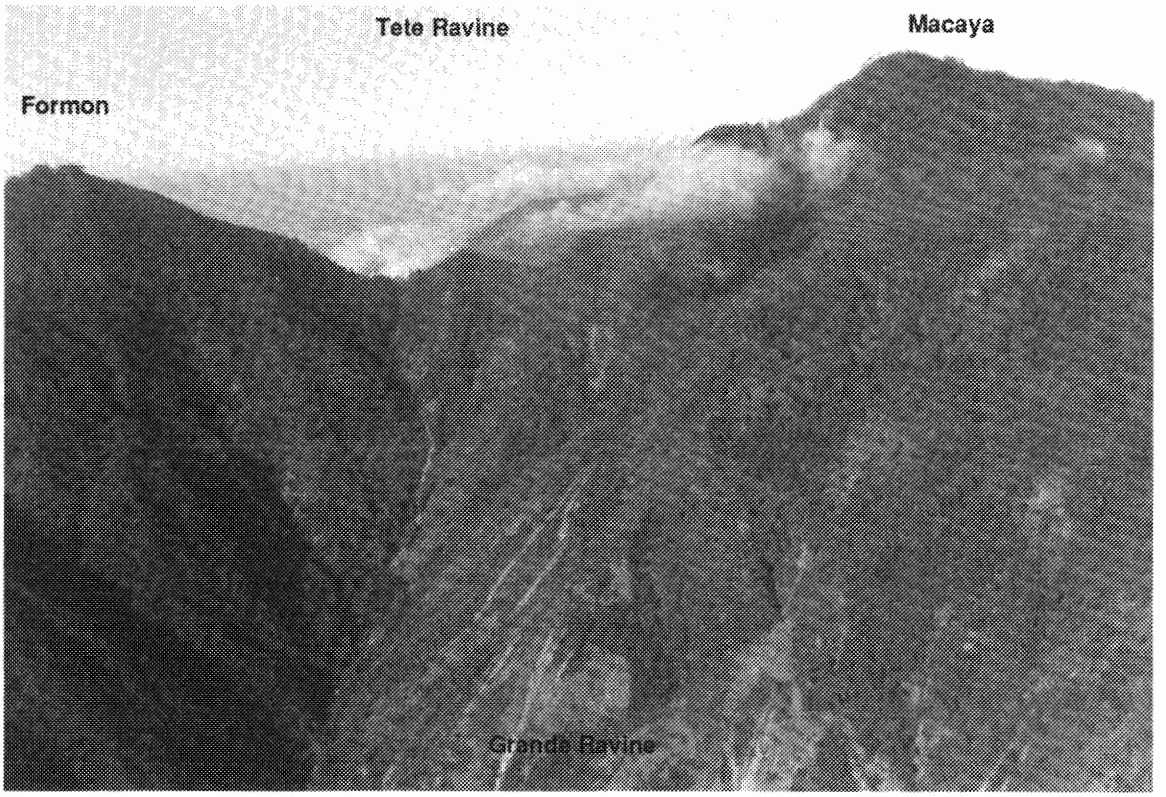
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Macaya Biosphere Reserve Area

1992

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RESUME

GESTION ET CONSERVATION DES AIRES PROTEGEES EN HAITI

Ce volume résume l'historique de la conservation en Haïti et le plan de gestion des parcs nationaux présenté au gouvernement haïtien en 1986. Il propose un système de gestion et d'administration des aires réservées, deux modèles de réserves de la biosphère et des alternatives à court et moyen terme. Il est, cependant, recommandé au lecteur de se référer aux figures, aux appendices et au texte anglais pour de plus amples détails.

Historique des aires protégées

Le concept de protection des aires naturelles en Haïti remonte à 1926. Il est étroitement lié à la protection des réserves forestières et des bassins versants. La législation concernant la protection des ressources naturelles et des zones réservées est copieuse, code rural de 1962, lois du 17 août 1955, du 7 avril 1958, du 28 mai 1968, décrets du 18 mars 1968, 31 mars 1971, décrets-lois du 23 juin 1937, du 27 juin 1944. La création des parcs nationaux naturels des mornes la Visite et Macaya date du décret du 23 juin 1983. Ce dernier remanie celui du 18 mars 1968 concerant la création de huit parcs nationaux et sites naturels et définit les responsabilités du MARNDR vis à vis de ces dix parcs. Les objectifs des zones réservées ou parcs nationaux ne sont pas définis donc leur gestion et administration crèent d'importants problèmes. Elles sont partagées entre deux institutions à budget restreint. Entre 1983 et 1988, les parcs étaient sous l'administration conjointe de l'ISPAN et du MARNDR qui n'ont pu se concentrer sur le programme de conservation des parcs nationaux naturels faute de moyens. A cette même époque, le Musée d'Histoire Naturelle de la Floride a travaillé sous contrat de l'USAID pour compléter les inventaires biophysiques, développer un plan de gestion pour les parcs nationaux du Morne la Visite et du Pic Macaya et un programme national de conservation.

Les objectifs du programme de parcs nationaux naturels en Haïti sont: 1) La protection des conditions et processus écoloqgiques naturels; 2) la promotion du patrimoine naturel national et son unique valeur; 3) le développement de programmes touristiques. Le programme de conservation des parcs nationaux devrait être développé dans les plus brefs délais car la flore et la faune du pays se détériorent à un rythme alarmant.

Objectifs des parcs nationaux

Les objectifs des parcs nationaux en Haïti n'ont jamais été définis. Le décret du 23 juin 1983 énumère les responsabilités du MARNDR comme suit:

a) protéger les conditions écologiques des parcs et sites naturels;

b) entreprendre l'inventaire des espèces animales et végétales des parcs et sites naturels;

c) étudier les caractéristiques des espèces endémiques de haute valeur scientifique ainsi que celles des facteurs physiques: géologie, sols, climats et autres des parcs et sites naturels;

d) identifier les aires naturelles terrestres ou maritimes du territoire national présentant des caractéristiques écologiques uniques ou spéciales et qui méritent d'être déclarées parcs ou sites naturels;

e) préserver les parcs et sites naturels de toute détérioration physique;

f) autoriser et supérviser dans les aires des parcs et sites naturelles tous travaux de recherche entrepris par la communauté scientifique;

g) diffuser toutes informations relatives aux parcs et sites naturels;

h) offrir les facilités d'accès et autres commodités aux visiteurs.

Un programme d'établissement d'aires protégées doit définir tout d'abord le but de chacun de ces espaces car leur objectif détermine leur plan de gestion. La synthèse des responsabilités remises au MARNDR résument les objectifs des parcs nationaux naturels comme suit:

1. *La protection des conditions et processus écologiques naturels.* Le bénéfice de ces actions est: A) la préservation des bassins versants, donc l'amélioration de la qualité de vie de tous les Haïtiens dans les aires adjacentes aux parcs nationaux; b) la préservation de la diversité des espèces naturelles donc du patrimoine national naturel.

2. *La promotion du patrimoine national naturel.* Ses bénéfices sont: a) l'enrichissement des connaissances des citroyens haïtiens sur les caractéristiques uniques de leur pays; b) la possibilité que de sages décisions soient prises pour le développement et l'utilisation durable des ressources naturelles à long terme.

3. Le développement de programmes touristiques et récréatifs qui prendrait avantage de la situation et de la beauté unique des parcs et des caractérirstiques spéciales comme la flore, la faune ou la géologie. Il est certain que les Haïtiens tireraient parti des parcs au niveau régional et national sans abimer leur qualité si le plan de gestion est développé et établi.

Administration des parcs nationaux et réserves naturelles

Ce plan propose une unité administrative, "*Parcs Nationaux Naturel d'Haïti*" ou Parcs Haïti, pour gérer toutes les divisions fonctionnelles d'un programme global de conservation. Cette organisation aurait à sa tête un directeur et serait sous la tutelle d'un seul ministère. Parcs Haïti serait en charge des sites naturels déjà identifiés par le gouvernement, proposerait d'autres sites uniques (plages, grottes, paysages uniques, jardin botanique etc.) et travaillerait en étroite collaboration avec le MARNDR, l'ISPAN et d'autres institutions concernées.

Parcs Haïti devrait être une institution autonome qui mettrait sur pied un programme de conservation fontionnel pour Haïti. Elle serait supervisée par un conseil, le Conseil Consultatif des Parcs Nationaux (CCPN) formé des directeurs de l'ISPAN, des Ressources Naturelles du MARNDR, de l'Office National du Tourisme, du président de la Société Audubon Haïti, d'un citoyen haïtien dûment intéressé à la conservation, d'un représentant d'une organisation internationale de conservation et du directeur de Parcs Haïti qui serait le

président et coordonateur de ce conseil. Les membres se réuniraient au moins une fois l'an pour discuter des programmes et de leur développement qui serait effectué avec le personnel proposé dans le tableau ci-dessous.

PARCS NATIONAUX NATURELS D'HAITI
(PARCS HAITI)

Bureau Central

Directeur
Assistant Directeur en Education et Récréation
Assistant Directeur en Conservation et Recherhe
Secrétaire-comptable
Secrétaire-bibliothécaire
Chauffeur
Messager
Gardien

Parc La Visite	**Parc Macaya**
Superviseur de Parc	Superviseur de Parc
Gardien	Gardien
Cuisinière	Cuisinière
Agents de Parcs (7)	Agents de Parcs (7)
Ouvriers (15)	Ouvriers (15)

Deux alternatives sont proposées pour la création immédiate de Parc Haïti. La première prévoit un contrat avec une institution internationale de conservation qui s'occuperait du programme en employant et entrainant des Haïtiens sur une période de cinq ans. La deuxième suggère, comme le projet de la Banque Mondiale, d'utiliser le personnel du Service de Protection de l'Environnement du MARNDR. Cependant, il est recommandé que Parcs Haïti n'ait qu'un seul directeur.

Les responsabilités de Parcs Haïti sont les suivantes: Exécution du plan de gestion, fonctionnement de Parcs Haïti, usage publique, gestion de l'environnement des parcs, observation et évaluation des caractéristiques naturelles, et développement des programmes éducatifs. Ces différentes activités seraient entreprises par le directeur et ces assistants pendant 1) la phase d'exécution qui comprendrait la révision du plan de gestion, les appels d'offres et embauchages,et 2) la phase de fonctionnement qui engloberait la coordination entre différentes institutions, les présentations et les relations publiques, la supervision du budget et la coordination sur le terrain. Le budget quinquenal de ces opérations est de 12.573.950 gourdes et comprend l'installation, les constructions, les salaires et les opérations.

Les parcs nationaux en Haïti

Le Parc National Pic Macaya

Il est situé dans le massif de la Hotte, à 36 km au nord'ouest de la ville des Cayes. On y accède difficilement, par la seule route voiturable de Ducis-Le

Prêtre-Platons. Il s'étend autour de deux montagnes dominantes, le morne Formond (2219 m) et le Morne Macaya (2347 m).et inclut de profondes ravines, d'autres mornes de formation karstique et volcanique et des forêts de pins et de feuillus riches en espèces endémiques. Son climat accuse des précipitations de plus de 3000mm/an due aux alizés, aux vents d'est et aux nordés. Le parc constitue le château d'eau de la Grande Ravine du Sud, la rivière de l'Acul, de Port-à-Piment, des Roseaux et de la rivière Glace, dont la stabilité est affectée par le déboisement excessif en "faveur" de cultures non-rentables. Ce parc est grandement menacé par une poignée de paysans qui mettent en jeu la vie de milliers de gens en aval.

Le décret du 23 juin propose arbitrairement une surface de 2.000 ha, cependant elle devrait être de 7.500 ha et comprendraient les régions et caractéristiques suivantes (Appendix III. Réserve de la Biosphère de Macaya. Proposed management plan):

1) Le morne Macaya (2.347 m), le morne Formon (2.219 m), le pic le Ciel (2.170 m), Civette (1.533 m) et Grande Plaine (1.900 m) zones de recharge de la nappe phréatique et sources de 5 rivières. Ces zones devraient rester boisées car elles accusent des pentes de plus de 60%, retiennent des milliards de tonnes de sols et protègent les systèmes d'irrigation en aval. La réhabilitation de ces zones sera extrêmement coûteuse à la nation haïtienne, car d'accès difficiles.

2) Bois Formond, Bois Durand situé entre la crête du morne Cavalier (1570 m), Sous Bois et les plaines de Durand et Formond. Zone de recharge de la nappe phréatique et d'importance capitale car particulièrement riche en espèces endémiques animales (oiseaux, agouti, reptiles et amphibiens) et végétales (orchidées, sapotilliers, mélastomes, calbassiers).

3) Mare Cochon/Diquillon de formation karstique et riche en espèces endémiques. Habitat unique et essentiel des nez longs (*Solenodon paradoxus*).

Cette surface de 7,500 ha ne représente 0.27% du territoire national, et le minimum requis pour un programme de conservation de la région qui contient le plus haut taux d'endémisme de l'île et constitue le château d'eau des milliers d'hectares des régions en aval.

Géologie

La géologie de la région de Macaya est complexe et se situe entre le Crétacé inférieur et le Récent. Elle est caractérisée par deux formations, celle de Macaya composée de roches calcaires à topographie karstique et celle de Dumisseau caractérisée par un conglomérat de roches volcaniques basaltiques, de turbidites calcaires, de cherts, de grès siliceux, et par un relief très accidentés avec des gorges étroites. Ce sont des zones à fort ruissellement. De nombreuses failles traversent le parc du nord au sud et d'autres de l'est à l'ouest. La plus importante faille qui sépare le morne de Formond de celui de Macaya date du Miocène et traverse une bonne partie de la presqu'ile du sud et le parc via la Grande Ravine du Sud. Des affleurements de basaltes peuvent être observés jusqu'à 1600 m sur le morne Formond. La plupart des géologistes pensent que la formation Macaya superpose celle de Dumisseau.

Sols

Les formations géologiques régissent la composition des sols de la région qui varient entre des oxisols et des ultisols à pH légèrement acide ou neutre. La plaine de Formond et le "Rak Bois" Formond comporte de profond oxisols à pH neutre, tandis que celle de Durand, les mornes vers Cavalier, la zone de Kay

Tilus, du Morne Formond et de Trois Sources ont des ultisols. Ces sols sont très suceptibles à l'érosion et sont déjà menacés dans beaucoup de régions.

Flore

La flore du parc comporte près de 500 espèces de plantes vasculaires dont 102 fougères (3 endémiques), 99 espèces de mousses et 49 espèces d'hépatiques, 1 conifère endémique, 141 orchidées (38 endémiques du massif de la Hotte et 58 de l'île d'Haïti), 367 autres plantes à fleurs (55 endémiques du massif de la Hotte, 18 du Massif de la Hotte et de la Selle, 39 de l'île). Trois espèces sur dix sont endémiques de Macaya. Un bon nombre de ces espèces sont sensibles à la déforestation et risquent de disparaître malgré leur potentiel sylvicole, médicinal et ornemental non encore exploité (Appendix I). Ces plantes sont groupées dans la forêt de pins, des forêts de feuillus, des bosquets denses, et/ou fragmentés, des jardins en jachère à l'intérieur des zones écologiques de Holdridge. La forêt très humide de montagne de basse altitude se situe dans la région de la plaine de Formond et des "rak bois" Formond/Durand, la forêt très humide de la zone sous-tropicale au nord du pic Macaya. Les crêtes des mornes Formond et Macaya sont du type de forêt très humide de montagne. Les régions du haut de la Grande Ravine du Sud et de Diquillon sont des forêts pluvieuses de montagne de basse altitude et finalement la forêt pluvieuse de la zone sous tropicale se situe dans la région du plateau de Mare Cochon vers Catiche.

Faune

Le parc national de Macaya compte 11 espèces de papillons dont le *Calisto loxias* connu seulement de cette région. Cinquante sept espèces de mollusques ont été collectés en 1983 dont 2 nouveaux genres, 27 nouvelles espèces, 23 endémiques. L'erpetologie de la zone compte 18 amphibiens et 14 reptiles (analyses en cours).

La faune aviaire d'Haïti est riche et comporte 73 espèces d'oiseaux dont 24 endémiques. Un grand nombre de migrateurs nichent uniquement dans les forêts montagneuses d'Haïti comme le "Chat-huant", diablotin ou pétrel (*Pterodoma hasitata*). Le parc national Macaya compte 65 espèces dont le Caleçon Rouge (*Temnotrogan roseigaster*), le kat Je Sid (*Phaenicopohilus poliocephalus*), le Ti Chit Kat Je (*Xenoligea montana*) et le colibri (*Tudus angustrirostris*). Les analyses d'enquêtes confirment qu'onze espèces sont vulnérables à cause de la dégradation de leur habitat et menacés d'extinction. Des programmes de rétablissement et de conservation sont urgents, ils seront difficiles mais pas impossibles. La disparition d'espèces entraine tout un déséquilibre qui affecte grandement les hommes à court et à long terme.

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.

Paléontologie

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). Les fouilles ont revelées que les mammifères collectés dans la région de Formond vivaient depuis le Pleistocène supérieur et l'Holocène inférieur.

Gestion et utilisation de l'espace

La gestion du parc national Macaya comprendrait les volets suivants sur des espaces bien spécifiques: 1) la récréation ouvertes aux touristes; 2) l'enrichissement où se déroulent les expositions pour l'information du public sur le parc; 3) la préservation biologique qui représente l'activité la plus importante du programme de conservation; 4) la régénération qui permet la restauration des systèmes naturels; 5) la recherche qui comprend des stations climatologiques et laboratoires; 6) les guérites de sécurité et d'information; 7) les zones d'utilisation spéciale qui ne peuvent être visitées qu'avec un permit; 8) les zones de service et d'entretien où sont placés les dépots et où le personnel fait la mise en place pour les différents programmes.

Le plan de gestion du Parc National Pic Macaya est divise en neuf thèmes: 1) l'Administration dont serait responsable un superviseur de parc; 2) l'entretien qui serait entrepris par une équipe à plein temps; 3) la sécurité assurée par des agents de parcs entrainés; 4) la récréation et le tourisme; 5) l'enrichissement et l'interpretation; 6) les relations publiques; 7) la recherche; 8) le plan quiquenal de conservation qui comprend la préservation des systèmes existants et leur régénération dans les aires critiques, la préservation de la faune et de la flore, la stabilisation des bassins versants, des aires érodées et la régénération des forêts; 9) le plan décennal qui comprend le bornage du parc et des zones réservées, les appels d'offres, l'emploi et la formation du personnel nécessaire, la construction des guérites de sécurité, d'autres centres d'accueil dans les régions de la Guinaudée, Déglacis, Trois Sources, l'établissement des plan de conservation et de préservation, le développement des attractions pour touristes, la pose d'affiches et panneaux, les recherches sur les espèces endémiques, l'amelioration et entretien des structures et des routes de pénétration.

Parc National La Visite

Il est situé à 22 km de Port-au-Prince dans le Massif de la Selle. L'accès est diffile via la route de Furcy et Ka Jacques (55Km) ou encore par la route de Jacmel-Marigot-Seguin (150 Km et plus de 6 heures de route en jeep). Il s'étend tout au long de la crête de ce massif entre le morne d'Enfer (1.900 m) et le morne Kadeneau(2.155 m). Le point le plus haut du parc est la borne de 2.282 m du Morne Cabaio. Le décret du 23 juin 1983 propose 2.000 ha. Le bornage officiel du parc n'a pas encore été entrepris, cependant les limites naturelles du parc entourent une surface de plus de 4.500 ha. Le morne d'Enfer est une extention naturelle du parc qui se trouve dans une aire non habitée à l'ouest de la Visite et de la route de reliant Furcy à Seguin. Cette aire devraient être comprise dans le parc car c'est un habitat-refuge pour les espèces endémiques. L'ensemble requis pour la protection efficace des bassins versants et des espèces endémiques (du Morne Kaderneau au Morne d'Enfer) représente 6.300 ha (Appendix III. Map of la Visite).

Géologie

La géologie du parc la Visite reflète celle de l'île et est constituée de deux formations. La formation de Neiba composée d'un bloc calcaire de l'Eocène qui comprend des dolines, des grottes souterraines et des ravines et la formation Dumisseau du Crétacé supérieur qui comprend du basalte et des olivines. Les limites septentrionales du massif de la Selle accuse une faille.

Flore

La flore du parc la Visite est riche en espèces endémiques groupees dans des forets de pins et de feuillus. Elle compte plus de 300 especes de plantes vasculaires dont 12 d'orchidées, 3 conifères et 60 fougeres. Des 262 plantes a fleurs collectees en 1983, 60 especes sont endemiques de l'île, 40 du massif de la Selle et 12 du massif de la Selle et de la Hotte.

Faune

Le parc national du Morne la Visite compte 20 espèces de papillons dont le *Calisto archebates* connu seulement de cette région. Quarante cinq espèces de mollusques ont été collectés en 1983 dont 27 nouvelles espèces. Trois amphibiens et un reptile sont endémiques du massif de la Selle. La faune aviaire accuse 67 espèces d'oiseaux dont 17 endémiques de l'île. Seul l'agouti (zagouti) et 4 chiroptères vivent encore dans ce parc. Seize mammifères terrestres et 4 chauve-souris ont disparus au cours des 1000 dernieres années.

Ressources

Les ressources géologiques et biologiques sont inventoriées dans les rapports des parcs nationaux (Géologie, flore, papillons, malacologie, erpétologie, oiseaux et mamifères des parcs nationaux). L'analyse de ces documents indiquent que les parcs nationaux sont de grande importance à cause de leurs caractéristiques uniques. La géologie des deux parcs révèlent des détails sur le passé d'Haïti quand les sommets des montagnes étaient des écueils. Le grand fossé de la Grande Ravine du Sud entre le morne Formond et le morne Macaya fait partie d'une immense faille qui coupe en travers la péninsule du sud de Tiburon à la Plaine du Cul-de-Sac.

L'importance de chaque parc est discuté en matière d'endémisme. Le parc Macaya contient plus de plantes et de mammifères endémiques que celui de la Visite, cependant le parc la Visite abrite 2 espèces endémiques d'oiseaux

de plus, et deux fois plus de lépidoptères que le parc Macaya. Beaucoup de mammifères dont quinze terrestres et quatre chiroptères ont disparus du parc la Visite. La perte des mammifères endémiques dans les deux parcs est dramatique, mais pas unique. La moyenne des pertes des espèces endémiques à travers la Caraïbe pendant les 3000 dernières années est de 88%. Il est clair cependant que les pertes à la Visite sont plus importantes que celles à Macaya puisque la Visite est une zone perturbée. Une espèce endémique de la région de Macaya a disparue avant même qu'elle n'ait été décrite. D'immenses efforts pour trouver en de nouvelles sont restés vains. En effet, cinq espèces ont disparues au cours des trente dernières années, ce qui coincide avec la perte dramatique des habitats naturels.

Les Réserves de la Biosphère

Une stratégie qui établirait un programme de conservation des ressources naturelles en Haïti doit combiner développement durable et conservation pour satisfaire les besoins d'une population sans endomager les écosystèmes naturels. Ceci est possible grâce au développement de réserves de la biosphère. Ce concept permet de promouvoir et maintenir la balance entre les hommes et le milieu naturel par une utilisation adéquate de l'espace. Il semble convenir à la gestion des aires protégées en Haïti. Une réserve idéale est composée d'une aire réservée entourée de zones fonctionnelles. Dans la région de Macaya, le projet de l'université de Floride a développé ce modèle qui n'est toujours pas officiel auprès de l'UNESCO. Elle consiste en une zone réservée qui est le parc national Macaya, et des zones fonctionnelles qui comprennent l'agriculture, l'agrosylviculture et l'élevage, des zones d'utilisation spéciale et de forêts. Chacune des zones peut être géree par des organismes différents moyennant une bonne collaboration. Ce serait le rôle de Parcs Haïti de protéger le parc national et de coordonner les activités de production avec d'autres organisations.

Il est recommandé d'inclure les sites naturels déjà identifiés par le gouvernement dans un système de réserve de la Biosphère. Trois réserves potentielles existent dans le massif de la Selle (Réserve de la Biosphère de la Visite), de la Hotte (Réserve de la Biosphère de Macaya) et dans le département du Nord (Réserve de la Biosphère Henri Christophe). Cette dernière comprend 5 unités qui abrite des zones de coopération (tourisme, agriculture, agrosylviculture, sylviculture, conservation et régénération). Ces unités sont placées dans un contexte historique, touristique ou de protection des bassins versants pour allier la conservation au développement. Elles sont choisies dans la zone de la Citadelle Laferrière, du Borgne, de Bassin Zim, des Mornes du Cap et de la source de la Grande Rivière du Nord.

Le futur des aires protégés en Haiti

La gestion des aires protégées requière un plan actif et dynamique et son exécution à long terme qui devra être implanté dans les plus brefs délais, autrement les 2% de forêts et de végétation naturelles qui restent encore au pays seront rapidement détruits. Le projet de l'université de Floride financé par l'USAID a fonctionné pendant cinq ans et aurait encore beaucoup à faire pour protéger le parc. Plus de 12 sites naturels devraient être gérer. Le projet de la Banque Mondiale qui embrasserait un grand volet de conservation et de protection de l'environnement est en suspend. En attendant qu'il soit implanté, l'université de Floride a obtenu de la Fondation MacArthur un don qui supporte des activités de conservation et d'éducation environnementale pendant seulement trois ans. La conservation des ressources, parcs et sites naturels en Haïti est urgente.

Introduction

This volume is a revision of the Stewardship Plan for the National Parks of Haiti published in 1986 (Woods and Harris, 1986; Woods, 1986). Those volumes summarize a series of biogeophysical surveys of the national parks of Haiti funded by USAID (contract number 521-0169-C-00-3083-00), and present an initial plan for the development of a national park system for Haiti. The volumes also discuss the initial concept of the Macaya Biosphere Reserve (MBR) that became the focus of the United States Agency for International Development (USAID) sponsored project by the University of Florida in the Macaya area. The Stewardship Plan and other Biogeophysical Survey Reports are out of print now, and are difficult to find. This volume revises the original Stewardship Plan to take into account the work of the University of Florida Macaya Biosphere Reserve Project (UFMBRP) during the past five years. We have also included a chapter on the importance of developing Species Recovery Plans for use in conserving endangered and threatened species, and a chapter on managing Natural and Historic sites that are linked in a natural and historic sense, but disjunct in geography. This volume is intended to be used in association with *The Natural History of Southern Haiti.* That volume summarizes all that is known about the natural patrimony of southern Haiti, and includes detailed Species Recovery Plans for three critically endangered species.

Three alternatives are proposed for the development of a national park system for Haiti.

The University of Florida has been working with USAID, the Institut de Sauvegarde du Patrimoine National (ISPAN), and the Ministere de l'Agriculture des Ressources Naturelles et du Developpement Rural (MARNDR) for over fifteen years to promote the conservation of the natural resources of Haiti. This work has resulted in a number of scientific publications and reports documenting the unique natural patrimony of Haiti, and pointing out the special nature of the Massif de la Hotte. With funding from USAID/Haiti via contract number 521-0169-C-00-3083-00, the Florida Museum of Natural History and the University of Florida completed a biogeophysical inventory of the national parks of Haiti, and proposed a plan for the administration and stewardship of these newly-established national parks. With additional funding from USAID/Haiti via contract number 521-0191-A-00-7107, some of these plans were initiated under the Macaya Biosphere Reserve Project. The present volume is a view of what we believe is the best route for creating a ongoing program in Haiti in general, and the Macaya area in particular during the next ten years.

Our objectives in this book are to provide recommendations on how to establish a program of natural resource conservation, preservation and management in Haiti. We have tried to formulate our recommendations using the concept of "dynamic" national parks and biosphere reserves. We use the word dynamic to emphasize that any management plan will have to change as political and economic conditions in Haiti change (we hope improve), and as the programs designed to administer natural areas mature during the ongoing process of institution building that must occur in Haiti during the coming decade. Our analyses and recommendations are focused on the region of the Massif de la Hotte. This mountainous area is one of the most important sources of water in Haiti, and many endemic plants and animals are restricted to this area of high mountain peaks and remote, well forested valleys.

The concept of "dynamic" management is introduced for protected areas in Haiti.

In recognition of the importance of the Macaya region to the natural patrimony of Haiti, as well as to its role in water conservation, a large part of the Massif de la Hotte was placed under the protection of the Government of Haiti (GOH) as Parc National Pic Macaya. Legislation which passed in 1983 created Parc National Pic Macaya in the Massif de La Hotte and Parc National La Visite in the Massif de la Selle (Map 1). These are the first national parks of significant size in Haiti, and therefore have special importance in the history of the Republic. Our objective is to provide data, analyses, historical comparisons, recommendations and a plan of operation that can be used by the GOH, interested International Organizations, Non-Governmental Organizations (NGOs), and Private Volunteer Organizations (PVOs) in planning, implementing and administering a national parks program, and regional

biosphere reserves. The recommendations in this report are based on our own personal analyses and reflect our experiences in Haiti, as well as our original ideas for national parks in the area (Woods and Rosen, 1977).

Our park plan may not be the only viable solution to the question of how to create a functional program in national parks in Haiti. We are not sure what the best route to take is because of the many financial, administrative, social, historical and scientific questions that have weighed heavily on our minds as we have tried to formulate a national park program that is best suited for Haiti. We sincerely believe, however, that with the assistance of the many important institutions and programs discussed in our document, Haiti will be able to create a long-lasting program in the conservation of natural resources and the protection and promotion of its natural patrimony. If this is done, water and soil will be available for future generations of Haitians to use in maintaining the quality of life in their fragile island nation. The development of programs such as the ones outlined in this book will also help preserve what is left of the natural patrimony of Haiti. And that natural patrimony is truly special, as is outlined in *The Natural History of Southern Haiti*. With wise land stewardship, there is a sustainable future for Haiti. Without land stewardship, the future is a grim one. On this summer day in 1992, Haiti is at a crossroads. We hope that this book will be a signpost that will help point the direction towards a better future for all Haitians, and preserve Haiti's very special natural heritage.

The Literature on Natural Resources and Conservation of Haiti

Haiti has a long history of human occupation and alteration of its diverse ecosystems. Enough is known of the biological diversity of the country, based on an analysis of fossil vertebrates from cave and sinkhole deposits and of fossil pollen in sediments, to say with certainty that until the time humans arrived on the island between 5000 and 7000 years ago, remarkably diverse floras and faunas were present in Haiti (Woods, et al., 1986, Woods and Ottenwalder, in press). Historical accounts indicate that significant elements of that diverse flora and fauna were present until long after the time of Columbus, and that many regions of the country were still forested and contained diverse natural ecosystems into this century (Wetmore and Swales, 1931; Wetmore and Lincoln, 1933; Wetmore, unpublished field notes; Ekman, 1926, 1928, unpublished catalog; Cohen, 1984; Lowenstein, 1984; Woods and Ottenwalder,

The natural patrimony of Haiti must be protected.

1993). But it is difficult for most people interested in the natural resources of Haiti to gain access to this information.

There is a very sparse literature on the natural resources of Haiti in general. The best body of literature relates to the natural resources of the Macaya area. This literature is reviewed by Woods and Sergile in *Haiti, A Research Handbook* edited by Robert Lawless (1990). The book is available in most libraries. Another good 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 available in most libraries because they were privately published in very limited numbers via xerox. A complete set of David Wetherbee's publications is available at the Florida Museum of Natural History (FLMNH), and several other major museums and libraries in North America, 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). The three volumes by Moreau de Saint-Mery provide a comprehensive description 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.

Enough is known about the diversity of Hispaniola to start a conservation program.

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



Dr. Erik Ekman returning from collecting plants in the Pic Macaya area. Dr. Ekman first visited Haiti in 1917.

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 *The Natural Resource Data Base* (Sergile and Woods, in press). 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.

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 I

The Concept of National Parks and Biosphere Reserves in Haiti

1. Introduction

This chapter is a review of how national parks came to be in Haiti. It also presents some of our ideas as to why it has been so difficult create a national parks infrastructure within the present organization of the Government of Haiti. The chapter is a combination of many ideas first presented in the original Stewardship Plan (Woods and Harris, 1986), and of our experiences on the MBR Sondeo. The objective in this chapter is to present the legal framework around which the creation of the national parks of Haîti took place, especially Parc National Pic Macaya, as well as our experiences trying to make the national park work within the context of the rapidly changing political situation that followed the change in governments that was begun in 1986 with the fall of Jean Claude Duvalier. The Macaya Biosphere Reserve Project began at about the same time as fall of Duvalier, and continued through a series of political changes that continue to this day. Some of the major political events which took place in the last decade and which influenced this project are summarized in the following table (and placed within a broader summary of Haitian history).

HAITIAN HISTORY

SIGNIFICANT DATES

First Taino Indians	5,000 BC
First Europeans (Columbus)	1492
First French Buccaneers (Ile de la Tortue)	1625
Treaty of Ryswick	1697
Saint-Domingue	
Start of Slave Uprising	1791
Slaves Freed in Saint-Domingue	1793
Toussaint Louverture	1795
French Invasion	1799
Death of Toussaint	1803
Independence of Haiti	Jan.1, 1804
Henry Christophe Rule of North	1808-1820
Haitian Control of All Hispaniola	1822-1843
"Code Rural" of Boyer	1826
Years of Turmoil	1843-1915
U.S. Marine Occupation	1915-1934
Francois Duvalier (Papa Doc) Rule	1957-1971
Jean Claude Duvalier (Baby Doc)	1971-1986
(29 years of Duvalier rule)	
National Park at La Visite Establised	5 May 1981
National Park at Pic Macaya Established	23 Jun 1983
Beginning of the MBR Project	1986
Jean Claude Duvalier Overthrown	Feb. 7, 1986
Failed Election & Murders	29 Nov. 1987
U.S. Aid Cut	Dec. 1987
Manigat Elected President	17 Jan. 1988
Manigat Deposed, Namphy in Place	June 1988
Attack on Father Aristide	11 Sep. 1988
Coup d'Etat & Gen. Avril in Place	17 Sep. 1988
Election of Jean-Bertrand Aristide	Dec. 1990
Coup d'Etat Removed President Aristide	30 Sep. 1991
OAS Embargo against Haiti	Nov. 1991
UFMBR Final Macaya Area Survey	8-16 April 1992
OAS Embargo Strengthened	17 May 1992
End of MBR Project	31 May 1992

2. Terminology

Many organizations, individuals and terms are used in the course of this report. In order to provide a guide to the reader 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 only the acronym is used.

DMRE Departement des Mines et des Ressources Energetiques

FLMNH Florida Museum of Natural History

GOH Government of Haiti

INAHCA Institut National Haitien de la Culture et des Arts

ISPAN Institut de Sauvegarde du Patrimoine National

IUCN International Union for the Conservation of Nature and Natural Resources

UFMBRP 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 [also known as **DARNDR** and sometimes as **Damien**].

MUPANAH Musee du Pantheon National d'Haiti

NCS National Conservation Strategy

NPS National Parks Service of the United States

ONTRP Office National du Tourisme et des Relations Publiques

PC Parks Canada

Parcs Haiti Parcs Nationaux Naturels d'Haiti

SPE Service de la Protection de l'Environnement

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

USAID United States Agency for International Development

UNEP United Nations Environment Program

UNESCO United Nations Educational, Scientific and Cultural Organization

WBP World Bank Environmental and Forestry Project

WCS World Conservation Strategy

WWF World Wildlife Fund

The following words are used in the text of this report without definition. A brief definition of each is provided below.

BIOTIC DIVERSITY. The desired condition of having the greatest number of compatible species associations in natural area. The goal of our stewardship plan is the 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.

ENEDMIC 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.

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) condition. The activity is one element of a stewardship plan.

SITE EXHIBIT. An exhibit located within the boundaries of the national park or at a scenic location with a view of the park. The exhibit is capable of withstanding the effects of weather with only a shelter to protect it from direct rain.

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 if 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.

3. Conservation Strategy in Haiti

The national patrimony of Haiti consists of a blend of natural and cultural history. This "history" consists of physically tangible items such as endemic species and cultural artifacts as well as intangibles such as unrecorded folk music, culture and unique vistas and beautiful landscapes. No single item of natural or cultural history is any more important than another. All aspects of the national patrimony are to be cherished and conserved to the degree that national pride and identity dictate. The Conservation Strategy for Haiti should: 1) identify these items; 2) formally acknowledge their existence and worth; 3) follow a standard decision-making process to determine their disposition. All cultural and natural history items must or can be conserved, but the process of definition, deliberation and decision making should not be compromised. The Government of Haiti (GOH) should carefully design and designate the responsibilities of its departments and institutes so that all elements of the national patrimony are encompassed by an administrative unit with a clear mandate for the evaluation and eventual disposition of a particular kind or class of patrimony. Several departments and institutes of the GOH are responsible for various aspects of national patrimony (see table, page 20). We stress, however, that while overlapping responsibility for conservation may appear ideal on the surface, it is not ideal in practice. Disputes regarding authority and perceived responsibility often can develop. We recommend that the GOH reduce the level of overlap between departments and institutions where possible and work with each unit of the national organizational structure to clearly define their areas of responsibility. When it is not clear which unit has responsibility for all aspects a particular class of national patrimony, such as in the case of the national natural patrimony, then the GOH should consider establishing a new administrative unit.

Many of the cultural and natural history items alluded to above are not renewable and thus their conservation strategy should be

distinct from that of renewable natural resources. A museum piece or scenic vista can be "used" in the sense that it can be looked at, appreciated and studied, but actual physical use may quickly destroy it. Similarly, a forested watershed may be "used" to precipitate, obtain and moderate clean water supplies, but actual physical use of the same watershed may destroy it just as surely as the physical handling of a prized national artifact would destroy the artifact. For this reason we advise caution in adopting the philosophy that all natural resources are renewable and thus can be "developed" for sustained use. The definition of conservation presently proposed by the IUCN is as follows:

> The management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations.

Note that the emphasis is on management of the human use rather than on the management of the resource itself. By this definition, conservation is positive and covers the spectrum of specific approaches. These include PRESERVATION of resources such as cultural artifacts and critically rare plants and animals; MAINTENANCE of resources such as viable populations of native plants and animals and unspoiled beaches and vistas; SUSTAINABLE UTILIZATION of resources such as rich alluvial plains, forests, and game birds; RESTORATION of resources such as deforested mountain slopes; and ENHANCEMENT of resources such as watersheds, forests and upland areas.

A forested watershed may be "used" to precipitate, obtain and moderate clean water supplies, but actual physical use of the same watershed may destroy it just as surely as the physical handling of a prized national artifact would destroy the artifact.

In Haiti the preservation of resources such as endemic species and the enhancement of resources such as watersheds and forests become a common concern. This is because in most regions of the country so much habitat for endemic species has been altered from its natural state that many species of plants and animals have become extinct or have been severely reduced in numbers. The areas where habitats have been least disturbed are in remote montane regions. These are the same regions where the watersheds of some of the major river systems of Haiti are located. These areas, such as specific regions of the Massif de la Selle and Massif de la Hotte of southern Haiti are places where forest cover remains and endemic species are still present. The objective is to save important elements of the national natural patrimony by saving habitats. The habitats that are preserved, maintained, restored or enhanced improve the quality of the ecosystem and promote water and soil conservation. Therefore, in a country such as Haiti, where land and resources are limited, the effort to save important elements of the national natural patrimony is not a luxury that the country cannot afford, but rather a critical link in the preservation of its natural resources and especially its soil and

water resources. Sites for national parks and conservation areas must be carefully selected with the aim of preservation of natural patrimony and conservation of water and soil.

The original idea of the University of Florida on how to develop a sound conservation strategy for Haiti can be summarized in the following table:

USUAL STEPS IN DEVELOPING A CONSERVATION STRATEGY

1). The Biological Phase
Research
Inventories
Recognition of Endemics

2). The Conservation Phase
Proposing Conservation Schemes
Lectures and General Articles
Development of a Conservation Strategy

3). The National Parks Phase
Legislation
Governmental Action
Long-term Commitment & Ecosystem Stability

The concept of national parks in the Massif de la Hotte region was pioneered by the University of Florida in close association with ISPAN and MARNDR. 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 1600 meters elevation). Two important problems remain to be resolved. 1). The first is to find an appropriate organization in Haiti with a GOH mandate and sufficient funding level to take charge of the administration of the park. During the past decade both ISPAN and MARNDR expressed sincere interests in the conservation of soil, water, and natural resources, as well as protecting the natural patrimony of Parc National Pic Macaya. Louis Buteau of MARNDR assigned three technicians to the

UFMBR project, and he closely monitored the progress of the conservation plans for the area. MARNDR worked closely with a team from the World Bank to design a project that would protect the national parks of Haiti through a strengthened program at the SPE of MARNDR. Albert Mangones of ISPAN developed a plan to create a "Division du Patrimoine Naturel," and made an official proposal to the GOH for the establishment of this division within ISPAN. But these plans have floundered at the present time. Albert Mangones retired as Director of ISPAN, and there is no longer a program to protect the natural patrimony at ISPAN. The World Bank Environmental and forestry Project (WBP) has been suspended until the political and economic situation in Haiti stabilizes, and MARNDR does not have the financial base or resources to assume full and comprehensive responsibility for the national park at Macaya. So, the question as to what organization is capable of administering national parks in Haiti is unresolved, and the national parks program in Haiti is floundering.

The second, and equally important, problem that must be addressed is the complex role of the local communities in the Massif de 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. It is with this in mind that the University of Florida, in conjunction with USAID/Haiti, developed a plan to create a biosphere reserve in the Massif de la Hotte region. The University of Florida, with funding from USAID/Haiti, worked closely with residents of the Massif de la Hotte region to understand their needs and expectations, and to evaluate these criteria within the framework of wise use of the natural resources and physical features of the Massif de la Hotte area.

The question as to what organization is capable of administering national parks in Haiti is unresolved, and the national parks program in Haiti is floundering.

The UFMBR Project anticipated writing a final plan that would have integrated all of these data into an official document following the guidelines for biosphere reserves from around the world. This document would formally request that the area including and surrounding Pic Formon and Pic Macaya be officially recognized as a World Biosphere Reserve. The plan for the Macaya Biosphere Reserve when completed would include a series of land use maps and proposed land use zones, and would recommend specific land use practices for all areas within the biosphere reserve. Every attempt would be made to integrate the human and natural resources of the Macaya area of the Massif de la Hotte into a plan that

will improve the quality of life for all concerned. The goal of the Macaya Biosphere Reserve Project of the University of Florida was to protect the biological diversity, promote the wise use of renewable natural resources, conserve the water and soil, and improve the quality of life of local residents of the Macaya area through wise land use policies and innovative interactions between local residents, concerned Non-governmental Organizations (NGOs), international organizations, and the GOH.

The planned Macaya Biosphere Reserve has also floundered. The economic and political problems in Haiti made it impossible for a GOH institution to come forth to take full responsibility for the national park at Macaya. The political conflict between the United States and Haiti often made it impossible for the UFMBR project to interact with GOH sponsored organizations like MARNDR. And the desperate plight of local residents in the MBR area, made worse by economic hardships created by the embargo against Haiti in 1992, made it difficult to involve local residents in a program of mutually planned land stewardship. These problems made it impossible to develop a program or write a document requesting official designation of the Macaya area as a World Biosphere Reserve from UNESCO. So the biosphere reserve project is floundering.

Desperate peasants in the Macaya area are moving into the national park to cut wood and make gardens. No GOH organization is in place to prevent this. Local residents in the surrounding buffer zone are also increasing the rate of habitat destruction. The reasons for these difficulties are complex. The solutions are even more complex. But several things are very clear. 1). The idea of preserving biological diversity in Haiti has to include more than just a series of biological fortresses designed to keep people out. 2). The GOH is going to need to create some group with a mandate and interest in preserving natural resources in the country, and the nucleus of that group barely exists at the GOH level at the present time. 3). The stewardship of fragile lands in remote areas of Haiti should include input from local residents, but local residents alone will not be good stewards of the land because local economic conditions in Haiti are so desperate that exploitation of the environment is perceived as a necessity.

A few desperate peasants are cutting trees and establishing gardens at the expense of the nation.

This complex situation is best summarized in the following table, which summarizes the present concept of the University of Florida as to how to develop a sound conservation strategy in Haiti:

STEPS IN DEVELOPING A CONSERVATION STRATEGY FOR HAITI

Biological Conservation in Haiti: The Macaya Experience

1). The Biological Phase
Research
Inventories

2). The Conservation Phase
Proposing Conservation Schemes
Lectures and General Articles

3). The National Parks Phase
Legislation Passed in 1983

MARNDR & ISPAN Administration

4). The "Reaction" Phase
Redirection of Habitat Exploitation
Emigration
Socio-economic Stres

5). The "Sondeo" Phase
Recognition of Need for AdditionalInformation
Design of Sondeo Team
Resolutions of Conflicts
Fieldwork and Writing Report

6). The Biosphere Reserve Plan
Recognition of Limitations of National Parks
Study of Biosphere Reserve Concept
Modification of Classic Biosphere Reserve Outline
Biosphere Reserve-The HaitianModality
Planning and Recognition of MBR as Official Biosphere Reserve

7). The Long-term Conservation Phase
Determination of GOH Role in MBR
Determination of Alternative Funding Sources
Integration of Private, GOH, and International Organizations

4. Actions of the Government of Haiti in Conservation

Park National Pic Macaya is located in the Massif de la Hotte, and is part of the official list of National Parks of Haiti. The background legislation that established Parc National Pic Macaya, as well as all legislation relating to national parks in Haiti are described and discussed below.

The Government of Haiti (GOH) has taken a legislative role in the past to protect the environmental and natural patrimony of the Republic by passing laws and decrees. The law of 17 August 1955 (Moniteur number 87, 26 September 1955) regulated cutting, transporting and selling wood, protected the environment and created "Zones sous protection" and "Zones reservees." Law Number Eight (Des Forets) of the Rural Code of Francois Duvalier (Moniteur number 51, 28 May 1962) passed even stricter legislation concerning the protection of forest resources and controlled activities in forest reserves. The decree of 31 March 1971 (Moniteur number 26, 1 April 1971) regulated hunting and protected nine categories of birds in accordance with the recommendations of the "Convention pour la Protection de la Nature et la Preservation de la Fauna Sauvage dans l'hemisphere occidentale," which Haiti ratified. In addition to the laws of 1955 and 1962, protecting the natural forests of the Republic, and the law of 1971, regulating hunting and protecting certain bird species, the GOH has passed legislation concerning national parks. The decree of 1968 (Moniteur number 23, 18 March 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 was expanded to include natural lands in the "Communique" of 5 May 1981 that appeared in the *Nouveau Monde* which discussed establishing the first "Parc Naturel" in Haiti in the area between Morne La Visite and Morne Kadeneau in the Massif de la Selle.

The official creation of "Parcs Nationaux Naturels" was by decree published in *Le Moniteur* (number 41, 23 June 1983). The decree listed as existing laws: four articles of the Constitution; a 1921 law on public utilities; a 1926 law on "Forets Nationales Reservees;" a 1940 law concerning "monuments historiques;" a 1958 law organizing DARNDR; the decree of 1968 naming "Parcs Nationaux" and "Sites Naturels" ; the decree of 1979 creating ISPAN; a 1982 law on regionalism; a 1982 law on uniform structures; and the decree of 1982 creating the Musee du Pantheon National d'Haiti (MUPANAH).

Laws regarding protected areas need to be enforced.

The decree of 23 June 1983 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 hereafter we will designate as Parc National La Visite and "Morne Macaya du Massif de la Hotte" (2,000 hectares), which we will designate as Parc National Pic Macaya.

Article 2 of the decree directs that "l'administration generale, la protection et la mise en valeur des parcs et sites naturels terrestres et maritimes sont a la charge du Departement." The "Departement" is not identified in Article 2 nor any place in Article 1.

The major responsibilities for the national parks program of Haiti are listed in Article 3 of the 1983 decree under additional responsibilities of MARNDR. Article 3 is quoted below (Le Moniteur No.41 1983:458):

> "En plus des attributions courantes définies dans la Loi Organique du 7 avril 1958, le Département de l'-Agriculture, des Ressources Naturelles exerce les attributions suivantes ayant trait à la gestion des parcs et sites naturels;
>
> a) protéger les conditions écologiques des parcs et sites naturels.
>
> b) entreprendre l'inventaire des espèces animales et vegetales des parcs et sites naturels.
>
> c) étudier les caractéristiques des espèces endémiques de haute valeur scientifique ainsi que celles des facteurs physiques: géologie, sols, climats et autres des parcs et sites naturels.
>
> d) identifier les aires naturelles terrestres ou maritimes du territoire national présentant des caractéristiques écologiques uniques ou spéciales et qui méritent d'être déclarées parcs ou sites naturels.
>
> e) préserver les parcs et sites naturels de toute déterioration physique.
>
> f) autoriser et superviser dans les aires des parcs et sites naturels tous travaux de recherche entrepris par la communauté scientifique.
>
> g) diffuser toutes informations relatives aux parcs et sites naturels.

h) offrir les facilités d'accès et autres commodités aux visiteurs.

Based on these legislative acts, our interpretation of the primary conservation goals of the GOH are: 1) watershed management; 2) soil stabilization and conservation; 3) enhanced and sustained potable water supplies; 4) sustained yield forest products. We endorse a strong and unwavering commitment to these goals, which can greatly facilitate the preservation of endemic species, the maintenance of natural biotic diversity, the development of a parks-related tourism industry, and the protection of natural ecological processes. Within the 23 June 1983 GOH National Parks decree are eight specific goals and responsibilities for the national parks program:

1). Protect natural ecological conditions and processes.

2). Identify sites possessing a significant element of national patrimony.

3). Preserve existing parks and potential park sites.

4). Inventory and describe natural plant and animal species.

5). Research and propose necessary management for endemic species.

6). Research and describe critical processes of the natural ecosystems.

7). Develop an interpretation and education program to inform the people of Haiti of their patrimony.

8). Develop a recreation and tourism program based on sites of national patrimony.

The priority rank and relative importance of each of these specific goals as given above are based on the evaluation of Woods and Harris (1986) in the Stewardship Plan for the National Parks of Haiti. The rationale for the ranking is simple: protection of the natural ecological processes and conditions goes furthest to ensure achievement of all that follow. On the other hand, the identification and preservation of an endangered species or even an isolated physical site removed from the natural context (ecosystem) is a last ditch effort that is doomed to failure in most cases. Identification, research and interpretation of endemic or even presently unknown species will be possible only if the natural sites on which they occur are secured now. To wait is to risk describing the past rather than the present.

Woods and Harris (1986) synthesized these statements, as well as many conversations with personnel from the governmental and

The official creation of "Parcs Nationaux Naturels" was by decree published in *Le Moniteur* (number 41, 23 June 1983).

private sectors of Haiti, into the following list which they believed represented the purpose of the Parcs Nationaux Naturels program in Haiti.

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.

Types of Haitian Patrimony and the GOH Authority Responsible

Type of Heritage:	Cultural	Geological	Agricultural		Natural	
Examples:	Indian Artifacts Colonial Artifacts Art	Marble Quarries	Fisheries Forests Farms	Mountain View Seashores	Caves Wildlife Mangroves	Ekman's Juniper La Selle Thrush
Approach to Conservation:	Museum Monuments	Regulaion	Soil Conservation Reforestation	Not Developed	Forest Reserve National Park	Zoological Garden Botanical Garden National Park
GOH Authority:	INAHCA	DMRE	MARNDR		PARCS HAITI	

CHAPTER II

Administration Plan for Parks and Natural Reserves in Haiti

1. Objectives

The objective of this chapter is to recommend a plan to create a unified program to administrate all units of the National Parks of Haiti, and to implement sound programs in stewardship, conservation, education, recreation and public awareness. All of the "programs" that have been created so far are either on hold, or have been suspended. Albert Mangones of ISPAN has retired, and ISPAN is no longer involved with natural resources and natural patrimony. The World Bank Project with MARNDR has been suspended. The University of Florida Macaya Biosphere Reserve Project, which has functioned as a surrogate national parks program for the past five years, has expired. So, as of June 1992, no "program" in national parks exists in Haiti. The primary objective of this book, and this chapter in particular, is to provide an outline on how to rapidly create an effective program to take responsibility for national parks and protected natural areas in Haiti.

An environmental education program to develop public awareness is urgently needed.

2. Special Concerns

The major concerns about the existing program in national parks in Haiti that have been expressed by various individuals we have interviewed during the course of our work on the MBR project are listed below.

1. There is a lack of a tradition of national parks in Haiti, and therefore the philosophy of "preservation" of the natural patrimony is a new concept that must be accepted.

2. There are few people in Haiti trained in ecology or natural resource planning.

3. There are many other priorities in the country, and human needs should take precedence over long range preservation and conservation goals.

4. There is no organization in Haiti that is clearly appropriate to manage the national parks. MARNDR is responsible for developing a sound program to improve the agricultural potential and "utilize" the natural resources of the country. ISPAN is responsible for preservation of the national patrimony with an emphasis on cultural and historical events, and is no longer interested in natural resources. The Office of Tourism is responsible for promoting tourist activities and recreational facilities.

5. There was conflict between MARNDR and ISPAN (INAHCA in 1986) in working together during the initial stages of implementing a program in national parks, and the program did not move ahead as rapidly as expected by international organizations.

6. There are not enough funds available to support a meaningful program on national parks within any of the existing GOH ministries at the present time.

7. The integrated plan for the future development of a national parks program that was developed by USAID, UFMBRP, MARNDR, The World Bank, and the MacArthur Foundation has floundered because of the current political and economic climate in Haiti. The World Bank Project has been suspended. The UFMBR Project has expired.

8. The biggest concern of all is that the habitat of the Macaya area is disappearing at an alarming rate. Something must be done to protect the national park, and the flora and fauna of the area in a very short time, or it will be too late.

3. Parcs Nationaux Naturels d'Haiti

A. Introduction

Our present opinion, based on many years of trying to work with ISPAN and MARNDR to implement a program on National Parks in Haiti, is that an effective way to establish a viable program to protect nature and Haiti's natural patrimony is to create a new GOH organization that would only be responsible for the preservation of the national natural patrimony. This model follows the administrative plan for national parks in Canada and the United States. This organization could (we suggest) be called the "Parcs Nationaux Naturels d'Haiti," and given the acronym "**Parcs Haiti.**" We have chosen not to designate the program as a department, service or institution in order to emphasize the independent status of the new program. We are not sure what ministry the program should be placed under. There has been a tradition of shifting such programs from Ministry to Ministry in Haiti, as with the example of ISPAN. This is not a good situation, so we recommend that one Ministry be chosen from the options available (Interior and National Defense, Finance, MARNDR), or that a new Ministry for the Environment be created for this and other programs concerned with the fragile natural environment in Haiti.

The "Parcs Nationaux Naturels," as currently defined by law, includes eight sites designated in the decree of 18 March 1968 and reiterated in the decree of 23 June 1983 as well as Parc National Pic Macaya and Parc National La Visite as described in Article 1 of the 1983 decree. The chief administrative officer of Parcs Haiti should be a "Director" who would be in charge of the supervision of "all" activities of the organization. A strong rationale for the creation of Parcs Haiti lies in the wording of Article 2 of the decree of 23 June 1983 which states that "l'administration generale, la protection et la mise en valeur des parcs et sites naturels terrestres et maritimes sont a la charge du Departement." Since the "Departement" is not named or identified and since we recommend concentrating all activities under the direction of a "single" administrative unit, we recommend interpreting the intent of the law to be the creation of a program which should be designated as Parcs Nationaux Naturels d'Haiti. In order to have a short attractive name for the program that is easy to remember and identify with we recommend using the name **Parcs Haiti** whenever possible.

Parcs Haiti is proposed to be responsible for the preservation of Haiti's natural patrimony.

Areas of the natural patrimony that should also be included in the domain of Parcs Haiti include marine areas of unique importance, recreational beaches, scenic areas, caves and sinkholes with unique elements of the past or present flora and fauna, zoological parks, botanical gardens and natural biospheres of importance because of their unique features and influence on surrounding areas. A list

of actual areas under the domain of Parcs Haiti is presented below. We have included all areas mentioned in the law of 1983.

Parcs Nationaux Naturels

(current Law)

Sources Puantes	(10 ha)
Source Chaudes	(20 ha)
Source Cerisier et Plaisance	(10 ha)
Fort Mercredi	(5 ha)
Forts Jacques et Alexandre	(9 ha)
Lac de Peligre	(100 ha)
Parc National la Citadelle	(250 ha)
Parc National Pic Macaya	(2000 ha)
Parc National La Visite	(2000 ha)

Clearly, some aspects of the program in national parks as created by the decree of 23 June 1983 fall into areas of special concern to either ISPAN or MARNDR. For example, ISPAN is responsible for national monuments, and Fort Mercredi, Fort Jacques, Fort Alexandre, and la Citadelle Laferriere even though they are part of "Parcs Nationaux Naturels" as legislated in the decree of 1983. In many aspects of both Parc La Visite and Parc Macaya, forestry, reforestation, soil conservation and other areas of concern fall into activities usually assigned to MARNDR. Therefore, it would be wise to have representatives of both ISPAN and MARNDR on the advisory team of Parcs Haiti.

4400 hectares are set aside for national parks. This is 0.12% of the land area of Haiti.

The solution to these areas of overlap will require negotiations between the various branches of the GOH within the framework of the decree of 23 June 1983. We recommend as a solution to these overlapping responsibilities that all activities associated with the national natural patrimony be the domain of Parcs Haiti, that national historic sites and national historic parks remain the responsibility of ISPAN and that activities in the buffer zones surrounding the parks (such as the agricultural and forestry zones of the Macaya Biosphere Reserve) be administered by MARNDR (with an advisory role for Parcs Haiti). Parcs Haiti should work

very closely with ISPAN and MARNDR and there should be many areas where the three programs will interact. These interactions become a natural association if certain regions, such as the area around Parc National La Visite and Parc National Pic Macaya are designated "Biosphere Reserves" (see discussion below). For example, we recommend expanding the program at La Citadelle Laferriere to also become a Biosphere Reserve as discussed in Chapter V (see Sergile, 1990).

B. Organization of Parcs Haiti

The new Parcs Nationaux Naturels d'Haiti (hereafter called **Parcs Haiti**) should be an autonomous unit with direct responsibility for managing the national parks and protecting the national natural patrimony. For a period of ten years Parcs Haiti should concentrate on establishing a sound program in the conservation of natural resources and in developing Parc National La Visite and Parc National Pic Macaya. Parcs Haiti can be created as an organization by one of three methods (see below), and should immediately begin to assume the responsibility for building a national parks program and implementing the recommendations outlined here. Three possible methods for creating Parcs Haiti are listed below:

1. **Form a new GOH organization called Parcs Nationaux Naturels d'Haiti (Parcs Haiti).** This organization, as mentioned earlier, would not be designated as a department, service or institute and would not be a part of any existing program. It should be advised by a higher level authority made up of representatives from the GOH, private citizens and international organizations. This board of trustees should be called the **National Parks Advisory Council (PANAC).** The recommended members of this authority are: 1) Director of ISPAN; 2) Director of the Direction des Ressources Naturelles of MARNDR; 3) Director of the Office of Tourism; 4) President of the Societe Audubon d'Haiti pour la protection de l'Environnement (SAHPE); 5) a prominent private citizen of Haiti interested in conservation; 6) a representative of an international conservation organization; and 7) the Director of Parcs Haiti (Chairman). This council will be advisory to Parcs Haiti, and all meetings will be chaired by the Director of Parcs Haiti. The Chairman will be responsible for calling all meetings, and will be the coordinating force behind PANAC.

Parcs Haiti would be governed by a board of trustees.

The National Parks Advisory Council (PANAC) would meet at least once a year to provide guidance and to help make long range goals for the parks program that are in the best interest of the program, their respective organizations, and Haiti.

The staff of Parcs Haiti would be hired as soon as possible following the guidelines in the organizational scheme (below). The budget for the salaries of Parcs Haiti personnel as well as for all equipment and operating costs for a five-year period should come from a contract with an international organization, such as USAID, to be renegotiated at the end of the five-year period. The Director of Parcs Haiti would be the responsible person in charge of the budget.

As many as possible of the five administrative personnel should be hired from existing individuals within the governmental or private sectors of Haiti. If it is not possible to fill all administrative positions with qualified and interested Haitians, then it would be acceptable to designate one or two of the Assistant Directors from international organizations on a contract or subcontract basis for a period of time ranging from two to five years.

Parcs Nationaux Naturels d'Haiti

(Parcs Haiti)

Central Office

Director
Assistant Director for Education and Recreation
Assistant Director for Conservation and Research
Secretary/Bookkeeper
Secretary/Librarian
Chauffeur
Commissar
Office Guardian

Parc La Visite	**Parc Macaya**
Park Supervisor	Park Supervisor
Headquarters Guardian	Headquarters Guardian
Cook	Cook
Park Guards (7)	Park Guards (7)
Park Workers (15)	Park Workers (15)

Alternative "Parcs Haiti" Strategies

Because of the difficult economic and political conditions now being faced by Haiti, and because areas in the existing national parks of Haiti are being destroyed at such an alarming rate, it may be wise to consider an alternative and more immediate way of creating Parcs Haiti. The two alternative methods discussed below

would have the advantages of creating a national parcs program rapidly, and with less cost to the already over-stressed national budget of Haiti. Both are designed to create an independent program called Parcs Haiti, but in each case it would be over a longer term, and require more outside assistance from international funding agencies.

2. The second possible method of forming Parcs Haiti would be by immediately **contracting with an international conservation organization**, and giving them the mandate to run the program in national parks and train Haitian colleagues over a five- or ten-year period. Haitian staff would be hired where possible and the program would slowly train Haitian counterparts to assume full responsibility at the end of the contract period. Part of the Haitian staff could come from the SPE program of MARNDR, which is the group designated by the World Bank Environmental and Forestry Project as the organization responsible for national parks and natural areas.

There are many things to recommend this strategy for creating Parcs Haiti. One is that the fragile natural areas of Haiti would receive immediate attention and protection. This is very important, since many areas are rapidly being destroyed beyond recovery. A second important feature is that Haitian colleagues would receive training by the process of "twinning." They would learn during the process of actually running the Parcs Haiti program. And contracting with a group would be a relatively cost-effective way to run such a program since a high level of expertise would be immediately available without costly training, and all equipment and supplies purchased would remain part of the Parcs Haiti program. Another advantage of this approach is that the requirements of the contract can be very specific, so that the contracting agency would clearly know what is expected of them, and the GOH would be able to set specific tasks that met the needs of Parcs Haiti. Special care should be made in selecting the outside group to do the contract work to make sure that they are experienced in working in countries like Haiti. It would, in fact, be most desirable to select an organization that had experience working in the area of conservation in Haiti.

3. The third method of forming Parcs Haiti would be by **utilizing existing personnel within the SPE**. This strategy would follow the outline of the World Bank Environmental and Forestry Project. An outline of this project is presented in Chapter VII of this book. The World Bank Team designing the project selected the SPE as the GOH unit that should be responsible for national parks. The SPE could take on the cloak of Parcs Haiti, and, in fact, we would recommend that they use the name Parcs Haiti. One way to improve this option would be to add a third Assistant Director to

Parcs Haiti who was an international person on a long term contract basis. This person would have specific assigned responsibilities within Parcs Haiti, and would also be the overall mentor for the program. The person would have to be chosen carefully, and have excellent credentials in international conservation work and conservation biology. He or she should have an academic degree, preferably a Ph.D., in the natural sciences. The World Bank Project has designated such a person in its project design for SPE. Care must be taken that the person works for Parcs Haiti, and is independent of all influence from outside in order to insure that the person will be truly effective.

The advantage of this approach is that it is already within the design of the World Bank Environmental and Forestry Project. As such, there is a well-designed document for SPE to follow which was created in 1990. The outline for a budget and overall program are already in place, and only need to be slightly revised.

The disadvantages of this strategy for creating Parcs Haiti are as follows. 1) The World Bank Environmental and Forestry Project is currently suspended, and there is no guarantee that it will start again. 2) SPE is understaffed and undertrained to accomplish the required goals of Parcs Haiti, and it will take several years to get up and running at the required level of expertise. The World Bank Project was designed to use the University of Florida MBR project as its "twinning" component. The UFMBR project would have trained the SPE staff during the first year or two of the project in the area of national parcs management, natural sciences (i.e., the natural history of Haiti), and especially in the fine points of working in Parc National Pic Macaya and Parc National La Visite. This is no longer possible because the UFMBR project expired on May 31, 1992. 3) Parcs Haiti would be totally under the jurisdiction of MARNDR, which creates potential conflicts between conservation and natural resource utilization, and is an arrangement that has not worked well in the past. 4) Parcs Haiti would not qualify for many kinds of international funding if it was totally a GOH organization, and there is a good possibility of attracting such funding for a dynamic, semi-autonomous Parcs Haiti organization. So, there are some strong negative aspects to proposal number three. However, it is a viable proposal. It would be made more viable if an outside NGO could be added to the plan, and if the long-term goal of the organization was to move Parcs Haiti towards a semi-autonomous organization outside of the total supervision of MARNDR.

Whatever the method of establishing Parcs Haiti, an effort should be made to have a single Director, and an overall basic group of five administrators. This should be done even if it is necessary to borrow some staff members from MARNDR. This group of five

individuals would be totally responsible for the national parks program. The Director and two assistants would be assigned to the Central Office in Port-au-Prince. The other two individuals would be assigned to the national parks; one would be Park Supervisor for Parc National La Visite and the other Park Supervisor for Parc National Pic Macaya. The Central Office of Parcs Haiti should be apart from any GOH unit, especially MARNDR at Damien, so that it can establish an independent identity and work as a unit. The new program could still be a part of MARNDR, and a unit of the World Bank Project when, and if, it is implemented.

We recommend that Parcs Haiti be formed as soon as possible by a method recommended by the National Parks Advisory Council (PANAC). The selection of a permanent staff or appropriate international organization should be completed first. Active discussions concerning the budget for Parcs Haiti should be initiated at the earliest possible date so that the scope of the Parcs Haiti program can be carefully planned. During the next decade Parcs Haiti should continue to function as an autonomous program with the support and advice of PANAC.

C. Responsibilities of Parcs Haiti

The responsibilities of Parcs Haiti are discussed below in five major categories:

1) Implementation and development of the "stewardship plan;"

2) operation of Parcs Haiti;

3) public use of the parks;

4) environmental stewardship of the parks;

5) monitoring and evaluating the natural features of the parks;

6) developing an educational program for the parks.

We recommend that Parcs Haiti be formed as soon as possible.

The name of the administrator in charge of the duties outlined in each category is presented in parentheses in the following discussion. These suggestions are keyed to the organizational scheme presented earlier in this chapter. The final organization of Parcs Haiti may differ somewhat depending on how the staff is selected and which plan is followed. For example, it is possible that the GOH will choose to subcontract part or all of Parcs Haiti out to an international organization for the first five year period of the development of the parks. If this is done then we recommend that the duties of the Director, who should be a Haitian national, remain as listed in section one of the following discussion. The international organization could assume responsibilities for the

duties outlined in sections two through five. If the GOH decides to further divide the lines of responsibility, one international organization could be selected to operate the parks (sections two through four) under the direction of the Director, while another institution could undertake the duties outlined in section five to develop a method of monitoring the status of the most vulnerable features of the parks, to conduct research and to create an educational program. We have tried to write the "Plan for Organization of Parcs Haiti" in such a way that it can be adapted for any of the several ways of creating Parcs Haiti discussed in this chapter.

1. Implementation and Development (Director)

The Director of Parcs Haiti will be responsible for the overall program in national parks, the supervision of each Assistant Director, the interactions with the other branches of the GOH and the implementation of the program. The major features of the duties of the Director in implementing and developing a program in national parks are listed below.

a. Review the "Stewardship Plan" and "Revised Stewardship Plan" (this document) for Parcs Haiti and work with the staff and other branches of the GOH to formulate a final plan.

b. Hire all staff of Parcs Haiti, and supervise and evaluate all personnel.

c. Coordinate all staff and projects into a unified program with a clearly-understood mission and well-defined goals.

d. Develop a schedule for the implementation of the "Stewardship Plan," and coordinate all phases of the work so that the schedule is maintained.

e. Develop a training program for the staff of Parcs Haiti.

f. Supervise all security forces of Parcs Haiti.

g. Meet regularly with the PANAC and branches of the GOH, especially MARNDR, to promote cooperation, productive interactions and the planning and implementation of specific projects.

h. Meet regularly with international organizations to develop programs of assistance in technical areas and in seeking additional funding for Parcs Haiti.

i. Coordinate the duties of "Interns" and volunteers from foreign institutions.

j. Supervise and manage the budget.

k. Present speeches, write articles and in all other ways promote the concept of Parcs Haiti. As soon as possible, Parcs Haiti should create a tape and slide presentation of high quality to use in these presentations.

h. Carefully guide the growth of Parcs Haiti by evaluating all proposals for additional programs. The Director will have the responsibility of deciding which features of the national natural patrimony are in need of being included in Parcs Haiti, and coordinating feasibility studies. The Director will work with the staff of Parcs Haiti and outside consultants in reaching a decision on any proposal based on the overall well-being of Parcs Haiti, the natural feature under consideration and the overall interests of the GOH.

2. Operations (Delegated to various staff by the Director)

In the long term, the day to day administration of the overall program of Parcs Haiti should be conducted by an individual or office that is responsible for administration and maintenance. This individual, who could be an Assistant Director for Administration, would meet regularly with the Director. However, since money will be tight no matter which of the methods of creating Parcs Haiti is selected, we recommend that these duties should initially be carried out by the Director and other staff under the Director. In this way the Director and support staff will learn how to operate a national parks program by intensive day by day experience. Some of these activities are:

a. Coordinating activities with each Park Supervisor.

b. Coordinating activities with volunteer agencies.

c. Coordinating all activities of the staff of the Central Office of Parcs Haiti.

d. Supervising the use and maintenance of motor vehicles.

e. Supervising the use and maintenance of all equipment and supplies.

f. Maintaining a Parcs Haiti library and research collection that would include a series of photographs of specific habitats, maps, reports, journal articles and books on the natural patrimony of Haiti and the national parks.

3. Public Use (Assistant Director for Education and Recreation)

All aspects of the use of the park by the public should be supervised by an individual or office that is responsible for education, recreation and tourism. This individual would report to the Director on a regular basis. The person would also work closely with the supervisors of each park and could be responsible for:

a. Designing and posting all signs.

b. Designing access routes and trails.

c. Designing scenic areas.

d. Designing special recreational features.

e. Public relations.

f. Develoing educational exhibits for the parks.

g. Working with hotels, airlines and tourist organizations.

h. Writing a weekly column for newspaper and writing scripts for release to interested organizations.

4. Environmental Stewardship (Assistant Director for Conservation and Research)

All aspects of the programs concerned with the conservation of natural resources within Parcs Haiti and the stewardship of the resources within the parks themselves should be supervised by an individual or office responsible for conservation, preservation and stewardship. This person would meet regularly with the Director and with each Park Supervisor. They would be one of the major links between the Central Office of Parcs Haiti and the parks, and might spend significant periods of time in the field. The person would be responsible for:

a. Designating all Biological Reserve Zones.

b. Caring for all special concern areas.

c. Representing Parcs Haiti in discussions concerning activities in the "Buffer Zone."

d. Implementing reforestation and reclamation projects.

e. Working with local land owners near the parks and organizations in Port-au-Prince to promote land use practices that are appropriate for the areas of the parks.

f. Coordinating activities with MARNDR or area NGOs to develop a seedling nursery.

g. Fire control, and controlled burning of certain habitats to prevent damaging wild fires.

h. Representing Parcs Haiti in the implementation and coordination of the "Biosphere Reserves" in the areas of the national parks.

i. Working with the staff of Parcs Haiti and international projects such as the University of Florida MacArthur Foundation Conservation Project, to design, draft, and utilize Species Recovery Plans for endangered and threatened plants and animals of Haiti.

5. Monitoring and Evaluation (Assistant Director for Conservation and Research)

One of the most important aspects of the program in national parks is monitoring and evaluating the status of the ecosystems within the parks and the biosphere reserves. This important function will allow Parcs Haiti to make decisions on land use, recreation and resource management. As special needs arise information on the status of the environment of the parks will allow Parcs Haiti to rapidly adjust policies to accommodate environmental emergencies, such as the continued decline of a particular endemic species or the sudden increase in the numbers of a pest or predator. The individual in charge of monitoring and evaluating the environment would work closely with the Director, other Assistant Directors, Park Supervisors and international research teams. Ongoing research projects are an important component of the monitoring and evaluating process. The main responsibilities of this person or office would be:

One of the most important aspects of the program in national parks is monitoring and evaluating the status of ecosystems within the parks and the biosphere reserves.

a. Periodic evaluation of the status of particular features of the parks (Black-capped Petrel colonies, etc.).

b. Coordinate the basic research project on the meteorological characteristics of the parks.

c. Coordinate with (international researchers) selected projects that are needed to complete a biogeophysical inventory.

d. Work with national and international researchers to coordinate their projects.

e. Review all research proposals to make sure there is a Haitian counterpart on each research project.

f. Review all applications for research or collecting to determine if there is a conflict with the principles and policies of the parks.

g. Develop a series of maps of each park.

h. Develop a series of air photographs of each park.

i. Be responsible for taking a series of photographs of specific locations of the parks at the same station over a number of years to document changes in plant communities.

j. Assist the Director in evaluating other areas that have been recommended as national parks.

D. Budget for Parcs Haiti (5 years)

A suggested budget for Parcs Haiti has been developed for a five year period, and is presented in the table at the end of this section as well as in abbreviated form in the last chapter of this book. The major budget categories are: 1) cost of setting up the Central Office and Park Headquarters programs; 2) cost of information, boundary and entrance signs; 3) cost of constructing exhibits; 4) cost of publications advertising and promoting the parks and for the publication of basic data (scientific results and new species descriptions); 5) cost of training programs for Parcs Haiti personnel; 6) cost of research programs; 7) operating expenses for Central Office; 8) operating expenses for parks and biosphere reserves; 9) operating and maintenance costs for vehicles; 10) salaries. The total proposed budget for Parcs Haiti (five years) is $2,514,790. There is nothing absolute about this budget. We are presenting it here because we know how hard it is for most institutions to develop such budgets, and because we have had first-hand experience working in this area as a result of the UFMBR project. This budget is intended for planning purposes only, and we do not guarantee that it is perfect or complete.

Budget justification

1. **Set-up costs.** The cost of setting up the Central Office and parks is $132,000 to build the facility and $145,000 for equipment and supplies. These costs include desks, chairs and basic office equipment as well as two vehicles. The cost to set up facilities at each national park is estimated to be $29,100, including the purchase of a vehicle for each park. In addition, a building must be constructed at La Visite (estimated cost $20,000). A building is already in place at Macaya. A complete list of all recommended items is presented in the table at the end of this section.

2. **Signs.** It is important to place signs at the entrances to the parks as soon as possible to signal the official status of the parks and to welcome visitors. These signs should come out of the existing

budget. Boundary and information signs should also be posted as well as signs for nature trails. The signs must be weatherproof, sturdy and attractive. The road signs, nature trail signs and supplemental signs will cost $8,000. Some signs have already been set out as part of the final activities of the UFMBR project.

3. **Exhibits.** As part of the educational program, exhibits should be available at the Central Office and within each park. These educational exhibits will make the park experience more meaningful to visitors and will educate park personnel and visitors alike as to the importance of the parks as component parts of the biosphere reserves. The exhibits could be designed in Haiti and constructed in the United States as a subcontract with the Florida Museum of Natural History or other institution experienced and competent in the area of natural history graphics. The cost for eight large exhibit signs is $10,000, with information on both sides so that the messages can change to introduce variety.

4. **Publications.** We propose publishing a general purpose brochure on Parcs Haiti and the national parks at the earliest possible date. This brochure will explain the purpose of Parcs Haiti, describe the major features of Parc Macaya and Parc La Visite including lists of major species, maps of the parks and a message. It will also present information on how to make contributions and support Parcs Haiti. The cost of the initial publication is $6,000. We recommend additional more specific brochures and small booklets to be published the second and third year of the budget period at $5,000 each year. In addition, it would be desirable to publish a book on the National Parks of Haiti. This book, well-illustrated with photographs, could be sold in Hotels and bookstores. We believe that it would sell well. A similar very attractive book has been published of the National Parks of the Dominican Republic. The estimated cost of this book is $20,000.

We believe that it is very important to make the results of the parks inventory available as quickly as possible. These "results" include descriptions of new species, analyses of major plant and animal associations and specific discussions of the major features of the parks. We recommend that these results be published as a single volume of the Bulletin of the Florida Museum of Natural History, where other descriptions of the flora and fauna of Haiti have been published. Each chapter would have a complete abstract in French. All new species and important new data can then be made available to Haiti within one year, and be readily available to students and professionals in Haiti during the training sessions and development stage of a national parks program. The recommended budget for this publication is $10,000.

Other important publications that should be published as part of the Parcs Haiti program are:

The Natural History of Haiti
Useful Trees of Haiti
The Mammals of Haiti
The Birds of Haiti

Some of these books are already underway. Their publication has also been designated as a high priority activity by the University of Florida MacArthur Foundation Project (see description of this project in Chapter VII). The MacArthur Foundation Project will be able to assist Parcs Haiti in the publication of some of these books, and places a high priority on having these books, booklets, and conservation posters available in Haiti. We feel that one of the largest problems in Haiti is the general lack of knowledge about the importance of the natural resources and natural patrimony of the country.

It is anticipated that a second scientific publication will be appropriate at the end of the five-year budget period. This publication would include the results of research over the five-year period and would include Haitian counterparts as authors. We have budgeted $10,000 for this second scientific publication.

5. **Conservation Posters.** Six conservation posters should be produced as part of the Parcs Haiti conservation and education program. These conservation posters are listed below.

A Color Poster on "Connaitre et Proteger la Richesse Naturelle d'Haiti" has already been completed as part of the UF MBR project;

A Color companion poster to the above is needed that provides detailed information on each species;

A Color Poster based on a painting by a famous Haitian artist should be produced that will depict both the native flora and fauna of Haiti and the fanciful plants and animals that normally are part of traditional Haitian paintings. We hope that this painting (poster) will become an instant success, and start a new movement in Haitian art whereby Haitian artists will include more native animals of the country in their paintings. The planning for this project is already underway as part of the MacArthur Foundation Project.

A Black and White Poster concentrating on biological conservation in the Pic Macaya Area is needed, and is currently being planned as part of the MacArthur Foundation Project.

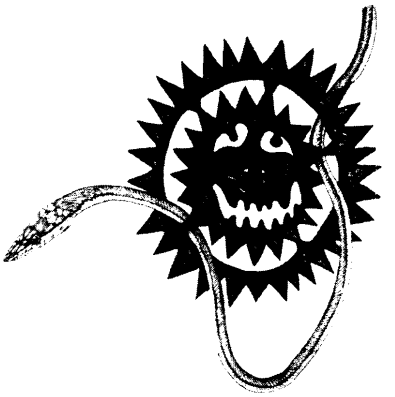
A Black and White Poster concentrating on biological conservation in the La Visite area is needed.

A Color Poster on recreational activities in the National Parks will be needed when tourism in the parks becomes possible.

The first of these posters, "Connaitre et Proteger la Richeses Naturelle d'Haiti," has already been completed, and 6,000 copies will be distributed in Haiti in the fall of 1992. The poster is displayed on the cover of this book. The cost was shared by USAID and the MacArthur Foundation. We designed the poster, and it was painted by Laurie Walz. Subsequent posters could be done in the same way at the Florida Museum of Natural History, at another international institution, or within Haiti.

The estimated total production cost of each color poster is $8,000. The cost of production of the black and white posters is $3,000 each. The total budget of Parcs Haiti over the next five years for posters should be $30,000.

We also recommend that a coloring book be produced based on the "Connaitre et Proteger la Richess Naturelle du Haiti" poster. This simple coloring book would have a color representation of the poster on the cover, and include pages with the outline of each plant of animal. Each page would have a simplified message concerning the particular plant or animal. These coloring books would be distributed free to schools throughout Haiti as part of the Parcs Haiti Environmental Education Project. The estimated cost of this booklet is $10,000.



Part of Haiti conservation poster, "Connaitre et Proteger la Richesse Naturelle d'Haiti." This snake is Uromacer frenatus, "La Madeleine," the proposed national snake of Haiti.

6. **Environmental Education Program.** One of the important activities that Parcs Haiti should be involved with is Environmental Education. This can be accomplished by lectures and involvement with schools. It can also be accomplished on site using the local exhibits, conservation posters, etc. Many of these items are budgeted above. An additional budget of $10,000 a year should be set aside for Environment Education.

7. **Training programs.** We believe that the most economical way to run a training program is to make use of seminars, workshops and training sessions in Haiti. Each two week session would be conducted by an international expert or team. We have budgeted $3,000 for each session and recommended four sessions per year ($12,000). During the second year we recommend that the Director participate in the national parks seminar and visit several mayor institutions (such as the University of Florida) which have international conservation programs $5,000). The research programs (see following item) can also be incorporated into the training programs.

8. **Research Programs.** We believe that research is one of the most important components of a developing program in national parks. The data generated from selected research projects will be used in making management-related decisions and in building the recreation and education programs. Parcs Haiti personnel should be included in all research projects and therein receive valuable training that will be specific to natural science in Haiti. We propose spending 6.5 % of the budget, or $165,000 on research for a five year period. The recommended research projects are listed below with their duration and total cost in parentheses.

A). Composition of major plant associations (5 years; $30,000).

B). Growth and regeneration of endemic plants (5 years; $30,000).

C). Habitat requirements of the endangered species of endemic mammals (5 years; 30,000).

D). Biology of the Black-capped Petrel (3 year; $30,000).

E). Regular inventories of park avifaunas (5 years; $10,000).

F). Baseline Meteorological studies (5 years; $5,000).

G). Distribution and habitat requirements of Invertebrates (5 years; $15,000).

H). Habitat requirements for endemic herpetofauna (3 years; $15,000).

Total Research Budget $165,000

One major goal of these research projects is to create Species Recovery Plans for endangered species in Haiti. The concept of Species Recovery Plans is discussed in detail in Chapter VI of this book, and Preliminary Species Recovery Plans are presented for three species in Southern Haiti in *The Natural History of Southern Haiti* (Woods and Ottenwalder, in press). The availability of Species Recovery Plans is essential if Parcs Haiti is going to be able to make comprehensive plans for conservation in Haiti. They will provide the data base that will be necessary for Parcs Haiti to live up to its obligation to advise the GOH on the complex questions that arise in planning for sustainable development on an island where resources are limited and conservation and development are frequently at odds.

9. **Operating Central Office.** The specific estimated costs of running the Central Office are listed at the end of this section. We believe that it is very important to have a well-organized Central Office to tie together all aspects of the parks program. Since the parks program will also coordinate the activities of the biosphere reserves associated with each park, the Central Office will become a meeting place for many people and ideas. It will quickly become

the crossroads of all conservation activities in Haiti and the clearinghouse for most information on the natural ecosystems of the country. The total estimated cost of the office is $32,000 per year or $160,000 over a five year period. On top of this is the cost of renting or building the Port-au-Prince Parcs Haiti facility.

Our estimate is that it would cost $25,000 per year to rent a reasonable building for a Central Office. It would be cheaper in the long run to construct a new building. The decision as to which strategy to follow, and where to locate the building should be made by the Director of Parcs Haiti in conjunction with the National Parks Advisory Council.

10. **Operating Parks.** The estimated costs for the operation of the parks is $28,450 each or $56,900 per year. The cost of operating the parks over a five year period would be $284,500.

11. **Operating Vehicles.** We propose purchasing four vehicles for use in the parks. Two vehicles are for use in the Central Office. One of which will function in the capital and the other will come and go to the parks. All of the vehicles should have 4-wheel drive. Two vehicles will operate in the parks and transport the Park Supervisors back and forth between the parks and the Central Office. The estimated annual cost for operating the four vehicles each year is $20,400 for a total cost of $102,000 over five years. Individual items are listed below.

12. **Salaries.** The salaries of the three administrators and five support staff of the Central Office are listed below. We have done our best to estimate salaries that are fair and provide incentives and a sense of pride, but at the same time are not out of line with other salaries. These determinations will need to be revised by the Director of Parcs Haiti and the Advisory Council for National Parks.

Specific Budget Explanation
Setting up Main Office in Port-au-Prince

ESTIMATED #	ITEM	COST
Office set-up		
1	Office Typewriter	500
1	Portable Typewriter	350
1	Computer System	5,000
*	Computer Software	1,000
12	File Cabinets	2,500
10	Desks	3,500
10	Desk Chairs	1,000
1	Conference Table	800
20	Chairs	800
2	Storage Cabinets	800
10	Book cases	1,000
4	Map cases	800
1	Drafting Table	500
1	Drafting equipment	250
4	Air Conditioners	2,000
3	Audiovisual Equipment	1,500
1	Videocamera	3,000
3	Tape Recorders	750
1	Copy Machine	1,000
3	Cameras	750
1	Radiocommunications	12,000
2	Vehicles	32,000
*	Other Miscellaneous	2,000
Total		**$73,800**

Park Set-up (each)

ESTIMATED #	ITEM	COST
1	Typewriter	350
1	Woodstove	500
1	Storage Cabinet	400
1	Chainsaw	350
1	Generator	2,500
4	Guns (shotguns)*	500
4	Altimeters + pocket transects	1,000
-	Field Furniture	500
-	Shovels, picks, etc.	1,000
1	Gas stove	500
1	Gas Refrigerator	500
1	Toilet	100
2	Sinks	200
*	Solar generator	2,000
-	Hardware	200
1	Vehicle (pick-up)	16,000
1	Motorcycle	1,500
-	Field Equipment	1,000
Subtotal	$29,100 Times two =	**$58,200**

Building Construction and/or Rental

Parcs Haiti Headquarters	$125,000
Parc Macaya Headquarters	(Done)
Parc La Viste Headquarters	20,000
Total	**$145,000**

*This type of gun is useful for research (to collect seeds in high elevation trees).

Signs

2	4'x8' Entrance sign	$2,000 *
60	Information signs	3,000 *
2	4'x8' Roadside exhibits	2,000
50	nature trail signs	1,000
	Total	$8,000

Exhibits

4	Double side exhibit panels	$10,000

Publications and Posters

1 volume	Scientific Results I	10,000
1 volume	Scientific Results II	10,000
5000	Information Brochure	5,000
-	Park booklets	5,000
-	Park booklets	5,000
-	Natural History of Haiti	10,000
-	Birds of Haiti	10,000
-	Mammals of Haiti	10,000
-	Useful Trees of Haiti	10,000
-	Conservation Posters	30,000
-	Conservation Coloring Book	10,000
1 volume	National Parks of Haiti Book	20,000
	Total	**$135,000**

Environmental Education Supplement **$10,000**

Training programs

20	Two week training sessions (3,000 each) (five year period)	60,000
1	Special parks seminar and visits for Director	5,000
	Total	$65,000

Research

8 Research projects (see discussion in Budget Summary)

Total	$165,000

Operating Central Office*

	per year	5 years
Telephone	2,500	12,500
Lights + electricity	4,500	22,500
Supplies	6,000	30,000
Incidentals	6,000	30,000
Per diem pool	10,000	50,000
International travel	3,000	15,000
Total	year	5 year
	$32,000	$160,000

* Rent not included

Operating each Park

	Per Year	Total
Uniforms	$ 350	$1,750
Per diem (Park Supervisors)	3,600	18,000
Park Maintenance	24,000	120,000
Supplies	500	2,500
Total	$28,450	$142,250
(x 2 for Combined Parks)	$56,900	$284,500

Operating four Vehicles

	Year	Total
Maintenance and tires	$8,000	$40,000
Gas	12,000	60,000
License and insurance	400	2,000
Total	$20,000	$102,000

Salaries

	Per Year	Total
1. Director Salary	30,000	*
Expenses	4,000	
2. Assistant Director #1 Salary	20,000	
Expenses	3,000	
2. Assistant Director #2 Salary	20,000	
Expenses	3,000	
5. Secretary	7,000	
6. Secretary-Librarian	6,500	
7. Chauffeur	7,000	
8. Commissar	4,000	
9. Guardian	2,500	
10. Park Supervisor #1 Salary	15,000	
Expenses	2,000	
10. Park Supervisor #1 Salary	15,000	
Expenses	2,000	
12. Headquarters Guardian #1	2,500	
13. Headquarters Guardian #2	2,000	
14. Park Guardians 3,500 each x 14	49,200	
15. Park Workers 1,500 each x 30	45,000	
TOTAL	$239,700	$1,298,290

*Note: We have added a 4% salary increase each year.

Total cost of setting up and running Parcs Haiti for five years is estimated to be approximately **$2,514,790.**

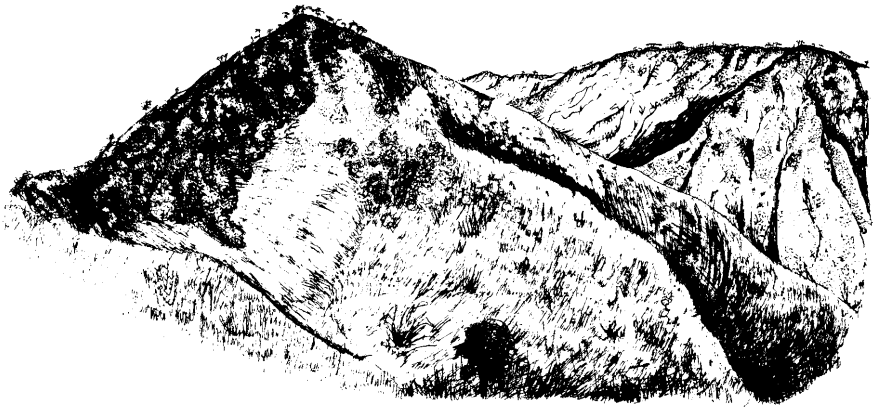
CHAPTER III

Parc National Pic Macaya

This chapter reviews the history, physical features, natural history, and management plans for the national park in the Massif de la Hotte that is known as Parc National Pic Macaya. This national park was the focus of activities of the University of Florida Macaya Biosphere Reserve Project, and is considered a Core Zone of the Macaya Biosphere Reserve. The area was being severely degraded at the time the national park was established. The activities of the UFMBR project nearly stopped the cutting of pine trees, and reduced the numbers of black bean gardens in the park. The project was also able to reduce the number of domestic animals in the park. The south boundary of the park was fenced as part of the MBR activities, and some reforestation was underway. As of 1991, the steep slopes of the park were beginning to return to forest cover.

This chapter should be viewed in context with Chapter VII, which presents a plan for the future. As of June, 1992, the park is clearly threatened. At the time of our final survey of conditions in the region in April, 1992, the park was once again being rapidly degraded. The fence had been torn down in places. We saw a number of peasants entering the park with hoes and machettes. Animals were being grazed well inside the park boundary. We found one young, healthy cow with its rear leg nearly cut off. The cow had been eating plants in a newly-planted garden on a steep

slope in the park, and the "owner" of the garden had cut the hind leg of the cow, which was dying, in retribution. This event sums up the current status of the park perfectly. Not only is the park being openly violated, but it was being violated with a sense of desperation. The competition for resources in the region is reaching a new level that makes the continued existence of the park questionable. So, the impression of Haiti at a crossroads is nowhere more vividly apparent than at Parc National Pic Macaya. The park is established, well-documented, and on the verge of becoming a model for the conservation of natural resources in Haiti. Until 1991, there was a sense of optimism about its future. As of 1992, the park is under attack and on the verge of total collapse. We hope that this in-depth discussion of Parc National Pic Macaya will not be its obituary.



Parc National Pic Macaya

Section 1. Location

The area designated as Parc National Pic Macaya is located on the Massif de la Hotte at the crest of the mountains where several major rivers originate (see Map of Macaya Biosphere Reserve, Appendix III). The park lies 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.

Section 2. Size and Natural Boundaries

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 hectares buffer zone in an internal document between MARNDR and 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 and USAID, a preliminary boundary for Parc National Pic Macaya was recommended as comprising 5,500 hectares. This proposal was accepted by ISPAN (at that time, under INAHCA) and MARNDR, and was used by MARNDR in conjunction with the recommendations of Florence Sergile, who was at that time the Parks Coordinator in the Direction des Ressources Naturelles (MARNDR), to determine the boundaries of the park by the boundary survey team from MARNDR. Because the original survey of the park was flawed and needs to be redone, we now recommend that the size of the park should be expanded to 7,500 hectares. The specific areas to be included and the justifications for doing so are discussed below.

The natural boundaries of Parc National Pic Macaya have been defined based on the results of the various inventory teams and the final reports of these investigations. 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 park.

Pic Macaya (2,347 meters)

- water generation and recharge zone
- unique broadleaved and pine forest communities
- nesting location for Black-capped Petrels
- soil conservation zone because of its steep slopes
- recreation area (wilderness setting)

Pic Formon (2,219 meters) and Pic Le Ciel (2,170 meters)

-unique broadleaved and pine forest communities
-possible Black-capped Petrel nesting area
-water generation and recharge zone
-soil conservation zone
-virgin forest zone

"Bwa Formon"

(The karst hills between Morne Cavalier [1,570 meters] and Sous Bois, including the forest covered area below Morne Cavalier and along rim of the Plain of Formon to 1,000 meters).

-many species of endemic orchids
-important habitat for the Zagouti (*Plagiodontia*)
-especially rich avifauna
-numerous endemic species

"Gran Ravin" of the Ravine du Sud

(from 1,919 meters in the saddle between Pic Macaya and Pic Formon eastward down the Gran Ravin to 500 meters elevation).
-numerous endemic species
-water conservation
-soil conservation because of steep sides, and numerous natural landslides

East-West Ridge of Pic Macaya

-unique Pine Forest with giant old growth trees
-water conservation zone because of abundant rainfall and cloud-combing phenomenon of tall pine trees
-deep layer of sphagnum moss acts as a sponge in retaining water
-possible additional nesting areas for Black-capped Petrels
-numerous endemic species
-wildest area of Haiti

East-West Ridge of Pic Formon

-unique elfin broadleaved forest
-water conservation (wettest area in Haiti)
-possible nesting Petrels

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

-only habitat with *Solenodon*
-rich broadleaved forest being rapidly deforested
-exceptional number of endemic species
-soil conservation
-region not currently in park, but designated as highest conservation priority for inclusion

Upper area of Riviere Trois Sources

(in the steep ravine between Pic Macaya and Pic Formon)
-easy access via new UNICORS\COSAR road
-very vulnerable to exploitation, which would destroy Petrel nesting area
-southwestern exposure, which would do irreparable damage to soils if deforested

Each of the above features will be discussed in greater detail in the section on the "major features" of the park, and has been described in elaborate detail in this document. All of the features are part of a natural ecosystem that ranges in elevation from 900 to 2,347 meters. If Parc Macaya were to include all of these areas it would be a 5,000 hectares "block" of terrain that would contain Pic Formon and Pic Macaya at their watersheds. Parc Macaya would also include a 500 hectare peninsula of land that stretches southward from Pic Le Ciel and include the forested karst hills around the western and southwestern boundaries of the plains of Formon and Durand that are rich in important sinkholes and have several small ponds. The park should also include 2,000 hectares NE 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 National Pic Macaya contain more endemic species than any other known area of Hispaniola. This is the absolute minimum size that the park should be to adequately protect the flora and fauna of the area. This size is also essential if the species of *Solenodon* described in the Solenodon Species Recovery Plan are to be saved from extinction. One of these species is a living fossil that occurs only in the Pic Macaya area.

Section 3. Access to Parc Macaya

Access to Parc National Pic Macaya is difficult. There are several ways to enter the park, but only one is practicable. That route is via the city of Les Cayes where there are several hotels that would be suitable for tourist accommodations. 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 in 33 kilometers and takes about two hours to drive.

From Les Platons the road is very rough. The route passes through Marche Sous Bois, and then the extensive karst hills that are still forest covered and which are known locally as "Bwa Formon." The boundary marker for the southern edge of the park is located beside the trail in Bwa Formon 100 meters before the road 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. From "Portal Formon" two trails can be used to pass through the park. The road continues on to the Park Headquarters and main facility at Caye Michel (named in honor of our colleague on the MBR project Michel Aubry, who died in an accident crossing the Riviere l'Acul).

The first mountain trail in the park passes directly northward and ascends the ridge of Formon via a series of gardens known as "Kay Ogil" until it passes over the top of the massif 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 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 Durand. On the Plain

of Durand is a region of sinkholes, ponds and streams. The karst hills south of the Plain of Durand are known as "Bwa Durand." 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 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 "Pa Lan Kont." 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 (2,200 meters) below the summit 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 2,347 meters, and is marked by chunks of cement (probably part of the old benchmark) wedged into the stump of a fallen pine.

This is the only practical route to take into the interior of the park. However, there are two other ways of getting into the interior of the park. One is by hiking into the north side of Pic Macaya 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 "Zapoti," 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 Wetmore and Darlington. A new road that is being built westward from Duchity will make the above route into the interior of Parc Macaya more feasible, and will open the area to potential exploitation and deforestation. This road was half completed in April 1992, and it is anticipated that it will be completed to quite near the north side of Pic Macaya by the end of the year.

Another route into the interior of Parc Macaya is via a new road that has been constructed by UNICORS\COSAR through the town of Rendel to hear the Riviere Trois Sources. This road passes deep into the heart of the park, and makes it very vulnerable to exploitation. The forests in the area are being cleared for coffee, and the ridge of Pic Formon is being rapidly deforested. This road provides access to the interior of the park in two ways. From the end of the road it is possible to walk east up the Riviere Trois Sources to just below the ridge connecting Pic Macaya and Pic Formon. It is also possible to gain access to the north ridge of Pic Macaya, and hike up the north trial to the summit. This is the old traditional route to the top taken by Ekman and Wetmore, although they gained access to this trail from the north side. A comprehensive discussion of the routes to the top of Pic Macaya is in Chapter II in *The Natural History of Southern Haiti* (Woods and Ottenwalder, in press).

Now that the trail has been cleared across Pic Formon from the south, the route from Les Platons should be considered the primary access to Parc National Pic Macaya. If the road between Les Platons, Sous Bois and Portal Formon were to be improved, this would provide easy access to Parc National Pic Macaya that would be suitable for tourists. However the route would require major supervision to prevent habitat exploitation. The route from Les Platons provides many picturesque vistas of Parc National as it traverses the broad plain and crosses the karst hills.

Section 4.

Major features of Parc Macaya

The following section summarizes all of the reports of the biogeophysical inventory. An attempt has been made to review the most important features of Parc Macaya, and to provide a synthesis of the information that is 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. These topics are discussed in much greater detail in the volume *The Natural History of Southern Haiti* (Woods and Ottenwalder, in press), and there is some overlap with information presented in that book. We feel that it is important to have this information in the Stewardship Plan, however, since it may be used as a reference volume on its own.

A. 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 indicate 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.

One of the most significant features of Parc Macaya is the extensive karst topography that occurs along the areas of low relief east and south of Morne Cavalier.

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. Occasional rocks that are greyish-brown or even darker in color 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.

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

70 to 80 milliion years ago the western portion of what is now the Southern Peninsula of Haiti, including the area of 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.

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. Exposure of 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 Demis-

seau 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).

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 used 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 forces that shaped geological conditions in Haiti are still at work in the region of the Macaya Biosphere Reserve.

B. 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 Demisseau 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 droughty and dryer than surrounding soils.

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 slope they are eroded moderately.

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.

To the west of the Park in the areas near the UNICORS\COSAR complex, 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 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.

C. 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 exist 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 part of the history of the region (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 subunits.

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"). Garden planted in cleared areas within the "Rak Bwa Woch" or on the Plain of Formon.

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 broad-leaved 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).

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, foothills 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, 2000-4,000 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 (Fp-S)
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

There are at least 133 species in 42 genera of orchids in Parc National Pic Macaya.

D. 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 the park area itself) and 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. Many of the orchids in this area are small and inconspicuous, but nonetheless scientifically important.

The diversity of orchids growing in the upper areas of the park is considerably less than 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.

E. The Macaya Biosphere and its Butterflies

Eleven species of butterflies are known from Parc National Pic 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 National Pic Macaya region while another is endemic to the Parc National La Visite.

Eleven species of butterflies are known from Parc National Pic Macaya.

The reason so many more butterflies occur in the Parc National La Visite region than in Parc National Pic Macaya is unresolved. Several species missing from Parc National Pic Macaya are widespread in Hispaniola, and it is surprising that they are not found in the Macaya area. One explanation is clearly that Parc National Pic Macaya is more isolated than Parc National La Visite. This appears to be one of the main explanations for why five endemic birds that 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 Appendix II.

F. Parc National Pic Macaya and its Land Mollusks

Fifty seven species of land snails were reported from Parc Macaya (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. See Appendix II, "Land Mollusks of the National Parks of Haiti," which lists all of the land snails known to occur in Parc Macaya.

G. The Reptiles and Amphibians of the Macaya Biosphere Reserve

There are at least 28 amphibians and 33 reptiles in the Massif de la Hotte. 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.

Fifty-seven species of land snails have been reported from Parc National Pic Macaya.

There are at least 28 amphibians and 33 reptiles in the Massif de la Hotte.

Collections from the study area include 18 frogs, 11 lizards, and 5 snakes. These represent approximately 58% of the taxa presented in the Appendix. 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 were wide-ranging. Only *Eleutherodactylus ventrilineatus* and the two un-

described 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 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 occur in very specific habitats.

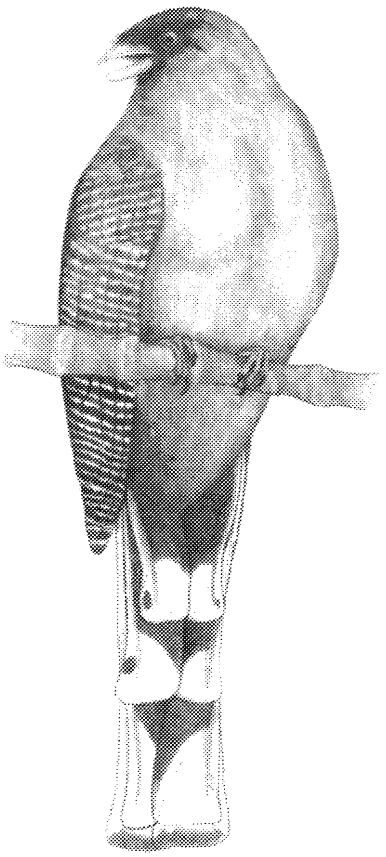
The creation of a park within the Massif de la Hotte is absolutely essential for the survival of the region's herpetofauna.

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 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 affects 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).



Hispaniolan Trogon

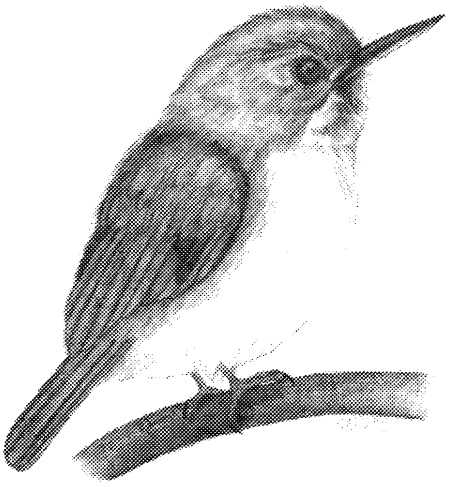
H. The Birds of Pic Macaya

A complete list of all bird species of Parc National Pic Macaya is presented in Chapter IV of the book on the *Natural History of Southern Haiti*. 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"): 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 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 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 increased destruction of the mesic forest in the Macaya region that has been 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 November 1985. 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, while in the montane zone of the park at about 1,300 meters elevation, 47 species occur (see Appendix II).



Narrow-billed Tody

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 during the winter months, huge flocks of migrant warblers feed in abandoned corn fields and gardens. 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 (see Appendix II). 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 which occurrs 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 further erosion. The open areas that occur following fires also expose the petrels to predation by dogs, cats and mongooses. Cats and mongooses 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.

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

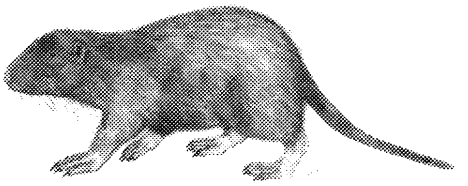
An additional colony may exist on the northwest face of Pic Formon.

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.

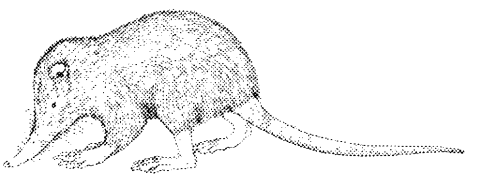
I. The Mammals of Macaya Biosphere Reserve Area

There were originally eighteen species of land mammals occurring on the Plain of Formon and the higher montane areas of Pic Formon and Pic Macaya (see Chapter V of the book on the *Natural History of Southern Haiti*). 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 eighteen 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 eighteen 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.



Plagiodontia aedium

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.



Solenodon paradoxus

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--the most important habitat for mammals that remains 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 14 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 why 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 of the 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

Of the original 18 species of land mammals occurring in the park area, only *Plagiodontia aedium* survives in abundance. The other surviving mammal, *Solenodon paradoxus*, is very rare.

Plagiodontia and *Solenodon* including specific studies on their habitat requirements and the impact of dogs, cats, mongooses, Black Rats and Norway Rats is necessary to insure that proper data is available for use in wise management decisions.

J. Paleobiology of the Macaya Biosphere Reserve Area

Studies in Paleobiology in the MBR 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.

Extensive excavations have been made in three important locations: Trou Woch Sa Wo, Trouing Jeremie #5, and Trouing Lan Genti #1.

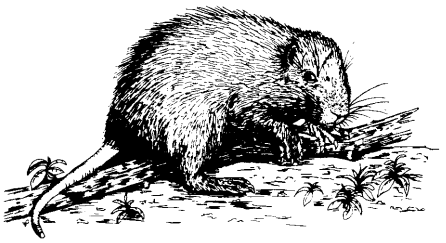
In July, 1984, excavations were made in sinkholes along the northern slopes of the ridges east of Pic Macaya in the center of Parc National Pic Macaya. This area of abundant rainfall extends from Pic Macaya (elevation 2,347 meters) eastward as a narrow series of heavily forested ridges. The ridges lie 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.



Rhizoplagiodontia lemkei

Other Fossil Mammals found in the MBR Area

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 four centimeters 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.



Nesophontes paramicrus



Nesophontes hypomicrus



Nesophontes zamicrus

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. marcanoi* 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 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.

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.

The long history of human occupation in the valley of the Ravine du Sud 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.

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.

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.

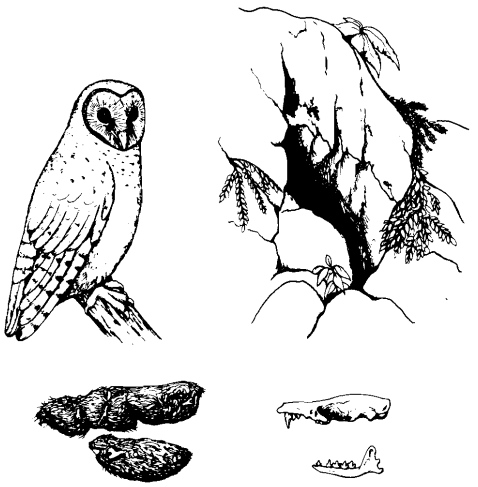


Plagiodontia aedium often feeds on the ground in areas of karst where it is difficult to move around because of massive blocks of limestone. Rodents foraging in these areas would be exposed to the danger of falling into the openings of sinkholes.

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Other evidence that indicates that much 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).



A modern Barn owl (*Tyto alba*) portrayed on a card which is handed out in the search for owls, caves, and fossil mammals. The fossil drawn here is the Small Island shrew.

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.

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 through Carbon 14 analysis of broken appendicular elements gathered at specific levels in the cave indicate ages varying from 3,715 $\pm$ 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.

Fossils of the mammalian fauna collected at Trou Woch Sa Wo were not divided into distinct stratiographic zones. The various taxa were 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 reveal 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.

Paleo Climates and Environments of the Macaya Area

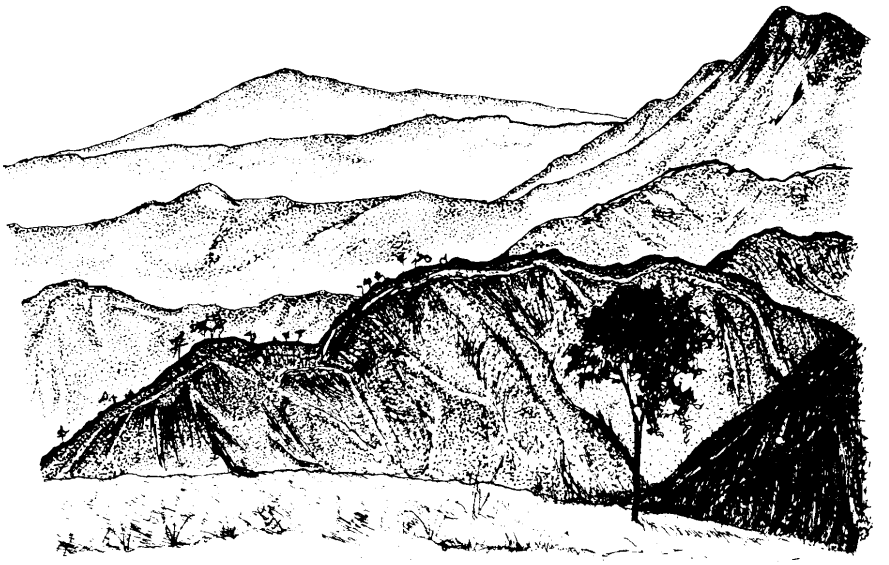
The above data indicate that the mammals collected in the Formon area (Trouing Jeremie #5) and at Trou Woch Sa Wo near Camp Perrin were living in this area of western Haiti in latest Pleistocene and early Holocene times. During this time period, environmental conditions in Hispaniola were probably very 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 3,500 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 tradewinds 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 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*), 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.



Parc National La Visite

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 1,600 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.

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 stratiography.

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 7,500 years ago. Between 6,500 and 7,500 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 6,500 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.

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 (Appendix II) 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 with human-related activities became intense. The table "Endemic Land Mammals of the Massif de la Hotte and Massif de la Selle" (Appendix II) compares the known endemic land mammals of the montane regions of the Massif de la Hotte with the Massif de la Selle.

During the past 20,000 years, 25 species of endemic land mammals occurred in Hispaniola. Of these, all but *Plagiodontia aedium* and *Solenodon paradoxus* have 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 became 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 more than 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.

Section 5. Critical Areas and Topics of Special Concern of Parc National Pic Macaya

The most significant geological, botanical and zoological features of Parc National Pic Macaya were discussed in the previous section. Significant regions and features of the park have been selected based on these data and the synthesis of the individual inventory reports. The areas in the Parc Macaya region that are in greatest need of protection or are of greatest significance are listed below.

Critical Areas

1) Karst hills from Morne Cavalier southeast to Sous Bois (region called "Bwa Formon" and "Bwa Durand").

   Importance: Most important habitat for endemic orchids. Also habitat with the greatest bird diversity. Only known habitat in the region where Parrots are found. Only place where *Plagiodontia aedium* still occurs in region unless Mare Cochon is added to Park.

2) Small ponds on Plain of Formon and Plain of Durand at 1,000-1,200 meters.

   Importance: Water conservation. Only available aquatic habitats in region.

3) Ridge of Formon from Pic Formon east across 2,170-meter Pic Le Ciel and on east along the ridge of Formon to 1,600 meter contour beyond Pic Macaya.

   Importance: The largest block of mesic Broadleaved forest left in Haiti. Water source for Ravine du Sud, Riviere l'Acul and Riviere de Port-a-Piment.

4) Western ridge of Pic Formon to 1,600 meter contour.

   Importance: Continuous with previous forest. Possible habitat for Black-capped Petrels. Suitable habitat for *Plagiodontia aedium* (re-introduction possible).

Several species of mammals, 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.

5) Pic Macaya.

Importance: Breeding Black-capped Petrels; Extensive pine forest with White-winged Crossbills. Numerous nesting endemic birds. Water source for Ravine du Sud and Riviere des Roseaux, Riviere Guinaudee, Riviere l'Acul and Riviere Port-a-Piment.

6) Eastern extension of the ridge of Pic Macaya to the north into the Diquillon region and eastward onto Mare Cochon.

Importance: Largest number of *Plagiodontia aedium* and *Solenodon paradoxus* left in Haiti; Habitat for many species of endemic frogs; Many endemic orchids; Source of Ravine du Sud, Riviere des Roseaux and Riviere Glace.

7) "Gran Ravin" down to an elevation of 500 meters where the two branches of the Ravine du Sud merge.

Importance: Mesic forest to low elevation; Abundant rainfall; good area for water conservation for Ravine du Sud. Controlled access to "Gran Ravin."

Special Concerns and Priorities

1. Protecting the Black-capped Petrels along the south face of Pic Macaya by preventing all fires in areas below their nesting colonies.
2. Protecting the few remaining "zagouti" (*Plagiodontia aedium*) in the karst hills on the Plain of Formon.
3. Expanding the protected area (national park) to the north and east of the main ridge of Pic Macaya to include 2,000 hectares of critical additional habitat (Mare Cochon) for *Plagiodontia aedium* and providing the only suitable habitat available for *Solenodon paradoxus* and the newly-discovered "living fossil" *Solenodon* sp.
4. Removing the dogs and cats from the karst hills of the Plain of Formon. This will be difficult because so many people live in the area.
5. Removing sheep and goats from the "Gran Ravin," and the upper areas of the Riviere Trois Sources.
6. Establishing a program of guardians to patrol the park and prevent deforestation and exploitation.

7. Completing an official boundary survey. This survey should resolve the conflict with UNICORS\COSAR in the "Cadiene" area near Morne Cavalier and the area between Pic Macaya and Pic Formon, and conflicts caused by the original survey, which was improperly done.

8. Initiating a soil conservation program in the "Gran Ravin" that will stabilize the steep slopes of the ravine. Pines and hardwoods (such as *Persea anomala*, the wild avocado) should be planted in suitable areas. Grass should not be planted unless seeds of an appropriate native species is available.

9. Replanting the areas around the small ponds on the Plain of Formon and Plain of Durand to keep them from filling in with surface soil. Rapid erosion from the newly cleared land surrounding the ponds is threatening them.

10. Protecting all areas of the "Rak Bwa" growing in the karst hills. This area is being rapidly deforested.

11. Replanting trees (pines and broadleaved endemics) on the Plain of Formon and Plain of Durand in ravines and badly eroded areas, and in the foothills to the north. Heavy rains carry away enormous quantities of soil and nutrients in these areas. Planting can be in strips along the ravines, in blocks around the ponds, and in patches in especially suitable habitats. These patches in addition to stabilizing the soil will create "edges" of habitat that will increase the diversity of the otherwise ruinate open areas of the Plain.

12. Developing Species Recovery Plans for endangered and threatened species. These Species Recovery Plans will be very important in planning activities in the parks.

Although Macaya is remote and the trails in most sections of the park are steep and difficult to traverse, an effort should be made to develop a program in wilderness tourism.

Section 6. Zones and Areas of Parc National Pic Macaya

The following discussion mentions various areas within Parc National Pic Macaya. They are part of the overall plan to create "Zones" in the region of the park, specifically in the area to be designated as the Macaya Biosphere Reserve (discussed in the next chapter). Within the MBR, Parc National Pic Macaya is considered a "Core Zone," which is an area that should receive maximum protection.

A. Recreation Areas

Recreation and tourism are not likely to be as important in Parc Macaya as in Parc La Visite because Macaya is remote and the trails in most sections of the park are steep and difficult to traverse. Many tourists will not want to undertake the exhausting hike

necessary to get to Pic Macaya or into the "Gran Ravin." Recreational facilities should be available in the park, however, to accommodate adventurous visitors, and an effort should be made to develop a program in wilderness tourism. The basic facilities and recreational plan for Parc Macaya should include the following.

A Park Headquarters already exists, and it has rooms that could be used to house visitors. There are also excellent camping places in the area of the Park Headquarters, especially in some of the upland meadows above Caye Michel. Some of these meadows offer views of the Formon Range to the north, and the Caribbean Sea to the south, and are near broadleaved forest habitats filled with endemic birds. The following should be constructed to increase the attraction of Parc National Pic Macaya to visitors:

a). A camping area should be built near Park Headquarters at Caye Michel. The camping area should have a latrine and a permanent source of pure water.

b). A nature trail should be constructed from the Park Headquarters up the ridge of Formon and descending into the "Gran Ravin" at 1,050 meters elevation where there is a picturesque waterfall, pure water and a pleasant place to construct a permanent campsite. There are several spectacular views from this trail. Visitors should be encouraged to employ a guide.

c). A nature trail should be constructed from the Park Headquarters westward and up the ridge of Formon, across Pic Le Ciel to Pic Formon. A camping area (log lean-to) should be constructed on Pic Le Ciel. The trail that crosses the ridge from Pic Formon to Pic Macaya should be closed to the public. The trail up Macaya is extremely steep and dangerous in several places as it passes over exposed areas of loose rock. The top of Pic Macaya is one of the most dramatic and remote areas in all of Haiti (see following section). Visitors to Pic Le Ciel and Pic Formon should be encouraged to employ a guide.

d). A nature trail should be constructed into the "Rak Bwa" forest to the south of the Park Headquarters.

e). Natural History exhibits should be constructed in and around Caye Michel (the Park Headquarters).

f). Consideration should be given to constructing a trail from the park headquarters to the cave where the Riviere l'Acul rushes from the mountain as a fully formed stream. This area is outside of the park, but in the "Buffer Zone," and therefore is part of the Planned Macaya Biosphere Reserve.

g). The Citadelle Des Platons near the town of Les Platons should be included in the biosphere reserve, and Parcs Haiti should

Everything possible should be done to maintain the top of Pic Macaya as a "wilderness." Trees should not be cut for firewood, and fallen branches should not be burned because the burning of excess wood is counter to maintaining the area in "wilderness."

work with ISPAN to develop the site. There should be information about the Citadelle available there, and also information about the park (a three hour hike or a ten kilometer drive). The view of the mountains from Les Platons is very impressive.

B. Special Permit Area

We recommend designating the top of Pic Macaya as a combined "Recreation Area" and "Biological Preserve Area." This designation acknowledges the exceptional mystique of Pic Macaya. The bird life is interesting because of the large numbers of endemic species, the towering pine forest is impressive, the vistas from the trail ascending the peak are spectacular and there is an almost spiritual mystique about being on Pic Macaya. These features mean that there is a recreational dimension and tourist attraction about the area that should be acknowledged and carefully cultivated. The area is also very fragile. The trails are easily damaged; the deep pine litter makes the zone susceptible to forest fires. The colony of Black-capped Petrels on the south side of the mountain are "threatened." Therefore, we recommend that a shelter be built at the top of Pic Macaya with a safe and secure place to build a fire.

Everything possible should be done to maintain the "wilderness" aspect of this area. Trees should not be cut down for firewood, and fallen branches should not be burned because the burning of excess wood is counter to maintaining the area in a "wilderness" state. Firewood should be carried in, when possible, or more appropriately camp stoves should be used to cook on. Visitors to the park should only be allowed to climb Pic Macaya (and camp there) with written permission (a permit) obtained at the Central Office of Parcs Haiti. We recommend that a fee be charged for the permit. There should be a place for the Park Supervisor of Parc Macaya to also sign the permit to insure close supervision of all who climb Pic Macaya. Two local guides (one to return for help should a visitor fall and become injured) should accompany all climbers. Since the trail to the peak is dangerous, the permit should include a signed waver to release Parcs Haiti from any legal liability in case of injury.

There are so many endemic species of plants and animals in Parc National Pic Macaya that one of the most important functions of the park is conservation of these species, many of which are threatened or endangered.

The top of Macaya is first and foremost an area of great biological significance, and should be set aside as a Biological Preserve Area. Therefore, what we are proposing is to have a small part of the "Biological Preserve Area" be set aside in the category of a "Designated Use Zone" even though it is in the middle of a "Restricted Area" (see below).

C. Biological Preserve Area

There are so many endemic species of plants and animals in Parc Macaya that one of the most important functions of the park is conservation of these species, many of which are threatened or endangered. Another important function of the park is watershed conservation which is best accomplished by increasing the percent of natural forest cover on the steep slopes and high peaks. Large sections of Parc Macaya should be set aside as conservation zones. The term "Biological Preserve Area" should be used for all these conservation areas.

The most important areas to set aside as "Biological Preserve Area" are listed below.

1. All of the karst hills along the margin of the Plain of Formon from Sous Bois to Morne Cavalier (with the exception of a well marked educational trail that will pass through this zone). This biological preserve is essential to protect the zagouti (*Plagiodontia aedium*), the Hispaniolan Parrot and many species of endemic orchids which only occur in the park in this region.

2. All of the eastern ridges of Pic Macaya as well as the adjacent Diquillon and Mare Cochon areas. This is the most important wilderness area left in Haiti. It could be given the special designation "Haitian Solenodon Wildlife Conservation Area." The presence of this conservation zone is absolutely necessary if the Haitian Solenodon is going to be protected from extinction in the next decade. This conservation zone and Solenodon conservation program is likely to attract funds from international conservation organizations.

3. The "Gran Ravin," from 500 meters elevation upward (westward) to the ridge connecting Pic Formon with Pic Macaya, should be protected. Few people live in the area. This area is severely degraded by overgrazing and recurring landslides. It has great biological significance, and is of importance in water conservation for the Ravine du Sud.

4. The "Basin Dalest" is one of the few extensive flat areas at moderate elevation (1,500-1,600 meters) in the park. It still has extensive patches of mesic forest and some giant pines. The basin is rich in bird life. The entire basin and eastern extension of the ridge should be protected as a "Biological Preserve Area."

5. The wet steep mountainside northeast of the ridge connecting Pic Le Ciel with Pic Formon should be protected. It appears to be so wet that it has never been burned, and has never been cut. It is the last totally virgin old growth forest left in Haiti.

The wet steep mountainside northeast of the ridge connecting Pic Le Ciel with Pic Formon is the last totally virgin old growth forest left in Haiti.

6. The entire area of summit of Pic Macaya (which is also designated as a "Recreation Area") should be protected. This is designated as a Biological Preserve Area in order to protect the breeding colony of Black-capped Petrels and the unique "mesic" pine forest.

D. Restoration Area

The following areas are in need of management in order to return to their biological potential or to correct severe environmental problems that threaten their future and the future of adjacent regions. Some of the areas are isolated from other zones, while others are within a "Biological Preserve Area," but have been severely degraded. The areas of special concern are listed below.

1. The Plain of Formon has been severely degraded and must receive immediate protection. Species recovery plans must be developed for endangered and threatened species.
2. The ponds on the Plain of Formon and Plain of Durand need special attention to prevent them from filling in with mud, and to enrich the areas around them for wildlife. Endemic shrubs and trees should be planted in a zone 20 meters wide around the ponds. *Pinus occidentalis* should be planted along the ravines leading to these ponds. The pines would prevent further soil erosion, and would provide habitat for endemic species. They would also create corridors for wildlife to follow to more protected areas of the park. The presence of mature pines is absolutely necessary for some endemic species of the area, such as the Haitian White-winged Crossbill which feeds on pine seeds.

Special attention should be paid to removing goats and sheep from the hillsides since they are overgrazing the vegetation, and starting erosion and landslides by walking in steep areas.

3. The "Basin Dalest" is designated as a "Biological Preserve Area." The degradation and deforestation on the bottom of this basin near a small house with a metal roof is especially severe. New gardens have been planted in the past year and many large pines have been cut. The house should be removed. All gardens should be destroyed. *Pinus occidentalis* should be planted in the gardens.
4. The steepest areas of the "Gran Ravin" on the south side of Pic Macaya are eroding away very rapidly. Special attention should be given to "securing" this area. The area is naturally unstable and extremely difficult to get to. Grass scattered onto the hillside would stabilize the slope.

   Note: There are many problems associated with planting grass. The presence of dried stems will create a severe fire hazard. Therefore we recommend planting pines on the

hillside wherever possible. Grass should only be planted if seed of a native species can be obtained. Special attention should be paid to removing goats and sheep from the hillsides since they are overgrazing the vegetation, and starting erosion and landslides by walking in steep areas.

Pinus occidentalis should be planted along flatter areas of the steep slopes and along the margin of badly eroded areas. The pines are a natural feature in the successional sequence of the region and would not only increase the stability of the fragile slopes, but would also increase the habitat available for White-winged Crossbills.

E. Maintenance and Service Areas

The following areas should be set aside in the park as part of activities associated with maintenance and service.

1. Park Headquarters
2. The "road" from Les Platons to the Park Headquarters.
3. A depot and work area at Portal Formon near Madame Robert's house.
4. A supplemental headquarters at Deglacis near water at 1,040 meters in the "Gran Ravin."
5. A supplemental headquarters in the "Guinaudee" region of the ravine of the Riviere de la Guinaudee (sometimes called Riviere Tordeau). We recommend that this be at 700 meters elevation in the ravine just outside of the Park boundaries. Access to this area from Beaumont and Duchity is not difficult. This would allow for access into the park to be from both the north and south. The long-range goal of having a hiking trail that would pass from Les Platons to Beaumont would create the need for a facility on the north side of the park. There is also a need for a security station in the area (see below) which could be part of the supplemental headquarters.

We recommend planting pines on hillsides wherever possible. Grass should only be planted if seed of a native species can be obtained.

F. Security and Information Areas

The following items are closely linked to preventing further environmental degradation in the park, and to making the park a safe and secure place to visit.

1. A sign describing the park should be placed at Les Platons.
2. A sign about the Citadelle Des Platons should be placed adjacent to the Citadelle along the access road to Parc Macaya. We recommend that the Citadelle become part of the Parc Macaya Biosphere Reserve program.
3. A sign about the park should be placed near the entrance to the park beyond Sous Bois (near Portal Formon). This sign should outline:

   a. Park rules
   b. Park features
   c. Map of Park

5. A guard station should be established at the depot near the trail as it passes Portal Formon.

6. At some time within the next decade, a guard station should be constructed near the supplemental park headquarters on the north side of the park in the valley of the Riviere Guinaudee along the access route (to be developed) from Beaumont and Duchity. It might be important to construct this guard station soon if the new road from Duchity threatens the park.
7. A guard station should be set up in association with the supplemental Park Headquarters in the "Gran Ravin" at or near 1,040 meters.
8. A guard station should be set up at the end of the UNICORS\COSAR road at the western end of the park. The park is very threatened by the presence of this road, and the activities of UNICORS\COSAR.

A series of signs which describe the park boundaries, park features, and park rules should be placed at park entrances and access roads.

G. Education Area

The remoteness of Parc National Pic Macaya means that it is not necessary to construct a separate site museum or to invest in expensive local site exhibits. The emphasis of the park should be on soil and water conservation and the preservation of endemic species of plants and animals. Recreation of the "wilderness experience type" should also be encouraged. If Parc National Pic Macaya ever develops into a major tourist facility, then the site museum can be constructed at or near the Citadelle Des Platons to take advantage of the historical importance of that facility and the remarkable view of the mountains.

During the first ten-year phase of the park, the main education zone will be an exhibit of two double-sided educational panels set

up at the Park Headquarters. These exhibits would provide a guide to the most significant features of the park. The two panels would have four exhibits:

1. Water Conservation
2. Geological and Physical Features
3. Major Forest and Plant Associations
4. Fauna of Parks

As part of the development of an access route to Parc Macaya, a nature trail should be constructed through part of the karst hills of the Plain of Formon (Bwa Formon).

H. Research Area

Three climatological research stations should be set up in the park to record air temperature, soil temperature, barometric pressure, rainfall, wind direction, and wind speed.

These stations should be at:

1. Plain of Formon at "Depot" (1,000 meters)
2. Summit of Pic Le Ciel (2,170 meters)
3. "Gran Ravin" outpost (1,040 meters)

No other research area is necessary. Since such large sections of the park are classified as "Biological Preserve Zones," care must be taken to preserve and protect the ecosystems in the areas. Collecting for plants or animals in any region of the park should be carefully regulated and reviewed. As with Parc National La Visite, we recommend that eight research projects be undertaken during the next five years. These projects are:

The emphasis of Parc National Pic Macaya should be on soil and water conservation and the preservation of endemic species of plants and animals.

1. A quantitative analysis of the composition of each major plant association in the park.
2. An analysis of microhabitat requirements of each endemic plant species as well as information on growth and regeneration.
3. An in-depth study of the ecology of the endemic mammals in an effort to develop an effective management program.
4. A detailed analysis of the habitat requirements and breeding biology of the Haitian Solenodon, White-winged Warbler, and Black-capped Petrel to develop effective management programs based on the Species Recovery Plans for these species.

5. A continuing analysis of the distribution and abundance of birds in an effort to understand the habitat requirements of the endemic species.
6. An in-depth analysis of the habitat requirements of numerous invertebrate species, and an effort to document additional new species.
7. An in-depth analysis of the specific habitat requirements of each species of amphibian and reptile in an effort to learn how to manage habitats to protect endemic species.
8. Baseline studies on the climate of each microhabitat in the park.

Section 7. Plan for Parc National Pic Macaya

The plan for Parc Macaya will be divided into nine topics. Each topic is briefly discussed in this chapter as it relates to the local situation in Parc Macaya.

A. Administration

There should be a full time "Park Supervisor" assigned to the park. As part of the MBR project, very adequate facilities have been constructed at Caye Michel on the upper Plain of Durand. This facility should serve as the Park Headquarters, office space, and the residence for the Macaya Park Supervisor.

Duties of "Park Supervisor"

1. Seek resolution of conflicts of land use with local landholders, farmers, peasants.
2. Coordinate the improvements on the road and access route to the park to improve access.
3. Serve as an active and effective spokesman for the park, and the concept of conservation on the Cayes, Formon, Macaya regions.
4. Coordinate and supervise all routine activities in the park as designated by the Director and Assistant Directors, such as maintenance, security of the park, and implementation of the park plan.

Collecting for plants or animals in any region of the park should be carefully regulated and reviewed.

B. Maintenance

There should be a full-time team of maintenance workers who carry out the instructions of the Park Supervisor via the designated "crew chief." The size of the group of workers will depend on the amount of work at any one season, or at any one time in the implementation of the park plan. However, there should be a nucleus of workers under permanent contract (a "crew chief" and 14 full-time workers is the suggested size). They should be hired from among people living in the region.

The maintenance crew is responsible for improving and maintaining access to the parks, building basic park facilities and assisting in reforestation.

C. Security

There should be a team of full-time guardians for Parc Macaya. This group should be under the direction of a "Chief of Guards" who answers directly to the Park Supervisor.

It is important that guardians be trained and placed within the park as soon as possible since there has been so much recent exploitation of the park for lumber and gardens. It is extremely important, however, that the presence of guards not become a bigger problem than the problem they are there to guard against. If the guards themselves are not correctly supervised, then they may organize the peasants to make gardens, harvest wood, and graze animals. The guards will also need to be fed and sheltered, and these compromise the security of the habitat. Some guard posts in the national parks of the Dominican Republic have been associated with exploitation of the habitat, especially when the posts are located in remote areas.

With the above special concerns in mind, guard posts should be established in appropriate places (near water and suitable services) of Parc Macaya. One guard post should be near Portal Formon. This post would secure the trail to Sous Bois (and the lowland areas to the south including Port-a-Piment and Coteaux) as well as the main route back to Les Platons (Chantal, Le Duc, Torbeck and Cayes). This should be the main guard post for Parc Macaya. It should include enough guards to secure the trail, as well as to patrol the south boundaries of the Park.

We do not believe that guards should live inside the park. Because of the remote nature of Parc Macaya, however, this is a special problem in the region of the Plain of Formon, and an even

greater problem for the outpost on the north side of the park. No easy solution is at hand because of the difficulty of transportation in the region. If the guards live in the nearby community, they will in time tend to watch out for the interests of that community, and will be vulnerable to conflicts of interest. For that reason, we recommend incorporating a security post into the depot facility of Parc Macaya at Portal Formon. This would be the main security facility for the park.

A second guard post should protect the north and northwest margins of the Park. This would secure the routes to Chardonnieres and below Des Barrieres on the north side of Macaya. There is water there, and easy access from both Duchity and Beaumont. This guard post would be part of the park headquarters outpost in that region. A third small guard post can be set up in the "Gran Ravin" for occasional use by the guardians from Portal Formon as they patrol the "Gran Ravin." Special care should be taken to prevent this area from being exploited since it is remote, and is already the site of considerable agricultural activity.

D. Recreation and Tourism

The major features of a recreational program are outlined under the discussion of the "Recreational Areas" in Section 6 of this chapter. The development of these facilities will provide tourists with something to do in Parc Macaya that is unique and appropriate for the region. It will also allow the park to be publicized, and will provide a public image for the park that can be advertised in Port-au-Prince where Macaya seems remote and poorly understood.

A nature trail through the karst hills of the Plain of Formon will allow the public and important visitors to view some of the best features of Parc Macaya without their having to hike into the remote sections of the park. This nature trail should have well-placed and appropriately designed signs to identify geological and botanical features. The trail can be incorporated into the access route to the park in some areas. If carefully planned, the nature trail will not conflict with the conservation goals of the "Biological Preserve Areas" of the karst hills region.

The Pic Macaya area has been set aside as a "Biological Preserve Area" because the habitat is so sensitive to damage by fire and disturbance by overuse. We have also recommended that a "Recreation Area" also be included on Pic Macaya. We have, therefore, designated the area of Pic Macaya as both a recreation and preservation region. Recreation should be allowed on Pic

Macaya (because the area has such significant recreational features), but only under carefully controlled and well-supervised conditions (see Section 6-B). There should be an attractive and secure campsite on the top of Pic Macaya, and a hiking trail along the ridge.

Eventually (within the ten year plan) plans should be made to develop a hiking trail that passes from Les Platons across the Plain of Formon, up the ridge of Formon, across Pic Formon, up the ridge of Macaya to Pic Macaya, down the north ridge of Macaya across the "bump" at Zapoti to the Riviere de La Guinaudee (or R. Tordeau, as it is called in the region), up to Desbarrieres and out to the town of Beaumont. This hiking trail is difficult to traverse because of its steep inclines. However, if properly maintained, it could be an attractive feature of the park area. The climb to Macaya (from either Les Platons or Beaumont) could be like climbing Mt. Kilimanjaro in Kenya, where certain hardy visitors are drawn by the mystique of the place and name. Fees could be charged for this "adventure" that would include campsite and guide fees (see Section 6-B). This would generate some revenue for the park, provide a focal feature for the park, and yet "control" the use of the zone so that a minimum of damage was done to the flora and fauna.

E. Education and Interpretation

The main educational goals for Parc Macaya for the first ten years are discussed in Section 6-G under the description of the "Education Area." These activities should be carefully coordinated with "Recreation and Tourism" activities. The major education and interpretation goals for the first ten years are listed below.

1. A sign at Les Platons about the Citadelle.
2. A sign at Les Platons about Parc Macaya.
3. A nature trail along the access route to the Park Headquarters. This trail should be a unit in itself, but should allow hikers from Les Platons the added feature of hiking along the trail as they approach the Park Headquarters. It should have a number of information signs about the natural history of the area.
4. Two exhibits in the Park Headquarters (see Section 6-G).
5. Good maps should be completed of the park, along with publications on the flora and fauna of the area. These would be useful in recreation, education and management.
6. Conservation Posters (one already completed).

The Pic Macaya area has been set aside as a "Biological Preserve Area" because the habitat is so sensitive to damage by fire and disturbance by overuse.

7. Natural History volumes that can serve as "Haitian Field Guides."

8. A full color brochure on Parc Macaya.

F. Public Relations

The park should be promoted in the media in Port-au-Prince after adequate facilities exist. The important features of Parc Macaya should be illustrated in entrance signs for the park that are prominently displayed near the entrance near Portal Formon and at the Park Headquarters. There should be exhibits on Parc Macaya at some locations in Port-au-Prince such as the Airport, MUPANAH, and certain hotels, as well as in les Cayes. A good exhibit could be placed in the lobby at Damien.

The Park Supervisor of Parc Macaya should be the chief spokesman for the park in the region. This person or a representative of the Central Office should give speeches in Les Cayes and other towns in the area, and should work with organizations in the area such as the Union des Cooperatives de la Region Sud d'Haiti (UNICORS). There are a number of conflicts or potential conflicts in the area that could damage the park. The park supervisor in association with the Director and Assistant Directors should be responsible for working at the local level to overcome these.

A tape/slide presentation should be available that can be used by the Park Supervisor and administrative staff in the Central Office to promote an understanding of the reasons behind the park and the objectives of Parc Macaya.

Conservation posters can help educate people about how important and unique the natural patrimony of Haiti is, and about the role of Parcs Haiti in protecting Haiti's fragile environment.

A video should be prepared that can be used to promote national parks in Haiti. Such a video is planned as part of the MacArthur Foundation Project (see Chapter VII).

Conservation posters should be used to promote the park, and to teach the principles of land stewardship. These posters can help educate people about how important and unique the natural patrimony of Haiti is, and about the role of Parc Haiti in protecting Haiti's fragile environment.

The MacArthur Foundation Conservation Project will help develop this Environmental Education Program, and prepare some of the educational materials required to make it a success.

G. Research

As much as possible, Parc Macaya should be a "Biological Preserve Zone." The area should be allowed to recover from over-exploitation. All research in the park should be carefully regulated. No extensive collecting of plants or animals should be allowed without a permit and permission of the Director of Parcs Haiti. However, information from research is an important tool in developing sound programs in management and conservation. Research should, therefore, be allowed when a good case is made of its relationship to the conservation goals of the park or to the development of an educational program for the park. Parcs Haiti should also keep in mind that the Massif de La Hotte is one of the most significant biological and geological regions of the Antilles. There will be a number of requests for important studies that have international significance. Where possible, these requests should be approved when assurances are given that the results will be made available to Parcs Haiti, and when personnel from Haiti are included in the research process.

All research in the park should be carefully coordinated with Parcs Haiti. Written requests must be approved before research is allowed. Final reports must be submitted. A Haitian counterpart should be assigned to each project. Where possible, the counterpart should work in the field with the investigators, and become part of the processes of documentation and analysis. Where appropriate, the counterpart should also be a part of the publication process.

For Parc Macaya we have determined the most important research goals for the next five years to be eight major projects. These are listed in Section 6-G.

Research must be done on the propagation of endemic species and the best way to regenerate the diverse mesic broadleaved forest that once characterized the entire region.

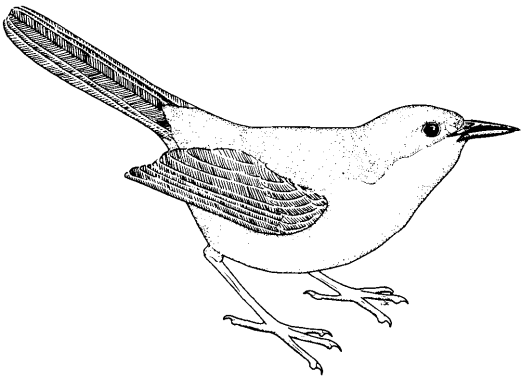
H. Five Year Conservation Goals

The major conservation goals for Parc Macaya for the next five years are listed below.

1. Preservation of the unique mesic broadleaved forest between Sous Bois and Morne Cavalier. The preservation of this forest will by association preserve numerous endemic plants and animals.
2. Preserve *Plagiodontia aedium*, *Solenodon paradoxus*, and the new species of Haitian Solenodon in Parc Macaya. The only way to be sure of doing this is to include the Mare Cochon area in the park, and to carefully manage the area. "Management" in the park for these endemic mammals means that dogs and

cats must be excluded (actively hunted) from the park and that the area must be protected from further deforestation. An active research program on the habitat requirements of both species should be undertaken.

3. Preserve the colony of breeding Black-capped Petrels in the park. Wise management will require additional information based on an active research project.
4. Promote the preservation of Hispaniolan Parrots in the park.
5. Conservation of the endemic plants and animals most closely associated with mesic broadleaved forest (Hispaniolan Trogon, Chat Tanager and especially the White-winged Warbler).



Chat Tanager

6. Develop a management program for the Pine Forests of the region that will protect the Haitian White-winged Crossbill. This is one of the most endangered species of Hispaniola. Mature pines are required to produce pine cones (and pine seed). Since this only happens every three years in some areas, it is going to be necessary to increase the areas of the Macaya region planted in pines. The Pine forests will be suitable for commercial exploitation, but must be carefully managed for the constant presence of mature cone-bearing trees. Cones must be available each year. Only native pines, *Pinus occidentalis*, should be planted.
7. Undertake a major program in watershed management that will increase the forest cover of Parc Macaya and stabilize areas where soil erosion is a major problem (ravines on the Plain of Formon and the "Gran Ravin"). These measures should increase the quality and quantity of water in the Riviere de l'Acul, Riviere des Roseaux, Riviere Port-a-Piment, Ravine du Sud, Riviere Glace, and the numerous tributaries of these major rivers. Research must be done on the propagation of endemic species and the best way to regenerate the diverse mesic broadleaved forest that once characterized the entire region.

The only way to be sure of preserving *Plagiodontia aedium*, *Solenodon paradoxus*, and the new species of Haitian Solenodon in Parc National Pic Macaya is by including the Mare Cochon area.

I. Ten Year Plan for Parc Macaya

The major features of the plan for Parc Macaya for the next ten years are discussed and outlined in the previous eight sections (A-H). All of these goals, and more, are possible to accomplish with a modest commitment of personnel and funds, and with a clear plan of operation. These goals are listed and summarized below.

1. Complete the boundary survey including the addition of all areas recommended in this report (Highest Priority).
2. Select a full-time Park Supervisor and staff (Highest priority).
3. Train and deploy properly equipped and highly motivated park guards to protect the national park.
4. Build guard stations at critical locations along access points to the park (Portal Formon, UNICORS\COSAR area, north side of Macaya, Grande Ravine).
5. Continue to develop the Park Headquarters and facilities surrounding Caye Michel (High Priority).
6. Establish "Biological Preserve Zones" to protect all plants and animals in the zones (water resources and geological features would also be protected).
7. Develop an associated historical site at Les Platons in conjunction with ISPAN. Initiate an active training program for all Parc Macaya staff and make sure Park Supervisor is part of a major training program for park administrators.
8. Design, manufacture and put in place additional signs for the park (entrance, boundary, information). Some of these signs were done as part of the final activities of the MBR project.
9. Resolve issues of conflict between UNICORS and other individuals and organizations in the region.
10. Improve the public image of the park in the area by clearly demonstrating the advantages of the park via a series of public meeting and workshops with local residents.
11. Complete a series of research projects that will ensure the conservation of endemic species of plants and animals.
12. Create educational exhibits for the Park Headquarters or Les Platons area.
13. Initiate the biosphere reserve by developing a buffer zone of 10,000-20,000 hectares around the park, and work with land holders in this zone to create a mutually satisfactory land use policy within the buffer zone (agriculture that does not damage the watershed or lead to extinction of endemic species).

14. Complete a recreational development program for the park and buffer zone that encourages visitors to make use of the scenic and aesthetic features of the park.

15. Improve access to the park via Les Platons, but only after a full-fledged program is in place in the region that can provide security to the park.

16. Develop supplemental park headquarters (outpost) and security stations on the north side of the park and in the "Gran Ravin."

17. Design and construct nature trails.

18. Develop an international fundraising program to be associated with the park.

19. Design an informational booklet or brochure on Parc Macaya.

20. Complete a ten year climate study of the region.

21. Complete a series of maps of the park and buffer zones.

CHAPTER IV

Macaya Biosphere Reserve

Introduction

This chapter summarizes our observations on the status of the "Planned" Macaya Biosphere Reserve. Our original goal was to conclude the MBR project with an official application to UNESCO for recognition of the area as a biosphere reserve. However, because of the political unrest and embargo, all institutions in Haiti are functioning at a reduced level. We do not believe that it is wise at the present time to propose the Macaya area for recognition because we are not sure what the commitment of the GOH will be in supporting the MBR, and it is still not certain what the status of the World Bank Project is. That project will be critical in rebuilding the infrastructure of MARNDR in the area of natural resources. If the World Bank Project in implemented and is successful in strengthening MARNDR, then that organization would be capable of taking a leading role in the development of MBR. If not, the role will have to come from some new organization. This new group could be a new GOH institution, such as Parcs Haiti (proposed in this document), or a non-GOH group such as one of the PVOs interested and committed to natural resources and the environment. Only time will tell. In the meantime, the following data can serve as a basis for an eventual document and program seeking official recognition of the area as the Macaya Biosphere Reserve.

CONSERVATION STRATEGY

An analysis of the rate of deforestation in Haiti predicts that by the year 2000 there will be no natural forests in Haiti if a serious conservation program is not undertaken soon (Cohen, 1984). Cohen estimated that forests cover only three percent of the country and concluded that Haiti is heading toward a process of desertification as a result of deforestation. One of the alarming consequences of the trend towards a complete loss of natural forests in Haiti is the loss of biological diversity. As an island of the West Indies, Hispaniola shelters many endemic genera and species (Dorst, 1974). The endemic reptiles and amphibians are especially numerous in mountainous areas (Schwartz & Henderson, 1988). Endemic plants are estimated to reach 39.2% of the total number of Hispaniolan plant species with 36 endemic genera and 1,797 endemic species (Howard, 1973; Borhidi and Muniz, 1985). There are 300 species of orchids found on the island of Hispaniola. In the La Citadelle region alone (25 km^2) eight orchids were recently identified (Zanoni et al., 1985). Among them is *Lepenthopsis quisqueyana*, which was reported for the first time in Haiti (Dod, 1986). The native and indigenous trees of the region produce lumber material, charcoal, and firewood. They also serve as shade trees for coffee and cocoa, and as shelter for the multitude of epiphyte and ombrophile species thriving in the region. Many species are used in folklore and traditional medicine. Finally, trees are important in combating erosion. This diversity should be protected by a management plan that takes into consideration: 1) the importance of the natural diversity; 2) the sustainable aspect of the exploitation of the resources; 3) the quality of life of the population exploiting the resource.

If a serious conservation program is not undertaken soon, by the year 2000 there will be no natural forests in Haiti.

Natural Resources Management Plan

The main objective of the natural resources management plan is to insure biological diversity for use by future generations. It addresses a conservation strategy through a biosphere reserve system that includes: 1) a conservation program, 2) a regeneration program to reconstruct the degraded areas, 3) a functional production program for the neighboring population.

The approach of the national parks to protect nature, wilderness, flora and fauna, and to eliminate exploitation or occupation for the benefit of tourism has worked well in countries such as the United States, where there is a long tradition of conservation, and economic conditions have been favorable. However, in small and underdeveloped countries such as Haiti, the strategy followed by the United States and other large developed countries is often

ill-adapted.

In Haiti, land is one of the scarcest natural resources. The exploitation of land is a way of living for 80% of the population, many of whom have an annual income as low as US $60.00 to $150.00. Demographic pressure in Haiti is high, with a density of 720 people per km^2 of arable land. Conservation is a must before it is too late. No matter how effective legislation may be in setting aside protected areas from being exploited, in countries with high demographic pressure this legislation is rarely operative. In such countries, efforts to establish a conservation program must take into consideration the needs of the local population. As stated by Marco Flores Rodas, Assistant Director General of FAO, "Until and unless the rural people are ensured adequate food and shelter and a dignified standard of living, all effort to establish and manage national parks and protected areas will be nothing but grandiose project in futility." (Flores Rodas, 1982)

A strategy to establish a program for the conservation of natural resources in Haiti should combine sustainable development and conservation in order to solve the basic needs of the population without permanently degrading the ecosystem. This can be best done by the concept of a "Biosphere Reserve," a concept that emphasizes the value of protected areas not only for the conservation of germplasm and the overall ecosystem, but also as areas where suitable exploitation of the resources by the local population is possible because of the knowledge gained from research, monitoring, education and training (UNESCO, 1984), and the thoughtful involvement of a number of individuals or groups in determining appropriate land use practices in specific habitat (i.e., zoning).

A strategy to establish a program for the conservation of natural resources in Haiti should combine sustainable development and conservation in order to solve the basic needs of the population without permanently degrading the ecosystem.

History of Biosphere Reserve Concept

Programs of conservation began more than a century ago with the creation of national parks. Since their establishment, people and governments realized that the concept of national parks was not appropriate with the increasing human populations, and social and economic instability. Great efforts have been made by many countries in the world to conserve nature. Several categories of protected areas were designed to strengthen their role in conservation and management of natural resources. In 1971, the Man and the Biosphere (MAB) program was initiated. A project named "biosphere reserves" was established to resolve conflicts between humans and the environment by demonstrating the value of conservation in improving human well-being. This project recognized the importance of combining strict conservation with adequate and

carefully planned use of the natural resources for the benefit of the local population. In 1985, the United Nations list of national parks and protected areas reported 244 biosphere reserves in 65 countries spread in 8 realms, and 193 provinces (IUCN, 1985). The MAB program is supported by IUCN and UNESCO.

Goals and Objectives of the Biosphere Reserve Concept

The main goal of a biosphere reserve is to conserve natural and managed ecosystems. This goal is achieved by the objectives stated by the "Guidelines for the selection of biosphere reserves" as follows (UNESCO, 1974, 1979,1983, 1984):

1. To conserve for present and future use, the diversity and integrity of biotic communities of plants and animals within natural ecosystems, and to safeguard the genetic diversity of species on which their continuing evolution depends.
2. To provide areas for ecological and environmental research including, particularly, base line studies, both within and adjacent to such reserves, such research to be consistent with objective "1" above; and
3. To provide facilities for education and training.

Establishment of an Ideal Biosphere Reserve

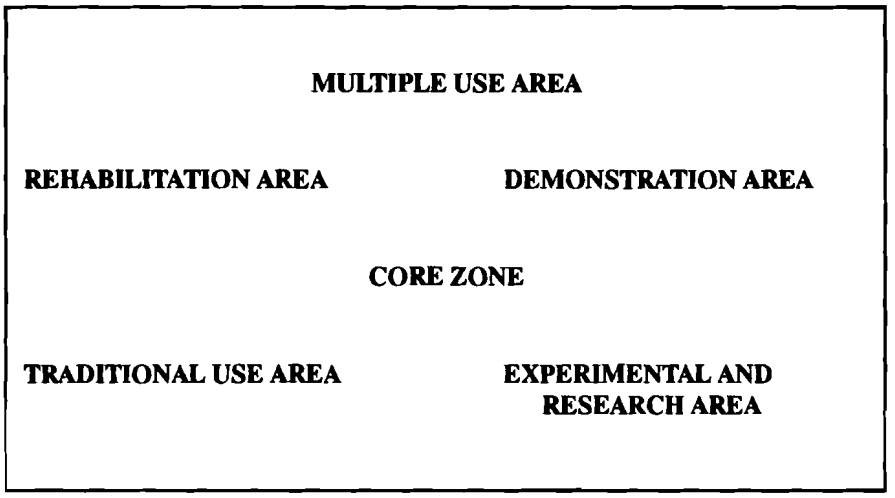
The design of an ideal biosphere reserve would consist of a nucleus, which is the core area, surrounded by areas used for research, demonstration, education, rehabilitation or regeneration, and traditional land uses, and multiple use areas that can serve collectively as a "buffer zone" (see diagram, opposite).

The main goal of a biosphere reserve is to conserve natural and managed ecosystems.

The core area is the heart of the conservation program. A core area is an undisturbed area protecting natural ecosystems with the maximum species diversity. Biological evolution, and natural processes can be studied in the core area, which can also serve as a "standard" for monitoring and comparing effects of human uses in the other areas included in the reserve.

Surrounding the core area are established zones managed for recreation, education, research, and economic uses of the resources. The rehabilitation areas are designed for reconstructing and improving the capacity of the degraded areas to conserve diversity. An experimental research area is included to investigate and develop improved techniques and strategies in agriculture and forestry that can be accepted by the local population. A

demonstration area is added for demonstrating appropriate techniques to the local population. Those three areas act as centers for applied research where improved methods can be demonstrated, and where training of technicians and local people can take place.



Ideal biosphere resesrve (Modified from Gregg and McGean, 1985)

The multiple use area is the equivalent of the "buffer zone" that surrounds all the previously mentioned areas. This area can include agricultural activities, reforestation, watershed management, soil conservation, and tourism compatible with the goals of the biosphere reserve. The multiple use areas serve as a boundary area between protected and non-protected areas.

In some cases the concept of a multi-site biosphere reserve can be applied (Gregg, 1983), when one site cannot accommodate all the function of a biosphere reserve or if many core areas can be identified. This is the option we choose for the Biosphere Henry Christophe.

An ideal biosphere reserve consists of a core area which is surrounded by areas used for research, demonstration, education, rehabilitation or regeneration, traditional land uses, and multiple-use areas that serve collectively as a "buffer zone."

Some Biosphere Reserve Programs of the Caribbean Area

The following are a few examples of committees and strategies that have been used to obtain help for biosphere reserves and/or national parks programs in Latin America and the Caribbean. The information on these biosphere reserves was provided by Paul Paryski of the UFMBR project. References are in the Literature Cited and Selected Literature section at the end of this volume.

1. COSTA RICA

The U.S. Peace Corps, British Voluntary Organization, FAO, UNESCO, AID, OAS, IUCN, WWF, and the Caribbean Conservation Cooperation are institutions that have been involved in providing international professional personnel in Costa Rica.

Students from the National Youth Movement of Costa Rica, the Boy Scouts, and the Lions and Rotary Clubs also have collaborated in this program. Technicians, materials, and tools have been obtained from municipalities and ministries such as the Ministry of Public Works, Ministry of Health, Ministry Public Education, Universities, Ministry of Culture, Youth and Sport, and Tourism institutions.

The national program of establishment and management of protected areas began with the 1969 Forestry Law. The law established the General Forestry Directorate to carry out the program that started with two Departments: National Parks and Forest Protection (1970). The Executive Branch of Government decrees all protected areas. To advise the Executive Branch, a National Forestry Council was established by law and made up of the Minister of Agriculture and Livestock, one representative of the Ministry of Commerce and Industries, National Electricity Service, University of Costa Rica and National Association of Wood Industrialists.

In 1972, an NGO, the Costa Rican Association for the Conservation of Nature, was created. In 1977, the National Parks Department was elevated to a Directorate.

Methods used to obtain general support

1. The most influential groups in Costa Rica turned out to be official government institutions, private groups and individuals, municipal authorities, and the University of Costa Rica. Because of their private status, the private organizations were able to take action against any activities damaging the resources of the protected areas. These goals were accomplished by meetings with ministers, talks to interested groups, interviews with the press, and the use of television. The best collaborator or "Godmother" has been the First Lady.
2. The inauguration of parks has been accompanied by some of the following activities. Ceremonious inaugurations accentuated by sending invitations to officials, church groups. When possible, the ceremony has been under the patronage of the First Lady.

3. Making use of national and political sentiment

4. Propaganda and publications. Brochures, articles, slogans.

2. DOMINICA

The Forestry Division initiated the program. A team of the Conservation Foundation prepared a public relations document for public awareness. The management of the park is in the hands of the Dominica's Forestry and Park Division.

3. GRENADA AND CURACAO

The Forestry Department is the group in charge of the management of the National Parks and Protected Areas System. The Fisheries Division assists in management of seascapes.

Other involved groups are: the Cultural Landmarks Steering Committee, the Agricultural Extension Division, the Horticulture Division, the Land-Use and Water Resources Division, the Land Division, the Tourism Department, the Education Department and Curriculum Development Unit, the Science and Technology Council, the Mirabeau Farm School, the Historical Society, and the National Trust.

4. TRINIDAD AND TOBAGO

There are 13 Game Sanctuaries and 6 Nature Reserves located within Forest Reserves. The reservation of land for Forest reserves was started in 1902 and completed in 1962. Second year Agricultural and Science students of University of the West Indies (UWI) are involved in this program. These students observe and study the systems of forest management and their effect on erosion and soil development.

5. BARBADOS

Some of the institutions involved in the conservation program are: the Parks and Beaches Commission, the Government Forestry Management Group, and the Barbados National Trust. The latter organization was incorporated by act of the Legislature in 1962. It is composed of: Patrons (i.e., the Governor General), a President, two vice-presidents, an Honorable Secretary, and an Honorable Treasurer. The trust is affiliated with the National Trust of England and Wales and to the National Trust for Historic Preservation in

Washington D.C. Under the Constitution of the Trust, there are three classes of membership: Benefactors to the Trust, Life Members, and Ordinary Members.

Biosphere Reserves - General

1983 - 226 biosphere reserves in 62 countries covering 115,482,876 hectares
Mean size: 202,000 to 510,000 ha
Common size: 10,000 to 25,000 ha

Protected areas in the Caribbean

Country	# areas	Total area
Antigua	2	2,500
Bahamas	4	122,540
Barbados	1	250
Bermuda	(NIA)	No information available
Cuba	4	24,305
Dominica	1	6,840
Dominican Republic	5	216,800
Grenada	27	3,335
Guadeloupe	NIA	
Haiti		5,000
Jamaica	NIA	
Martinique	1	70,000
Montserrat	NIA	
Netherlands Antilles	3	13,400
Puerto Rico	2	430
St Lucia	1	1,600
St. Vincent	NIA	
Trinidad and Tobago	12	16,567
Virgin Island (UK)	6	928
Virgin Island (US)	4	7,456

MACAYA BIOSPHERE RESERVE

Parcs Haiti and the concept of "Biosphere Reserves"

Biosphere Reserves are a new concept in which a balanced relationship between people and natural ecosystems are encouraged in order to demonstrate the value and need for conservation in supporting sustainable development. Biosphere reserves are major landscapes complete with characteristic landforms, floras, faunas and various patterns of human use and adaptation. They consist of Core Areas and surrounding Zones of Cooperation. Core areas are lands under some form of protection, and zones of cooperation are multiple use buffer zones where a variety of uses of the available resources may take place. The managers of the Parcs Haiti program should do all they can to promote and protect the core areas, which will be Parc National Pic Macaya and Parc National La Visite. They should also work with the GOH organizations responsible for the management of the surrounding lands (MARNDR and ISPAN) to insure a coordinated approach in cooperative research, restoration, supervision and monitoring. This could be under the general plan of cooperating together through the National Parks Advisory Council (PANAC) as well as through specific committees and meetings. Committees of concerned citizens from the region of the national parks should be organized and have an opportunity to be heard and be a part of the decision making process.

The active biosphere reserve program will include the core area (Parcs Haiti), the zone of cooperation lands (MARNDR), the historic monuments in the region (ISPAN) and concerned citizens (a committee).

Biosphere reserves are a new concept in which a balanced relationship between people and natural ecosystems are encouraged in order to demonstrate the value and need for conservation in supporting sustainable development.

Organization of Parcs Haiti and other GOH units in biosphere reserve concept

We propose that the parts of Parcs Nationaux Naturels designated by the decree of 23 June 1983 be integrated into the biosphere reserve concept in the following manner. The following chart lists all areas of the national patrimony that should be associated with each GOH unit, and also lists new items that might be added in the future (indicated with *).

In this list there are two actual biosphere reserves (Massif de la Selle, and Macaya Biosphere Reserve), and one area of great potential in northern Haiti which we recommend be designated as a biosphere reserve (Sergile, 1990). The proposed biosphere reserve around La Citadelle is discussed in detail in the next chapter.

Organization of Parcs Haiti and other GOH units in biosphere reserve concept

Place	Size (ha.)	GOH unit
Parc National La Visite (core)	6,300	Parcs Haiti
Buffer Zone La Visite	10,000	MARNDR
Parc National Pic Macaya (core)	7,500	Parcs Haiti
Buffer Zone Pic Macaya	10,000	MARNDR
Citadelle Des Platons	250	ISPAN
*Parc National Naturel La Citadelle	5,000	Parcs Haiti
Project La Citadelle	250	ISPAN
Region Milot/Dondon	--	MARNDR
Fort Mercredi	5	ISPAN
Fort Jacques et Alexandre	9	ISPAN
Souce Puantes	10	Parcs Haiti
Source Chaudes	20	Parcs Haiti
Source Cerisier et Plaisance	10	Parcs Haiti
*Lac de Peligre National Parc	--	Parcs Haiti
*National Botanical Garden	--	Parcs Haiti
Parcs Nationaux Maritimes	--	Parcs Haiti
Les Arcadins, Iroquois Islands		Parcs Haiti
Caves and Sinkholes	--	Parcs Haiti
Scenic Areas	--	Parcs Haiti

Biosphere reserves are major landscapes complete with characteristic land forms, flora, fauna and various patterns of human use and adaptation.

Summary of Data on Macaya Biosphere Reserve

Biogeophysical Survey (USAID) 1983-1986
Biosphere Reserve Project (USAID) 1987-1992
Rivers: Grande Ravine du Sud
l'Acul
Port-a-Piment
Roseaux
Glace
Core Area: Parc National Pic Macaya
Established: April 1983 by Presidential Decree
Area: 5,500 hectares (Park)
Main Features:
Pic Macaya (2,347 meters)
Pic Formon (2,219 meters)
Area of MBR (January 1992) 16,364 hectares
Land Use Zones of MBR (January 1992)

Core Zone	4,337 ha (27%)
Forestry Zone	4,070 ha (24%)
Agroforestry Zone	3,555 ha (22%)
Agricultural Zone	3,128 ha (19%)
Regeneration Zone	737 ha (05%)
Special Use Zone	496 ha (03%)

Overall percent of MBR in Conservation related activities	35%
Overall percent of MBR in Agricultural activities	65%

Since the creation of Parc National Pic Macaya in 1983, there have been significant changes in the biogeophysical environment in the Macaya Biosphere Reserve.

Current Status and Recent Changes in the Biogeophysical Environment

Since the creation of Parc National Macaya (Macaya National Park) in 1983, there have been significant changes in the biogeophysical environment in the MBR. The following is a summary description of those changes observed during the MBR Sondeo of 1988, with comments on the probable causes for the observed changes.

Formon

The vegetative cover on the slopes above the Plain of Durand ("Diran") and the Plain of Formon was undergoing natural regeneration. Previously, these very steep slopes, largely Terre

l'Etat (state land), were controlled by richer families in the area and were intensively sharecropped by farmers of lower socio-economic status. Active enforcement of interdiction of agriculture by the Agents de Parc (National Park Guards), hired and supervised by the Institut de Sauvegard du Patromoine National (ISPAN), had played a major role in allowing regeneration to occur. There appeared to be no actively cultivated parcels (gardens) above 1,300 meters, although regeneration is being somewhat retarded by use of these slopes as pasture for livestock (cattle, goats, and sheep).

In contrast, the region known as Kay Tilus/Kay Itil, the highlands (1,100-1,700 meters) to the northeast of Formon proper and east of the Ravine Seche (including the beginnings of the Ravine Casse Cou), had suffered extreme environmental degradation. In this area, the major source of water generation for the Riviere l'Acul, eleven very large (20m+ wide, 50m long) landslides were observed. Numerous gardens were present on slopes of more than sixty degrees and vegetative cover is reduced to short grasses. Much of the erosion in this area was probably caused by the very heavy rainfall accompanying Hurricane Gilbert. Continual and progressive destruction (slash and burn clearing) of the montane cloud forest close to the top of the ridge of Formon was occurring. This area is privately owned by wealthier farmers, some of whom are Agents de Parc. Effective land use control had not been attained.

The upper Cavalier area (Pic Cavalier to upper Sous Bois) was also regenerating. Again, these are primarily state lands on which agriculture, other than pasturing, had ceased.

Hurricane Gilbert did not greatly damage forests; however, the 1988 hurricane caused major erosion in areas which did not have effective vegetative cover.

The Rak Sous Bois area had suffered considerable environmental damage, caused by an exponential increase in the number of gardens present. This increase may have been due to the interdiction of agriculture on the higher slopes and mountains of the Park. The Rak Sous Bois has the greatest biological diversity of the entire MBR.

The larger state-owned lands of humid forest on the very steep slopes to the south of Plain of Durand, called the Rampes de Cavalier, had generally remained intact, probably as a result of the activities of the Agents de Parc.

In general, Hurricane Gilbert did not significantly impact the vegetative cover of the Formon area, although it caused major erosion damage, particularly on the principal paths and those higher slopes that did not have effective vegetative cover. Destruction of crops and livestock by Gilbert had increased pressure for agricultural land use on the cover that still remains. Approximately

40% of the livestock of the region was destroyed by Hurricane Gilbert.

Riviere Trois Sources

The entire area of the Riviere Trois Sources catchment basin, an environmentally very fragile area, had been heavily impacted by clearing pine forest and virgin montane cloud forest in order to plant gardens. Most of these gardens had been cleared by non-resident farmers from Rendel who planted black beans, which they believe required the complete removal of natural vegetative cover from the land. The entire river valley, bordered on both sides by very steep (60° + slopes) was scarred by numerous landslides. In fact, some paths were no longer used by the farmers, due to danger from rock slides. The greatest damage occurred on the southern slopes of the Riviere Trois Sources, extending to 1,650 meters on the Formon Ridge. In this area, virgin montane cloud forest with a unique ecosystem of rare native and endemic species was being destroyed.

The small farmer community at Sivette had enlarged its gardens to the east along the top of the Macaya Ridge and southeast on the extreme southern slope of the Riviere Trois Sources. New avalanches were observed on these slopes, and the access path had been partially destroyed. Damage extended to less than one kilometer from the saddle connecting the Formon and Macaya Ridges. In this area, a pioneer farmer, Mr. Pierre Edmond Paul, had occupied state land and opened this very critical zone to sharecroppers from Rendel. At least 20 hectares have been cleared, and large landslides were present.

Most of the gardens in the Macaya Biosphere Reserve are being cleared by non-resident farmers from lower elevations.

Again, the immediate cause of much of the erosion damage was Hurricane Gilbert. This was especially pronounced below the southwest face of Pic Macaya, on which large fires, probably started by farmers, had destroyed the natural vegetative cover. The immense loss of livestock and crops caused by Gilbert had also increased economic pressure on these very fragile lands. Gilbert did not greatly damage the forests of this area.

In this part of the MBR, the Agents de Parc had been totally ineffective. UNICORS\COSAR, however, played an important part in the deforestation of the zone. UNICORS\COSAR opened land for colonization. UNICORS\COSAR cleared forest lands, ostensibly to plant coffee. However, only 200 hectares of this land was actually utilized to plant beans, and only about 56 hectares was being used for coffee. These activities had legitimized the process of slash and burn agriculture, and had encouraged the use of these

fragile lands as an income generating resource for non-resident farmers from Rendel.

Pine trees (*Pinus occidentalis*) were being cut for lumber. At least seven "scieries" (logging frames) were seen in 1988. The trees were being purchased by lumber merchants in Rendel who hired teams to cut the trees into planks and beams. The lumber was sold in Rendel, Port-a-Piment, Les Cayes, and Port-au-Prince. We observed twenty-two planks being carried down to Rendel while we were working in the Trois Sources area in 1988. COSAR's lumbering complex high on the Formon Ridge (1,600 meters) had recently suspended operations.

As in the Formon target zone, fewer birds were sighted than in previous expeditions to the region. Hurricane Gilbert probably was the cause of the reduction in numbers of birds.

Pa Lan Kont. The Pa Lan Kont region is located at the head of the Ravine du Sud. Most ajoupas in the basin had been destroyed (probably by Hurricane Gilbert). The main environmental damage in the area at the time of the Sondeo was being caused by 36 sheep that were grazing at 1,365 meters on the slope of Macaya near a new ajoupa. There was enormous damage to the area from overgrazing. These sheep were preventing the regeneration of trees and grass, and the loss of vegetation of the steep hillsides had resulted in several landslides. There was a second ajoupa lower down in the ravine. There was much bean frass ("pay pwa") around this ajoupa, and a cooking fire was burning when we passed the area. No sign of recent garden activities was seen. We recommended that this ajoupa should be removed, and all agricultural activities in the Pa Lan Kont region should be curtailed. We also recommended that agricultural activities in the basin should be forbidden for the following reasons:

At Pa Lan Kont, sheep grazing on the slope of Macaya were preventing the regeneration of trees and grass, and the loss of vegetation of the steep hillsides had resulted in several landslides.

1) Fires escaping from gardens in this area sweep up to Pic Macaya (as they had from Tombe Kriye on the west side of the saddle below Pic Macaya).

2) There were already severe landslides in the basin and along the margins of the Riviere de la Ravine du Sud that threaten the watershed.

3) Pa Lan Kont is in the "heart" of the most forested region of the biosphere reserve. It is in the center of the main "Core Area," and therefore only conservation activities should be permitted in the region.

4) The slopes on both sides of the Ravine du Sud in this area (1,150-1,400 meters) are too steep to be able to hold their soil cover if the vegetation is cleared.

The name for "Pa Lan Kont" was described as meaning a place that is too strong to quarrel with.

Deglacis Region. This area spreads along the lower Ravine du Sud between 1,000 meters (where the Kay Ogil trail joins the ravine) and the confluence of the two main arms of the ravine that come together to form the Riviere de la Ravine du Sud at 800 meters. The area was settled in about 1965 by Ti Yo Yo Valerius, who named it "Deglacis" because he saw two big rocks which looked like two "glacis" (large, flat areas where grains are dried). He had six children, all born in the Ravine du Sud, and his daughter has 13 children (also all born in the Ravine du Sud). Our estimate is that there were currently 50 houses in the Deglacis area, and 400 people. The Deglacis area stretches for six kilometers down the Ravine du Sud from 1,000 meters to 600 meters, with the center of the district being at the confluence of the two arms of the ravines where there is the largest amount of flat ground (800 meters). There is a small store ("boutik") at that location. The lower trail from Deglacis to Formon connects near that location.

The sondeo team interviewed over 30 people on the morning of February 3, 1989. The group ranged in age from eight to fifty, and included eight women and two children. The pioneer (Ti Yo Yo) was a member of the group, but did not speak often. The main spokesman for the group was Espano Blaise, a young man of about 25. There were several very dignified looking members of the group, which we believe represented a very good cross section of the inhabitants of Deglacis. All of the people said that they were permanent residents of Deglacis. They seemed to have closest ties with Formon, and most frequently used the market at Sous Bois. However, there were also ties with Camp Perrin, where some of the people had come from, and where some went to market.

The women all reported having children (n= 8, range 3-13, average 7.5). We did not ask all of the women how many of their children survived. In order to estimate the number of people in the area we used the standard Haitian measure of six people per household. We estimated that there were fifty houses in the district, so by this measure the population of the Deglacis region would be 300 people.

Pa Lan Kont is in the heart of the most forested region of the biosphere reserve. Therefore, only conservation activites should be permitted in the region.

It appears from all of the reports the sondeo team received that Ropano Despagne is one of the major "developers" of the Deglacis area. He rented large blocks of land, and is subleasing blocks of this land to poor farmers. He built two buildings in the region, one ajoupa along the Kay Ogil trail on the north slope of the Formon ridge (recently destroyed by Hurricane Gilbert), and a tin-roofed ajoupa on a slight plateau on the south slope of Macaya above Deglacis. Large gardens of beans were being planted at the time

of the sondeo near Ropano's "kay tol."

The environmental damage in the Deglacis area was (and is) extensive. There is much erosion on the steep slopes of Macaya. Landslides are common, and there are areas where entire hillsides have slipped (the mountain is "throwing up" in Creole = "mon lan ap vonmi te"). The waterfall at 1,000 meters near the main stream bed of the Riviere de la Ravine du Sud (but on a side stream), had been extensively rearranged since our last visit to Deglacis two years ago (a sign of the force of the runoff from the deforested slopes above the waterfall). No water was running in most sections of the river bed. The residents of Deglacis were aware of the problem. Many peasants indicated that they knew that they should not be cutting the trees or planting gardens on the steep hillsides, especially of Macaya, but they wanted to be paid to stop making gardens. More accurately, they stated that they heard that the project was helping to make jobs for people in the Formon area, and that they felt they should be able to get jobs to help replant trees and rehabilitate the environment of the ravine. Espano Blaise, the spokesman for the group, was very emphatic and vocal about the justification for providing opportunity for the local residents of Deglacis. They want to be a part of the "rebwasman" of the ravine.

The concentration of endemic species of plants and animals in the area of the Macaya Biosphere Reserve is one of the most important features of the region. In an effort to evaluate the knowledge of local residents about some of the more dramatic of these species, questions were asked about species that members of the sondeo team knew well. Many peasants interviewed knew about the "zagouti," an endangered species of endemic rodent which they said lived in the big forest up on the high slopes of Macaya. More men than women knew of the animal. They did not know about the Solenodon or "Nez Long" (*Solenodon paradoxus*), although we know from previous work that peasants often confuse the "zagouti" and "nez long," and call them both "zagouti." We have collected remains of solenodons just west of the eastern boundary of the biosphere reserve on the east slope of Macaya, so we are confident the species occurs in the area. Peasants did not know of the presence of Black-capped Petrels on the ridge of Macaya. They were very aware of rats, "rat kay," mongooses, and "chat maron." The peasants of the Ravine du Sud eat cats ("chat maron"), which they catch with dogs. They also eat "zagouti" when they can catch them, but they are harder to catch than are cats.

Many peasants who were interviewed at Deglacis knew about the zagouti. They did not know about the solenodon, or about the presence of Black-capped petrels on the ridge of Macaya.

Our economic questions received the same pattern of answers as we received on the Plain of Formon. Most peasants sold their labor, and worked in "esquads." They earned (or paid) 2-3 gourdes per day. They sell beans for 7 gourdes per marmite if they have

many, and buy them for 12 gourdes when beans are scarce and they need them for planting. Coffee sells for 15 gourdes per marmite. There are no horses or mules in the area, because the terrain is too steep. There are some cows. There are no problems with their cows, sheep or goats. There are problems with their chickens ("pye sech"). Many animals were killed by Hurricane Gilbert.

The Sondeo team recommended that the following should be done in the Deglacis area (much of it has been done by the MBR Team):

1). Ropano's "kay tol" should become part of the MBR project. It should serve as a field headquarters for MBR staff working in the ravine, and a nursery or pepiniere ("pepinye") should be established nearby. It may be necessary to rent the kay from Ropano Despagne, or to buy it outright. Some repairs will have to be made to the structure, which was damaged by Hurricane Gilbert. The sondeo team also recommended that the kay t = l and surrounding region be renamed "Belvi" in order to emphasize the beautiful vistas and better life in the region as a result of the project.

2). All areas of the ravine west of the 800 meter contour line as it crosses the bed of the Riviere de la Ravine du Sud should become part of the "Core Area." No agriculture or agroforestry should be allowed in this zone, and all ajoupas and houses should be removed except for MBR structures. The boundary of the "Core Area" should be micro-zoned along the eastern margin so that it is easy to follow, and easily identified by everyone working or living in the area. The boundary should follow easily observed contours and landmarks, and reflect the major concerns of the MBR project to protect the watershed.

3). All areas east of the 800 meters line and boundary of the Core Area (running approximately north-south) should be the site of major extension efforts by the MBR project. Agriculture, agroforestry, and forestry activities should be promoted. A careful plan for zoning the region so that activities are focused on suitable habitats should be developed at an early date. Some areas will need to be micro-zoned as "Outlying Core Areas" when the slopes are very steep, or the danger of severe environmental degradation otherwise indicates reason for concern.

4). The center of activity of the Deglacis should shift eastward. As part of this plan, the Formon-Deglacis (via Kay Ogil) Trail should become restricted mainly to MBR activities. The main route to and from Deglacis should become the lower Formon trail.

The peasants of the Ravine du Sud eat cats, which they catch with dogs. The also eat "zagouti" when they can catch them, but they are harder to catch than are cats.

Pic Macaya. The top of Pic Macaya was damaged by the high winds and rain of Hurricane Gilbert. There is a bad landslide just east of the trail from "Fraz" to the top of Macaya, and all trees and soil have washed away, leaving a white gash. There are many fallen trees on the top of the mountain, most of them old pines that had previously died. Some of these trees may have been in excess of 250 years old. The trail along the east-west ridge of Macaya is impassable because of all of the fallen trees, and will have to be reestablished. There is evidence of regeneration of pines in the form of seedlings in sunny patches resulting from clearings in the forest canopy caused by the fallen giant pines. The sphagnum moss which covers many areas on the summit of the ridge of Macaya was saturated with water, and the dense vegetation of the climax forest on the summit appeared to be in good shape.

The Black-capped Petrels were still present on the south slope of Macaya at 2,000-2,340 meters west of the trail from "Fraz" to the summit. The terrible landslide to the east of the trail may have eliminated the nesting habitat for petrels in that region, and no petrels were heard east of the trail during the nightly census periods. Other birds known to occur on the summit of Pic Macaya were observed, including the extremely rare and endangered White-winged Crossbills. Therefore, we concluded that the hurricane did not disrupt the avifauna of Pic Macaya. We did not observe any White-winged Warblers, which may be the rarest bird in Haiti, and which is known to breed on Pic Macaya. We noted that **"A careful study of the status of this species is needed,"** but because of the ongoing problems in Haiti, this was not possible. The volunteer student who we sent to Haiti to carry out the study in November, 1991, arrived the day of the Coup d'Etat, and had to be evacuated from the country.

The terrible landslide just east of the trail from "Fraz" to the top of Macaya may have eliminated the nesting habitat for Black-capped petrels in that area.

The mongoose is now common of the top of Pic Macaya. Many signs of mongooses were observed (feces, feeding areas), and there were indications that mongooses on Pic Macaya are preying heavily on rats living on the summit. The population levels of both Black and Norway rats were considerably reduced since our last inventory of small mammals on Pic Macaya in 1986. The mongoose could also be having a very negative effect on the status of ground nesting birds, and any endemic mammals that might survive on the peak. The potential hazard of the mongoose on the colony of Black-capped Petrels is unknown, but the members of the sondeo team were concerned. **The team recommended that immediate efforts be undertaken to trap mongooses off of the summit of Pic Macaya.** The team also recommended that a census of small mammals be made on the top of Pic Macaya to determine if any *Nesophontes hypomicrus* still occur there, and to evaluate the impact of mongooses and rats on the status of the White-winged

Warbler and Black-capped Petrel. This survey was considered important for two reasons:

1) If *Nesophontes* is found to still occur on Pic Macaya it would focus international attention on the Macaya Biosphere Reserve.

2) If mongooses and rats are killing White-winged Warblers, Black-capped Petrels, and *Nesophontes hypomicrus*, it is possible that these endemic animals will become extinct before a plan to control rats and mongooses in the biosphere reserve is developed.

The student who was scheduled to work on this problem could not do so because of the suspension of Macaya Biosphere Reserve activities from October, 1991 to April, 1992.

Rak Bwa Habitat at Sous Bois/Portal Formon. The "rak bwa" forest is the major vegetative cover along the edge of the escarpment marking the southern and western boundaries of the Formon and Durand plains. "Rak Bwa" is a Creole term that is widely used and universally recognized in Haiti as a description of a forest (usually in a semi-natural state, but sometimes quite fragmented). This vegetative zone is the remnant of the broadleaved forest that once covered the entire plain and karst hills between Les Platons and Morne Cavalier. In most areas this forest has been cut for gardens (see Ekman's description of the Formon plain in the sondeo report). The forest remained intact along the region of the escarpment and on the karst hills because the presence of huge blocks and jagged broken fragments of karst ("kase dan") made the areas unsuitable for agriculture. In some areas rocks were more diffuse, and these were used as pastures (cleared or over-grazed). In many areas, however, the landscape is so rugged that there is very little soil and it is necessary to walk along the top of the tall sharp rocks (called dog-tooth limestone). These areas were covered with a mature climax forest where many important endemic plants and animals occurred. Without a doubt, the rak bwa forest between Sous Bois and Morne Cavalier is the most significant area of biological diversity left in Haiti. It is also one of the most threatened.

In most areas, the rak bwa forest has been cut for gardens. It has remained intact along the region of the escarpment and on the karst hills because the presence of huge blocks and jagged broken fragments of karst made the areas unsuitable for agriculture.

The sondeo team surveyed all of the areas of the rak bwa where "Zagouti" were observed by Charles Woods in 1986, and where Donald Dod collected endemic orchids. Most of these areas had now been destroyed. The big trees had been cut in most places, and many areas had been cleared and burned for gardens. The gardens were in areas of enormous rocks, and were planted mainly in pumpkins ("jouwoumou") and taro ("mazonbel" or "karaiyib").

The newly cleared gardens were hazardous to work in, since the farmer must slowly walk over the sharp tops of jagged rocks. Many crevices are over five feet deep. The loss of the remaining forest along the edge of the biosphere reserve is a tragic consequence of the establishment of Parc National Pic Macaya, and the closing of the park to activities such as making gardens. Since the rak bwa forest was outside the park boundary in most (but not all) areas, peasants turned all of their agricultural activities to these zones. Many of the peasants we interviewed were from as far away as Les Platons. Few were from the immediate area. The majority of the destruction of the rak bwa habitat has been since 1986. The rate of destruction is accelerating, and much new forest was being cut at the time of the sondeo in January and early February.

We are alarmed at the rate of habitat loss. The rate of habitat destruction accelerated during the period of the embargo following the Coup d'Etat (i.e., late 1991-early 1992). The Rak Bwa area is generally of poor quality for agriculture, but is of great significance as a biological reserve for endemic plants and animals for the biosphere reserve. Biologists from the University of Florida feel that it is the most biologically significant habitat in the biosphere reserve. **We recommend an immediate emergency effort to find a solution to the problem of the Rak Bwa.** The area needs to be carefully "micro-zoned." An overall management plan for the rak bwa needs to be developed. The cutting of the forest in many areas must be stopped. Areas where the forest has been cut since 1986 can still regenerate because of the coppicing nature of many of the trees. **In areas that the MBR teams identifies as having high ecological importance for endemic plants and animals, gardens should be removed (or at the very least, no new gardens should be planted and old gardens should be allowed to return to secondary forest).** These areas should be marked with spray paint, or orange marking tape.

We are alarmed at the rate of habitat loss. The rate of habitat destruction accelerated during the period of the embargo following the Coup d'Etat in 1991.

As an educational process for the local residents of the Sous Bois/Bwa Formon/Bwa Durand areas, a video tape could be made to show to local peasants the importance of the Rak Bwa to the way of life of the region. The video could document all of the ways the presence of the rak bwa improves the quality of life, and provides them with renewable natural resources such as: 1) poles for construction; 2) wood for fuel; and 3) water. In this way people may be more easily convinced of the importance of abandoning their gardens, and focusing their agricultural activities in more appropriate areas. In the case of non-resident farmers, local community action could be taken to exclude them from planting in inappropriate areas. We believe that it is important to establish a tradition whereby the local residents actively protect their own "community" from exploitation by non-resident farmers from such

remote districts as Les Platons and even Cavalier. These non-resident farmers are responsible for much of the habitat destruction in the rak bwa.

Local Guides Association

The sondeo was impressed by the attitudes of the various people on the Plain of Formon who had worked with the various expeditions to Pic Macaya. These people all seemed proud of their roles in the project, and anxious to remain a part of future expeditions into the heart of the biosphere reserve, especially Pic Macaya. In an effort to encourage this enthusiasm, we developped the Association des Guides de Macaya (AGMA). This association keeps a record of all guides and porters who have worked on projects.

We planned to give participants certificates as well as t-shirts and/or baseball caps bearing the Macaya Biosphere Reserve logo. The pesants would, in return, get credit for their participation, and be assured of continued work if and when other expeditions travelled into the biosphere reserve. This project was not successful. USAID refused to allow the MBR project to purchase the caps and shirts. The difficult political and economic environment curtailed MBR activities in the region, and no expeditions were undertaken. The park survey has not been completed, and no program for tourists has yet been launched. So, the guides have never had work, nor have they felt that the organization was worthwhile.

Conclusions

The Sondeo team presented the following conclusions based on the survey of Formon, Pa Lan Kont, Pic Macaya, Deglacis, and the Rak Bwa Formon during the periods 27 November - 12 December 1988, and 28 January - 5 February 1989. We feel that these conclusions are still valid, and represent a good summary of conditions in the region of the Planned Macaya Biosphere Reserve.

The rak bwa improves the quality of life by providing renewable natural resources such as poles for construction, wood for fuel, and water.

1) The presence of existing trails in the biosphere reserve are influencing the land use practices in the area. The sondeo team recommends developing a strict plan for the use of the trails, and a way to enforce the recommended guidelines.

2) The upper Ravine du Sud is being severely damaged by overgrazing in the Pa Lan Kont area. All sheep and cattle should be removed from this area. The presence of mature pine in the vicinity will allow for the rapid recovery of forest cover on the

degraded and steep mountain slopes as soon as the source of the overgrazing is removed (36 sheep at the present time). All future grazing in the area should be forbidden.

3) There are many recent landslides in the Ravine du Sud. Some of these landslides are very severe, such as one on the Formon side of Pa Lan Kont near where the sheep are grazing, and another near the summit of Pic Macaya west of the "Fraz" - Pic Macaya Trail.

4) Hurricane Gilbert severely damaged the soil cover on the steep slopes of the Ravine du Sud, and caused the death of many domestic animals. The sondeo team also believes many ajoupas in the Ravine du Sud were destroyed by the wind and rain of Hurricane Gilbert.

5) While many old large pine trees were blown down on the summit of Pic Macaya, there was little damage to the forest on the peak. The lower story vegetation is in good shape, and abundant water is stored in the sphagnum moss ground cover. The avifauna of the peak is in good shape. Mongooses appear to be much more abundant than they were three years ago, and are a threat to the endemic vertebrates of the Core Area.

6) The loss of forest cover in the Deglacis area is especially severe. The population of the area is at least 300, with many of these people being permanent residents. The watershed of the Riviere de la Ravine du Sud is threatened by the accelerating rate of deforestation. The local residents know that they are creating problems for residents of Camp Perrin (etc.), but want to be paid to become involved with the rehabilitation of the zone.

The rate of loss of the forest in the rak bwa zones outside of the national park is accelerating, and a crisis situation is rapidly developing. Emergency action should be taken to prevent any more rak bwa forest from being cut.

7) The Deglacis area is so important to the watershed that the sondeo team recommends enlarging the size of the Core Area to include all areas of the Ravine du Sud west of 800 meters (in the base of the ravine) and the saddle, as well as the areas west of the saddle indicated in the previous sondeo report.

8) The sondeo team recommends that the MBR project work in the Deglacis region as one of its Target Zones.

9) The rate of loss of the forest in the rak bwa zones outside of the national park is accelerating, and a crisis situation is rapidly developing. The sondeo recommends that a plan be developed for managing the rak bwa resource. Emergency action should be taken to prevent any more rak bwa forest from being cut. The future biological diversity of the biosphere reserve is threatened by the present trend. **Therefore, it is our recommendation that the entire rak bwa between Sous Bois and**

Morne Cavalier be designated as part of the Core Area, with small parcels being selected out as special use zones.

10) The research that the sondeo team recommends be undertaken in the Core Areas of the park include:

a) Weather stations at Pic Le Ciel, and the headquarters at Plain of Durand. A special effort should be made to document the percent contribution that the mists blowing through the forest trees make to the overall precipitation of the area.

b) Plant propagation trials should be undertaken to develop a plan for propagating endemic forest trees and shrubs.

c) Soil stabilization trials on steep slopes should be undertaken.

d) The status of small mammals, especially rats and the mongoose, should be undertaken within the Core Area, especially on the top of Pic Macaya.

Existing Trails in the Region of the Planned Biosphere Reserve

There are a number of trails in the MBR region that affect land use practices in the area. These trails allow access deep into the park. Some are traditional trails used by peasants, and other are trails created by MBR activities. These trails are discussed below.

Pa Lan Kont Trail. This trail connects the western region of the Plain of Durand near Morne Cavalier with Pa Lan Kont in the Ravine du Sud. This trail should remain open to provide access to Pic Macaya and the side trail to Pic Le Ciel. There should be specific guidelines (restrictions) for the use of this trail. They are:

Existing trails in the biosphere reserve area influence local land use practices. A strict plan for trail use and enforcement methods should be developed.

1) No domestic animals should be allowed on the trail.
2) No garden crops should be transported on this trail.
3) No pine planks can be transported on this trail.
4) A graphic sign (or several) should be posted to indicate that the use of the trail is restricted.
5) The trail is open for all other uses, including tourism, recreation, scientific, reforestation, and selected resource exploitation as determined in the MBR zoning plan.

Pic Le Ciel Trail. This trail departs from the Pa Lan Kont trail at the top of the Formon ridge at 1,950 meters and climbs up the

shoulder of Pic Formon to Pic Le Ciel. We recommend that a permanent weather station be established at Pic Le Ciel, and that the clearing there become an observation spot for the Formon/Macaya region. Therefore, the section of the trail from the main Pa Lan Kont trail to Pic Le Ciel should be well marked and well maintained. There should be a sign at the intersection of the two trails that indicates the position of the trail, and states that access is for research purposes only.

Pic Formon Trail. This trail continues on from Pic Le Ciel to the top of Pic Formon, and then descends the north slope of Pic Formon to the saddle. This trail is very important for gaining access to Pic Formon, and traverses some of the wettest and most significant habitats in the biosphere reserve. It could expose these areas to exploitation, so great care must be taken in controlling access to Pic Formon along this trail. We recommend that this trail be maintained at a very low level to restrict access to only those persons needing to get into the Pic Formon region for research purposes. The trail should not be clearly marked. A sign at Pic Le Ciel and the saddle should serve as a reminder that access to Pic Formon is by permit only.

Pic Macaya Trail. This trail ascends the south slope of Pic Macaya from the shoulder connecting Pic Formon and Pic Macaya. Access to the trail is via a short connecting trail up the east face of the saddle from Pa Lan Kont. The trail is very steep, and there are several dangerous sections. The trail is also vulnerable to damage from erosion if too much traffic exposes the vegetative cover to the effects of heavy rainfall. This trail should be kept open and well-maintained. There should be signs at the saddle indicating that access to Pic Macaya is by permit only. The camp grounds at the saddle, and at the top of Pic Macaya should be well maintained, and stocked with a supply of firewood (so nearby forest trees can be protected). There should be an information sign at the top of Pic Macaya indicating the summit elevation and a bit of the lore of Macaya. No permanent building or ajoupa should be constructed at the top of the mountain.

The Pic Macaya trail is very steep, and there are several dangerous sections. The trail is also vulnerable to damage from erosion if too much traffic exposes the vegetative cover to the effects of heavy rainfall.

Macaya Ridge Trail. The trail along the east-west running ridge of Pic Macaya should be kept open, but not well maintained. This trail will allow researchers to work on the top of Pic Macaya, but should not be so well maintained that vulnerable areas of the peak are exposed to exploitation. This ridge trail could eventually be connected with the trail up the west slope of Pic Macaya from Sivette to make it possible for hikers to travel from the south side of the biosphere reserve to the north. However, this should only be done after the administrative structure of the biosphere reserve is well established, and the need for this trail is clearly established.

Pa Lan Kont-Deglacis Trail. This trail connects Pa Lan Kont in the upper Ravine du Sud with Deglacis at 1,000 meters in the mid-Ravine du Sud. The trail is through rugged terrain, much of it along the stream bed of the Riviere de la Ravine du Sud. It is dangerous to traverse. No clear trail exists in many sections. We recommend that a survey team explore the region carefully to determine if a good route exists for a trail. However, since environmental damage has been so extensive in the Deglacis area, no clear connecting trail should be constructed that will expose the upper Ravine du Sud to the well populated Deglacis area.

Upper Formon - Deglacis Trail (via Kay Ogil). This trail connects the upper Deglacis area (1,020 meters) with Formon. Exploitation of the habitat along this trail has been very extensive. On the Deglacis side there are many pastures and gardens, and the site of an ajoupa (currently destroyed) maintained by Ropano Despagne. There are three areas on the top of the Formon ridge (1,925 meters) where trees have been cut and the forest cover burned in an apparent attempt to establish gardens. Farther down on the south slope of Formon, the trail passes through a small plateau and clearing (called Kay Ogil) where there has been a severe landslide and overgrazing. Farther down the Formon ridge the area adjacent to the trail shows extremely severe impact from overgrazing. Redicule Beljean (our guide, and an ex park guard) informed us that local peasants are feeling that the area should be planted in gardens once again, and that the pressure to continue to graze animals and to clear the soil cover is mounting.

We recommend that the use of the Formon-Kay Ogil-Deglacis Trail be severely restricted. People should be allowed to use this trail only to go back and forth to Deglacis. The main use of this trail should be by personnel associated with the biosphere reserve. Signs should be posted at the beginning and end of the trail, and at Kay Ogil indicating that access to this trail is "restricted." No domestic animals or farm crops should be transported on this trail. In this way, the extreme habitat destruction in the Ravine du Sud at 1,000 meters, and on the adjacent slopes of Formon and Macaya can be reduced. This is the area where the rehabilitation zones of the biosphere reserve will be concentrated. There is another trail that provides access to Deglacis (see following) that should become the main commercial route between Deglacis and Formon.

On the upper Formon-Deglacis trail, pressure is mounting to graze animals and to clear the soil cover.

Lower Deglacis Trail. The trail that connects the lower part of the Deglacis district with Formon was not seen by the sondeo team. This trail needs to be surveyed, and its ecological impact analyzed. However, from the description of the trail, which is east of the Kay Ogil trail, it appears as if this route is the most suitable for gaining access to Deglacis for the following reasons:

1) It traverses the Formon ridge at a lower elevation.

2) It connects Formon with the center of the Deglacis region.

3) It is farther away from the ecologically sensitive areas on the slopes of Pic Macaya and the ridge of Formon.

4) It is on the eastern margin of the biosphere reserve.

5) It does not pass close to the environmentally sensitive (and threatened) basin just east of Kay Ogil.

Plain of Durand to UNICORS\COSAR Trail. There is a need for a good route by foot or mule between the center of the biosphere reserve project on the Plain of Formon and the COSAR/western Formon-Macaya area. This route may already exist, or it will need to be surveyed. The Sondeo team recommends that the project develop and maintain this important route.

OVERVIEW OF THE TARGET ZONES: PHYSICAL FACTORS

The target region consists of at least three separate zones which will be referred to here as Formon, Trois Sources, and Deglacis. These zones are treated separately for most planning purposes because they differ in biogeophysical character, social structure, land tenure, and historical development. A brief description of each is provided below. The Sondeo team did not visit the Deglacis region during this investigation. Deglacis was evaluated separately by Charles Woods, Ellen S. Woods, Paul Paryski, Jenness McBride, and Roy Voss between 27 January and 6 February.

The three major zones of the target region--Formon, Trois Sources, and Deglacis--differ in biogeophysical character, social structure, land tenure, and historical development.

The overall Formon area extends from Sous Bois in the southeast, to Cavalier in the valley south of the escarpment of Formon/Durand, to Morne Cavalier in the west. It includes the steep slopes of the Massif Formon to the north and the ravines and rolling hills of the Plain of Formon to the east in the area of Ravine Casse Cou. Trois Sources includes the region surrounding the UNICORS\COSAR building on the Gran Plenn. A road is currently being built into the region, but at this time access is via a rough trail from the end of the road. The designation Trois Sources is based on the central feature of the zone, the Riviere Trois Sources. This river flows west from the saddle (ridge) connecting Pic Formon and Pic Macaya. The steep slopes of each mountain dominate the region.

Geology

Karst topography predominates east and south of Morne Cavalier and between 1,800 and 2,000 meters elevation 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. Exposure of 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 Cretaceous 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 La Selle Escarpment, 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.

Conservation agricultural practices should be developed to help farmers make the most productive use of level plains and gently sloping hillsides.

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).

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 used for agriculture in the future. Conservation agricultural practices should be developed which can assist farmers in making the most productive use of such lands.

Soils

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 course textured ultisols that may be formed on the colluvium and alluvium that has washed downslope from underneath the Demisseau 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 course texture leaves them droughty and dryer than surrounding souls.

Deep ultisols on intermediate slopes are susceptible to erosion and must be treated with great care.

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 slope, are eroded moderately.

To the west of the Park in the areas near the UNICORS\COSAR complex, 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 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.

The population of the area must become the stewards of all the lands in the biosphere reserve.

IMPLEMENTATION OF THE PLANNED MACAYA BIOSPHERE RESERVE

Recommended Land Uses

Two concepts are critical to the Macaya Biosphere Reserve, both of which represent radical departures from land management as it is currently practiced in the region. The first concept is that the core protected area, the national park itself, is seen as one element in a rational, managed use of a much larger land area. Thus, management of lands outside the core area becomes fully as important as management of park lands themselves. The core area is seen as critical to the successful management of the outlying lands (as a source of water, for example), and, in turn, the outlying lands are seen as part of a whole whose successful management contributes to preservation of the inner core.

Second, the population of the area itself must become the stewards of all the lands in the biosphere reserve. This means, in essence, that individuals are being asked to become stewards for lands which are not in fact their own, and that they are being asked to engage in land use practices whose benefits accrue not only to them and their immediate families, but also to other inhabitants of Haiti dependent on the resources provided by MBR.

Five general types of land use zones are recommended for the MBR. A brief description of each, the goals associated with each particular land use, and types of proposed land uses are given below.

Development of national and local institutions which can effectively oversee the utilization of lands in the biosphere reserve far into the future is critical to the successful management of these zones.

Three general concepts are embodied in these land use recommendations. The first is a traditional concept associated with Pic Macaya National Park--some core lands must be preserved in a relatively untouched state. Preservation is the major goal of land use in the Core Area and Special Use Zones described below. The development of national and local institutions which can effectively oversee the utilization of lands in these zones far into the future, and long after the University of Florida's involvement in this project ends, is critical to the successful management of these zones.

Other lands must be rehabilitated. These are lands which have already suffered moderate to extensive degradation. Simple preservation or maintenance of the status quo is insufficient here. These lands must be improved through planned, scientifically based land use management. In some cases, rehabilitation will involve returning these lands to a status more nearly resembling their former, untouched state. In other cases, however, lands

require rehabilitation for more intensive human use. Some parts of the rak bwa, for example, should be returned to a more natural state and others should be managed for more profitable, intensive human uses. Rehabilitation is the major goal of land use management in the Forestry and Agroforestry Zones.

Unlike preservation, development of methods for rehabilitation requires extensive scientific input. Only rarely has rehabilitation of lands been attempted anywhere in the world, and little scientific basis for rehabilitation exists in Haiti. Utilization of native species, for example, is an important element in rehabilitation. Yet, for many of the tree species of the region, virtually nothing is known about how to rear seedlings in nurseries, whether they can be coppiced for use in agroforestry systems, and how well they will survive in a highly altered environment. Further, most research in agroforestry on a worldwide basis has been conducted in a lowland environment. Relatively little attention has been devoted to the highland environment. Development of the scientific basis for rehabilitation requires a long-term commitment on the part of the University of Florida and USAID to the MBR.

Finally, land use on much of the land in the area must be greatly intensified. Current farming practices will not permit farmers in the area to gain a higher standard of living from their lands. Intensification of agriculture is therefore critical to long-term success of the MBR. Intensification means, in this context, both more intensive use of the land and higher value production. Technologies which can permit much more intensive production in the area are known. They require testing and adaptation under local conditions. Adapting these practices to local conditions and disseminating them to farmers in the region is a short-term goal of this project. Intensification is the major goal of project intervention in the Agricultural Zone.

Current farming practices will not permit farmers in the area to gain a higher standard of living from their lands. Intensification of agriculture is therefore critical to long-term success of the Macaya Biosphere Reserve.

Success in this area is largely based on increasing cash flow for farmers. The current farming systems employ, for all practical purposes, no outside inputs apart from labor (only one family has ever used fertilizer, for example). It is questionable that further intensification of labor is possible, and even if it is possible, labor intensification alone will not significantly increase the productivity and profitability of the farming systems described below. Therefore, the use of agricultural inputs such as improved seed and fertilizer is critical; it requires that farmers attain cash flow beyond that needed for immediate consumption. The University of Florida's short-term strategy, therefore, concentrates on ways of improving cash flow within the local economy.

LAND USE ZONES

The following idealized zones are designed to indicate the optimal land use activity for all of the habitats of the Macaya Biosphere Reserve. These determinations have been made on the basis of the gradient of the slope and the location within the reserve. During the course of the project, the definitions of these zones will be refined, and the concept will be expanded to cover all of the micro-habitats of the reserve. The expanded definitions will take into consideration soil and landscape characteristics (including the steepness of the slopes) as well as socio-economic factors. In this way the working definitions will function at the level of micro-zones, so that the most suitable activity for each location within the Macaya Biosphere Reserve will be designated on a high resolution land use map.

Core Zone

Description. These are the most fragile areas where a loss of forest cover and soils would result in extensive degradation of the surrounding areas. The core area is not yet ecologically degraded, and includes endemic plants and animals of unique importance. However, some habitat restoration may be necessary where the process of degradation has progressed to the point where the habitat is in danger of being lost.

Goals. Soil, water, and forest conservation, and preservation of biological diversity are the critical goals.

Uses. These lands should be totally protected from agricultural and forest practices. Suitable land uses include tourism (hiking, camping, photography), and research (with permits).

Special Use Zones

Description. These are biologically and ecologically valuable zones where total protection is not possible because of the proximity of the areas to high density human activities, the small size of the habitat (i.e., pond or spring), or multi-use requirements (i.e., springs, streams, and rivers). These areas also include corridors connecting disjunct habitats that are necessary to maintain biological diversity in the overall zone of the biosphere reserve.

Goals. The major objective of land use planning is to protect the habitat without excluding the use of the limited resource involved.

Uses. Only specific activities such as gathering water, washing clothes, searching for renewable resources (i.e., poles, honey) should be allowed.

Forestry Zone

Description. These are steep areas where soil stabilization is necessary, but where the habitat is not critically important to maintain biological diversity or prevent extreme erosion.

Goals. Important goals include protection of the soil, increasing overall precipitation levels (i.e., comb water as "dew" from the frequent cloud cover), and providing an alternate revenue source for local farmers based on wise use of a renewable natural resource.

Uses. Selective harvesting (no clear-cutting allowed) of trees would be allowed. Native trees where possible should be utilized because of the proximity of these areas to the Core Zone. Fast-growing native species of economic importance can be supplied from nursery stock as part of the forestry process.

Agroforestry Zone

Description. These are areas of moderate slope where intensive forestry, moderate agriculture, and some grazing can occur without exposing the soil to rapid erosion or degradation.

Goals. The major goal is to provide agricultural sites in otherwise fragile habitats for local farmers, as well as the appropriate technology to use these sites without destroying them. A major concern is to raise the productivity of these sites and to increase the income levels of local farmers who use them.

Uses. Any of several possible mixes of agroforestry techniques may be utilized, including alley cropping, grazing, production of fruit, intensive forestry, and production of other tree crops.

Agricultural Zone

Description. These are relatively flat areas with deep soils (usually oxisols) where well-planned intensive agriculture will not irrevocably damage the environment. Lands on moderately steep slopes where erosion is not a problem can also be included within the agricultural zone.

Goals. These areas should be utilized to maintain a high level of economic return and to raise productivity and incomes of local farmers.

Uses. Intensive agricultural production should be practiced on these sites.

The following table summarizes the relative amount of land recommended for inclusion in each land use category as of January 1989. The final distribution of the land into each category will be modified as the project progresses, as will our understanding of the optimal total size of the Macaya Biosphere Reserve.

Functional Zones of the Macaya Biosphere Reserve

Conservation Zones	1989	1992
Core	4, 400 ha	7,500 ha
Special use	500 ha	500 ha
Total	4,900 ha	8,000 ha
Regeneration	700 ha*	1,200 ha
Multiple Uses		
Forestry	4,100 ha	2,000 ha
Agroforestry	3,600 ha	3,900 ha
Agriculture	3,100 ha	2,500 ha
Total	10,800 ha	8,400 ha
Regeneration	Not Included	5,500 ha
Grand total	**16,400 ha**	**16,400 ha**

*Regeneration was planned in 1989 as an area where conservation efforts would have been concentrated.

Specific Recommendations for Formon

Garden activities and cutting of trees above 1,600 meters on the steep hills of Formon should continue to be banned.

The ban on garden activities and the cutting of trees above 1,600 meters on the steep hills of Formon should continue.

The rolling hillsides between 1,000 and 1,600 meters should be zoned for agroforestry and forestry uses. An active program to utilize this zone for firewood production, use of local endemics of economic importance, coffee and plantain production, and production of shrub crops (such as pigeon pea, *Cajanus cajanus*) should be developed. There is a significant problem of soil erosion in the Ravine Casse Cou and the Ravine Dalest. These ravines, and their associated connecting ravines, should be reforested (Agroforestry and Special Use Zones).

The Plain of Formon and Plain of Durand are appropriate locations for intensive agriculture with some attention being paid to soil stabilization in the ravines of the area.

There are several areas of unique value on the Plain of Formon and Plain of Durand, such as the small pond near Madam Robert's house and several karst domes scattered throughout the plains. These should be designated as Special Use Zones. The margins of the small pond, for example, should be reforested with appropriate endemic trees and shrubs (as well as some food trees such as plantains). Continued access to the small pond for washing and watering animals would be available at one location near the main trail.

The Rak Bwa at Sous Bois, Formon, Durand, and Cavalier are of great significance to the natural patrimony of the country. These areas are also of significance to the daily activities of the local residents of the region. Poles and firewood are collected there. Some pockets are suitable for agriculture.

The Rak Bwa should be maintained as a continuous unit from the Ravine Dalest and Ravine Casse Cou to the Rak Bwa, Sous Bois, Bwa Formon, Bwa Durand, and the upper ridges of Morne Cavalier. This will provide a continuous buffer zone for the area of the biosphere reserve. Careful zoning will allow pockets in this continuous rak bwa (once reconstructed) to be used for agricultural purposes, and should allow limited exploitation of the forest for poles and firewood, since these resources are renewable.

Specific Recommendations for Trois Sources

All land to the east of Morne Bois Pin in the basin of the Riviere Trois Sources should be designated as part of the Core Area. All of this land appears to be state land. The sondeo team also recommends that Morne Bois Pin and the steep slopes of Pic Formon between 1,600 and 1,800 meters also be included in the Core Area. Since some of this land is currently owned by UNICORS\COSAR, an accommodation should be reached such that UNICORS\COSAR agrees to strict enforcement of the laws of the biosphere reserve, or agrees to sell or trade land within this zone. The ridges above 1,600 meters of all of the mountains bordering the Riviere Trois Sources should be designated as part of the Core Zone.

Burning of fields should be discouraged in all areas below the core area to prevent wildfires from damaging the higher core area habitats.

The steep slopes of the entire watershed of the Riviere Trois Sources are vulnerable to rapid soil erosion, and should be designated as Agroforestry Zones. Appropriate uses of these lands include planting coffee, nut trees, pigeon pea, plantains, and the use of living terraces. Plantains are especially suitable as a food crop that can also be used to secure the soils in gullies and steep ravines. The planting of black beans alone should be discouraged on steep slopes.

Land along the margins of the Riviere Trois Sources is appropriate for intensive use, and should be micro-zoned as Agricultural Zones or Agroforestry Zones.

Burning of fields should be discouraged in all areas below the core area to prevent wildfires from damaging the higher core area habitats.

Current Environmental Conditions in the Macaya Area

Between April 7-16, 1992, we surveyed the project area between Camp Perrin, Formon on the slopes of Pic Formon, and the east and north sides of Pic Macaya in the region of Duchity. The techniques used were to travel into the region by jeep, to walk into more remote areas on foot, and to survey the entire Macaya region by a small plane (on April 14th). We made this survey to evaluate the effects of the economic embargo and the suspension of MBR project activities during the past six months on the natural resources of the area. Our general observations are summarized below.

1). The core areas of Parc National Pic Macaya (the high ridges of Pic Macaya and Pic Formon, and most of the upper watershed basins between the peaks) remain intact, and steeper and more remote regions of the park are still covered with a variety of forest types (most natural, and serving as important reservoirs of biodiversity as well as critical components of downslope watersheds).

There has been a great deal of deforestation of the "Rak Bwa" forests in the area of Formon and Durand during the last six months. This forest is the most important remaining forest in Haiti in terms of biodiversity, and is now very threatened.

2). The most eastern extension of the ridge of the Formon Mountain Range is almost completely deforested, especially in the regions of Bellefontaine and Lahatte. This deforestation is resulting in an expanding and massive landslide near the entrance of the Grande Ravine (the headwaters of the Riviere Grande Ravine de Sud), and to a significant degradation of the Ravine de Sud watershed.

3). There has been a great deal of deforestation of the "Rak Bwa" forests in the area of Formon and Durand during the last six months. This forest (old trees in areas of rugged exposed karst limestone) is the most important remaining forest in Haiti in terms of biodiversity, and it is now very threatened.

4). For the first time in the history of our work in the Formon/Durand area of Macaya, no parrots we heard or seen. The answers to our inquiries indicate it is likely that parrots are being collected by some people at their nest sites and eaten or sold for food.

5). The entire area of the plains of Formon and Durand have been cultivated for the planting of "potats." This is part of the regular two-year cycle of land use in the area, but this year the local farmers are planting far into the boundaries of Parc Macaya, often on steep slopes, and along the edges of steep ravines and water courses. As we walked out of the interior of the park, we passed six farmers at different locations walking into the park with hoes and machetes.

6). These unwise and desperate agricultural activities make all of the watersheds of the region, and particularly the Riviere l'Acul, vulnerable to heavy rains. On the night of April 13th such heavy rains fell in the region. During our flight over the area on the morning of April 14th, there was evidence of soil erosion and damage to the l'Acul watershed. The Riviere l'Acul was clouded with mud, and the water level was very high, a major change from the afternoon before when we came out of the area by jeep and crossed the low and clear flowing river.

7). The water catchment area of the Riviere Cavailon/Saut Mathurine hydroelectric plant is almost completely deforested. Much of this deforestation is very recent.

8). The area to the north, northeast and east of Pic Macaya (including Catiche, Duchity, and Beaumont) has been severely deforested. A few years ago this area was 40% forested. Most of the deforestation is very recent, and seems to be due to charcoal production. We saw many bags of charcoal being brought down from the area. There is a new road being built by the Cheron family of Duchity, with local assistance from people living in the region. The new road will pass from Duchity westward towards Lacadonie. This road was begun two months ago, and will be completed by this summer (July).

9). The national park is now surrounded by roads (the project road to the south, the UNICORS road to the west, the Cayes-Jeremie road to the east, and the new Cheron road to the north.

10). There is little or no forest cover east of Camp Perrin all the way to the Ridge of Pic La Selle in eastern Haiti. The areas to the north of the coast of the Cote de Fer region seem to be undergoing desertification. There are some patches of forest in the regions north of l'Asile, and a large area of important scrub forest on the peninsula west of Duverger projecting into the Baie d'Aquin.

11). The rainfall that occurred the night of April 13th (the night before our air survey), produced flooding and heavy silt content in almost all of the rivers of the area. The Riviere l'Acul below Le Prete was brown, and there was a great plume of mud at the mouth of this river west of Les Cayes. The Riviere

The forest cover in the core of the Macaya Biosphere Reserve is still intact.

Cavailon was so high that muddy water was spilling in a huge rapid over the hydro-electric dam. Saut Mathurine, which has been completely dry for almost a year, was spectacular, as were the lesser waterfalls along the Riviere Cavailon. Huge amounts of silt were being deposited in the sea on the morning of April 14th. This flooding and heavy erosion after a single rainfall is a consequence of the severe deforestation of the past few months. During the past few years such flooding and erosion were observed only after weeks of heavy rain.

Summary: The forest cover in the core of the Macaya Biosphere Reserve is still intact. This forest is the last remaining upland forest in Haiti, and is rich in endemic plants and animals (we found two new species of orchids on this trip, and are currently describing a new species of mammal that is a "living fossil"). The forest protects the upper watersheds of the six major rivers of the region. The area is still worth protecting because of its importance in water generation, watershed stability, and soil protection. However, the area is under siege. The rate of deforestation accelerated during the last six months. New roads are going to make it possible to rapidly deforest the area in the next two years. The deforestation has not yet reached the irreversible stage, however, and several projects are possible that could slow the rate of deforestation, protect the critical core areas of the region, and provide economic alternatives to local residents who are desperate for food and sources of cash. Reforestation activities, especially in already badly degraded steep areas of the watersheds, can help stabilize the watersheds, and can provide work and opportunities to educate local people.

Several projects are possible that could slow the rate of deforestation, protect the critical core areas of the region, and provide economic alternatives to local residents who are desperate for food and sources of cash.

We feel that the MBR project has worked to the degree that the amount of deforestation in the Formon/Durand area could have been much worse, and certainly the amount of environmental damage in the Formon/Durand region is much less than that in the Duchity area on the northeast side of Macaya where the project did not work. In general, the survey indicates heavy and recent deforestation in most areas we investigated except for the central area of Parc Macaya, and some Rak Bwa forest areas near the project headquarters at Formon/Durand.

CHAPTER V

A Proposed Biosphere Reserve for the Citadelle Area of Northern Haiti

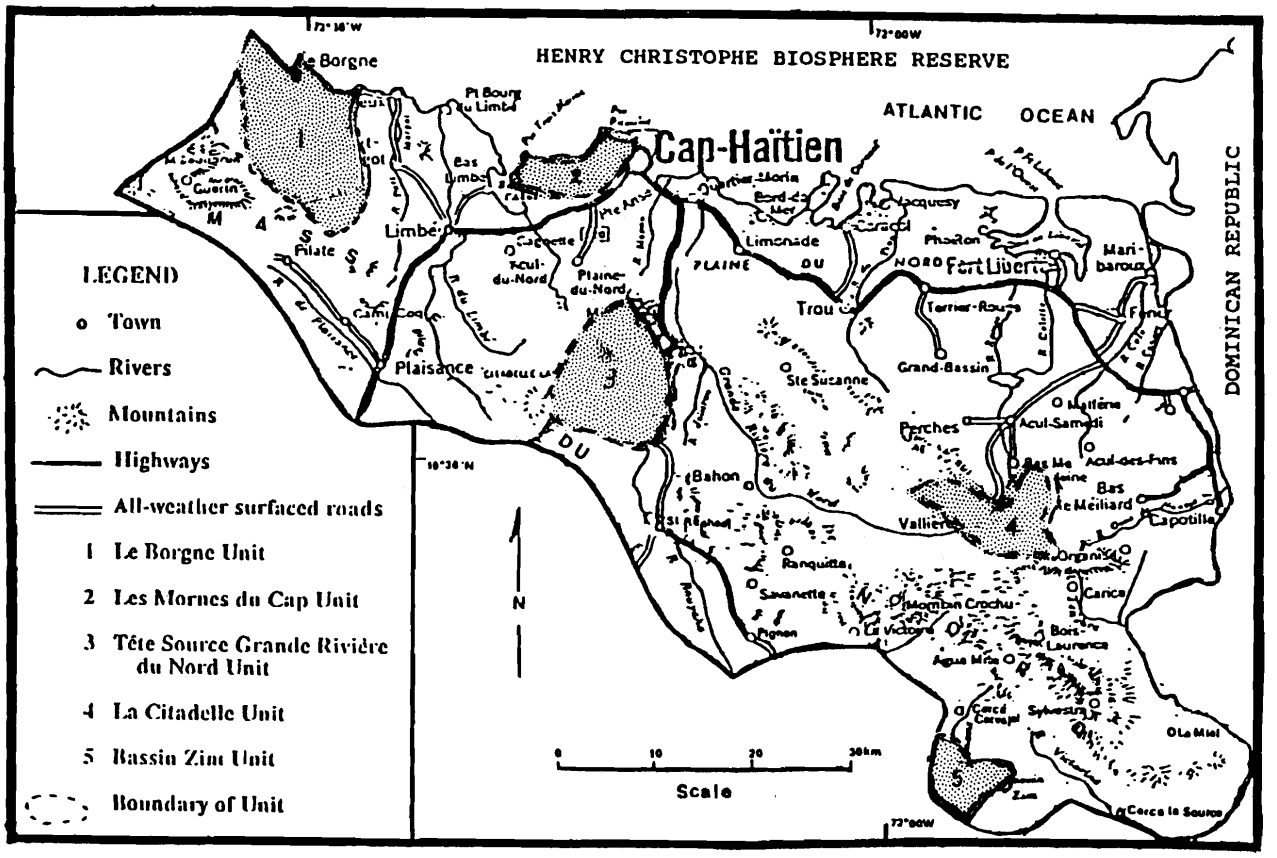
Henry Christophe Biosphere Reserve: The Antilles 2000 Modality

Two modalities among the patterns of biosphere reserve designs have been modified to create our "Antilles 2000 Modality." The examples that best fit as a model for the Henry Christophe Biosphere Reserve are the "Mexican Modality," developed in La Michilia (Western Sierra Madre, Mexico) and Mapimil (Central Chihuahuan desert, Mexico), and the multiple-site pattern recommended for the Lesser Antilles (McCrone, 1984). The "Mexican Modality," besides fulfilling the regular objectives of a biosphere reserve, stresses the need to pay special attention to the local population by understanding their needs and interests, and by developing programs for their benefit (Halffter, 1981, 1985). Projects for very poor local populations must help solve basic problems as well as strive to improve socioeconomic status so that they do not have to exploit nature to satisfy basic needs. The Haitian people and the inhabitants of the two Mexican biosphere reserves have extreme poverty in common. Therefore, integration of the needs of people in the plan for the Henry Christophe Biosphere Reserve should be a priority. However, it will not be possible to include the whole population of northern Haiti in such a program because: 1) huge projects have a tendency to fail due to of a lack of focus; and 2) a large portion of the northern territory

lacks conservation values, since the land is intensively exploited. Fortunately, part of this land can be protected.

The strategy to alleviate these problems is to use part of the Lesser Antilles approach, a multiple-site biosphere reserve. The entire northern area, which we refer to as Henry Christophe Biosphere Reserve, would represent a conceptual system with tangible resources included in units in such a way as to implement a conservation program (see below). Within this conservation system, some units of special concern can be designed to effectively carry out the conservation program. The units included in the global system should not be considered as distinct biosphere reserves; each one represents an important part of the overall unique life zones; and, due to the scarcity of land and the land utilization pattern, it is not feasible to incorporate all of them into one contiguous area.

Henry Christophe Biosphere Reserve and Units



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Northern Haiti in the context of protected areas

The conservation strategy designed to protect the natural resources of northern Haiti takes into consideration the socioeconomic realities of the region (dense population, poor peasants, illiteracy, vague land ownership), as well as the means of production (agriculture on small plots in mountains, deforestation to obtain more land), income generators (tourism, art and crafts), and natural features (biological zones, topography, soil classes).

The objectives of the Henry Christophe Biosphere Reserve are:

A. To protect and preserve the natural resources in northern Haiti for future generations by conserving the biological diversity of the region.

B. To insure the long-term conservation of the surrounding ecosystems by:

   1. restoring the eroded landscapes by reforestation with native and endemic species;

   2. protecting the remaining patches of natural habitat.

C. To develop and promote effective techniques in sustainable agriculture, agroforestry, and soil conservation by further research, monitoring and demonstration.

D. To contribute to the socioeconomic improvement of the neighboring human population by developing objective "C" and tourism.

E. To collaborate with other agencies involved in development by strengthening cooperation between conservation and development.

F. To establish an adequate legislation and management plan to insure the long-term viability of the natural resources.

G. To incorporate traditional land uses and local skills in the present and future management plan.

The Henry Christophe Biosphere Reserve is located in the Neotropical Realm biogeographical province of the Greater Antilles. This province contains the highest degree of endemism due to topographical diversity and isolation of ecological niches.

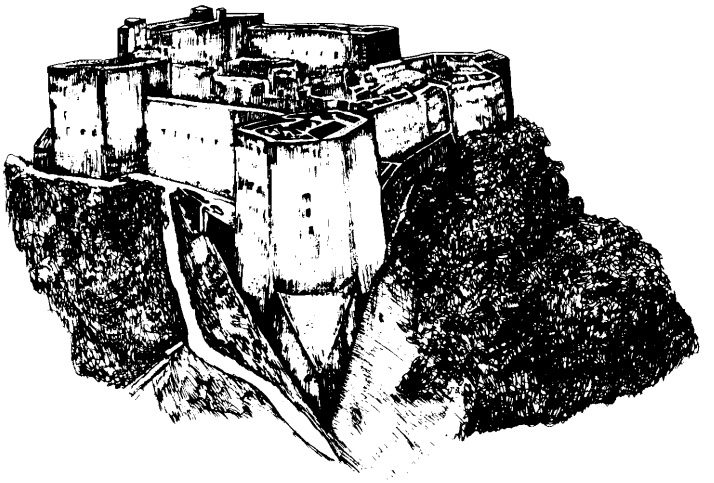
Criteria for selection of the Henry Christophe Biosphere Reserve

1. **Representativeness.** The Henry Christophe Biosphere Reserve is located in the Neotropical Realm biogeographical province of the Greater Antilles (Budowski & MacFarland, 1984). This biogeographical province of the island of Hispaniola contains the highest degree of endemism due to the diversity in topography and great isolation of ecological niches (Howard, 1973).

2. **Ecosystem diversity.** Various ecosystems occur in the different life zones. They vary from coast to mountains, from low mountain forest to high mountain forest (Organization of the American States, 1972; Holdridge, 1942, 1947).

3. **Naturalness.** The northern region of Haiti has a long history of exploitation. However, wild vegetation still occurs in some non-exploited areas, or in association with introduced species of economical use.

4. **Effectiveness as a conservation unit.** The common size of biosphere reserve as established by UNESCO (1983) is 10,000 to 25,000 hectares. The Henry Christophe Biosphere Reserve is 38,300 hectares in area. It is bordered on the south and west by two mountain chains, and on the north by the Atlantic Ocean. The combination of five life zones included in such a limited geographic region is unique in the Antilles.



La Citadelle

The proposal for land use in the biosphere reserve is a compromise between "national park" lands and the land use needs of peasants.

The establishment and management of this biosphere reserve is very complex. The conservation strategy designed to protect the natural resources should take into consideration the historical background and economic realities of the country, as well as different characteristics of the area including: sustainable agriculture, reforestation with endemic and native woody species, protection of herbaceous species, protection of the fauna, promotion of artisanship and tourism. The proposal for land use in the biosphere reserve is a compromise between "national park" lands and the land use needs of peasants. The resulting compromise in proposed land use is defined in the biosphere reserve land use concept. The land

use pattern will be developed by 1) selecting targeted conservation units within the Henry Christophe Biosphere Reserve, 2) proposing functional zones for each unit, and 3) developing specific proposals for land use in each.

The Henry Christophe Biosphere Reserve project is based upon guidelines for biosphere reserve designs for other developing countries in the tropics, with some modifications to accommodate the unique character of Haiti, and more specifically the northern portion of the country.

Targeted Conservation Units

The selection of a unit of special concern to be included in the Henry Christophe Biosphere Reserve is based on one or more of the following criteria:

1) natural vegetation is still found in fragile lands,
2) a biological zone needs to be preserved because of the presence of important plants and animals,
3) a major watershed of an important body of water is included in an area where natural vegetation can be protected,
4) a scenic and/or historical site is present that can attract tourists due to its beauty and/or uniqueness.

Units

By studying the topography and the history of the region, the following units have been selected (see map, page 140):

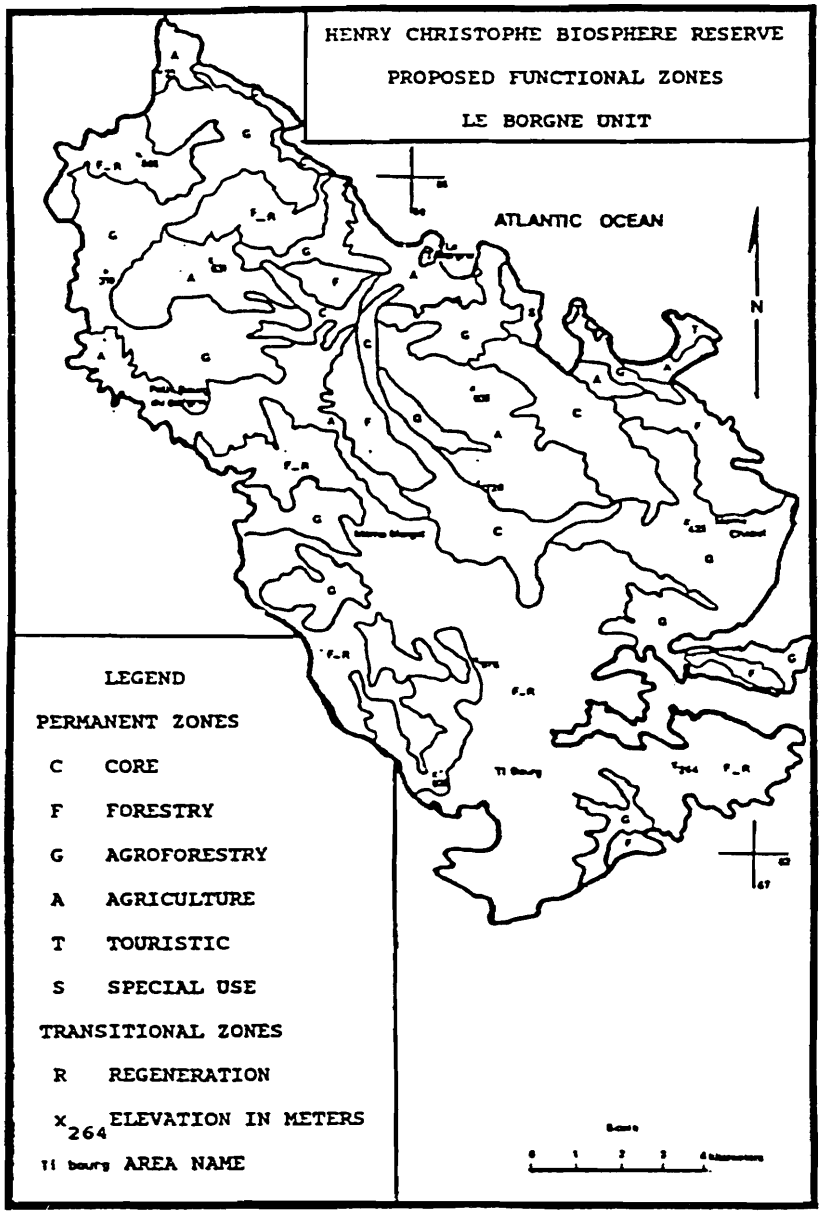
1) The Le Borgne unit
2) The Les Mornes du Cap unit
3) The La Citadelle unit
4) The Tete Grande Riviere du Nord unit
5) The Bassin Zim unit

The Henry Christophe Biosphere Reserve project is based on guidelines for biosphere reserve designs for developing countries in the tropics, with modifications to accommodate the unique character of Haiti.

Descriptions of the units

1) The Le Borgne unit

This targeted conservation unit is 146.65 km^2 on the northwestern coast of the Departement du Nord. This unit includes a subtropical wet forest, a low mountain wet forest (Sedwitz and Canet, 1972), and a mangrove community. The precipitation is as high as 2,400



Le Borgne unit and functional zones

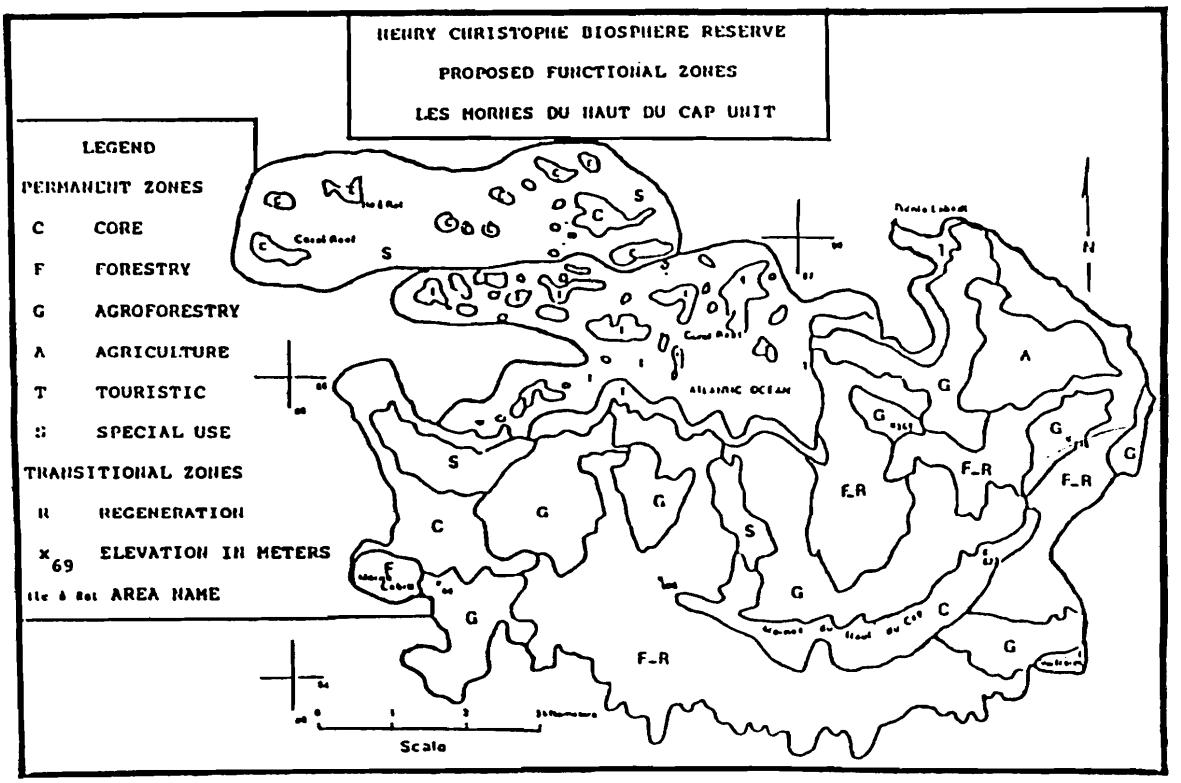
mm per year (Wood, 1963). Cliffs facing the Atlantic Ocean are an important habitat for marine birds. The soils of the Mornes Brigand are protected by a deciduous forest, and the mountains are the major feature of the unit. This area forms the watershed of the Riviere du Borgne and the Riviere de Port-Margot, both of which irrigate the plains below. The area is a major coffee producer due to the high rainfall pattern. During the 1950's the area was important for hevea (*Hevea braziliensis*) production. The Le Borgne area has a long history, beginning with the Pre-Columbian period. The numerous pictographs seen on the walls of grottoes (caves) in the area bear witness to a large Amerindian concentration (Moreau de Saint Mery, 1797). The towns of Le Borgne and Port Margot were the first settlements of the French (Buccaneers) on the island of

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Hispaniola (Moreau de Saint Mery, 1797). Ruins of French batteries can be still visited on the northern coast of this unit (A. Mangones et al., 1986). The Chouchou Bay is one of the most famous beaches of the country due to its beauty.

2) The Les Mornes du Cap unit

This unit encompasses three main biological zones in a 4,511-hectare area: a subtropical wet forest, a low mountain subtropical forest on karst, and scenic beaches and coral reefs (below). The small island "Ile aux Rats" is included in this unit because it is a refuge for the West Indian manatee. Part of the mountain slopes of Les Mornes du Cap have been successfully reforested with *Pinus occidentalis* at elevations as low as 300 meters. A high concentration of French batteries still dominate the high ground overlooking the Atlantic Ocean. It also include the Vertieres Monument commemorating the Independence Battle.

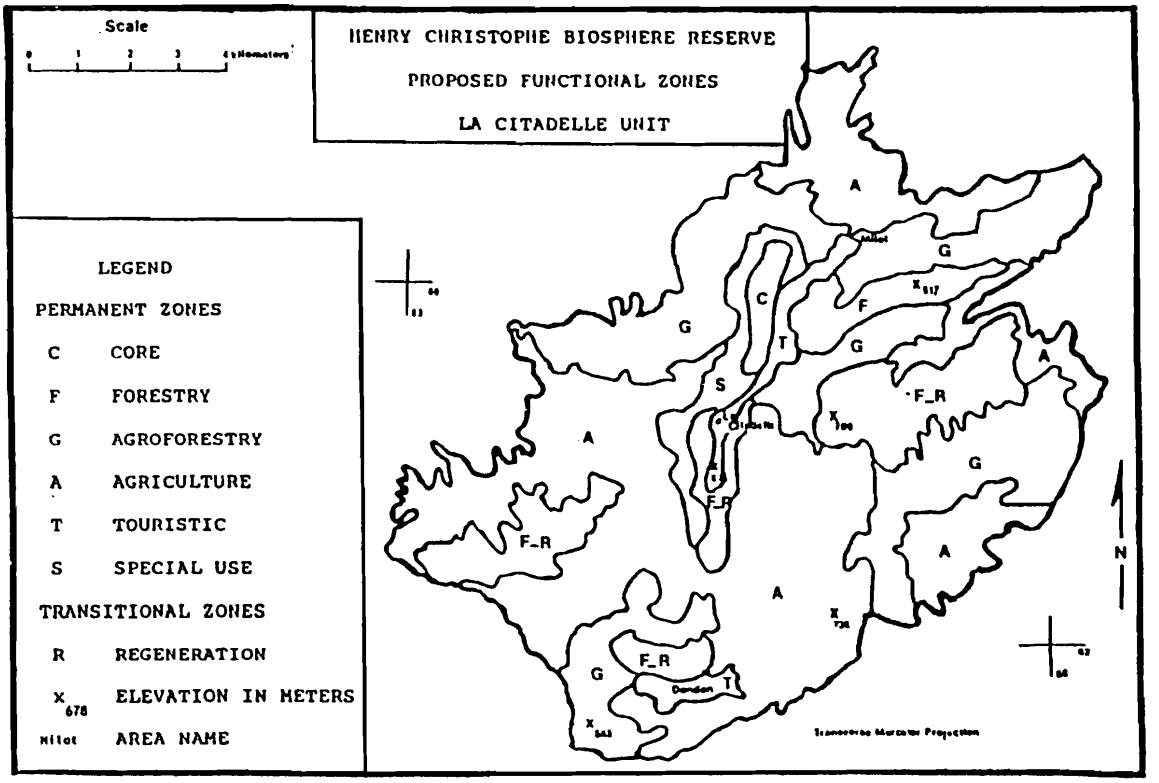


Les Mornes du Haut du Cap unit and functional zones

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3) La Citadelle unit

This is a 108.83 km^2 area which includes mountains and low lands. This unit (below) has a high touristic value because of its historic monuments: La Citadelle, Sans Souci, and Ramiers. It is one of the most populated areas in the northern region due to its favorable climate and tourism activities in the Sans Souci-La Citadelle area. The area is a well-known coffee producer because of its high precipitation (2,400mm/year) and its remaining woody vegetation cover. Many endemic species thrive on and around the rocks, which protect the soil from being washed away during the rainy season. The fragile lands surrounding those sites need to be protected against erosion while the needs of the local population of the area are met. The town of Dondon and the grottoes in the surrounding hills are of great touristic potential. The Voute a Minguet and the Voute aux Dames can serve as a cultural site. The area also has research potential in such fields as anthropology and zooarcheology.

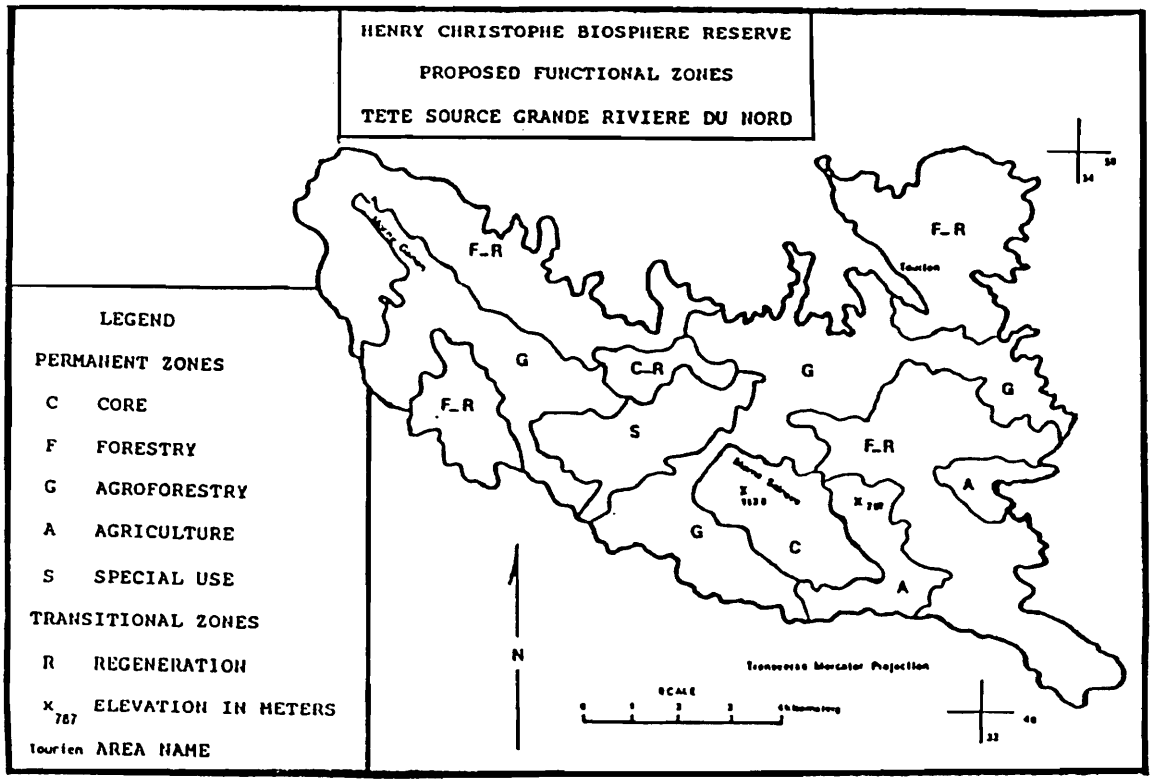


La Citadelle Unit and Functional zones

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4) The Tete Grande Riviere du Nord unit

This unit (below) is 98.13 km^2 and includes the watershed of two major rivers: the Grande Riviere du Nord, which drains into the Atlantic Ocean, and the Riviere Terre Neuve, which drains into Riviere Libon, a tributary of the Artibonite River, toward the Plateau Central. The Tete Grande Riviere du Nord watershed is centered around Morne Salnave which includes a subtropical wet forest with pine trees and broadleaf forest. This area is the least populated part of northern Haiti even though it has a favorable climate with approximately 2,000 mm/year precipitation. It was very populated by Ameridians at the time of Columbus and was a prosperous area during French colonization (Moreau de Saint Mery, 1797). The objective of establishing this unit is to protect the watershed of the major rivers of the north plain, as well as to protect biological diversity.

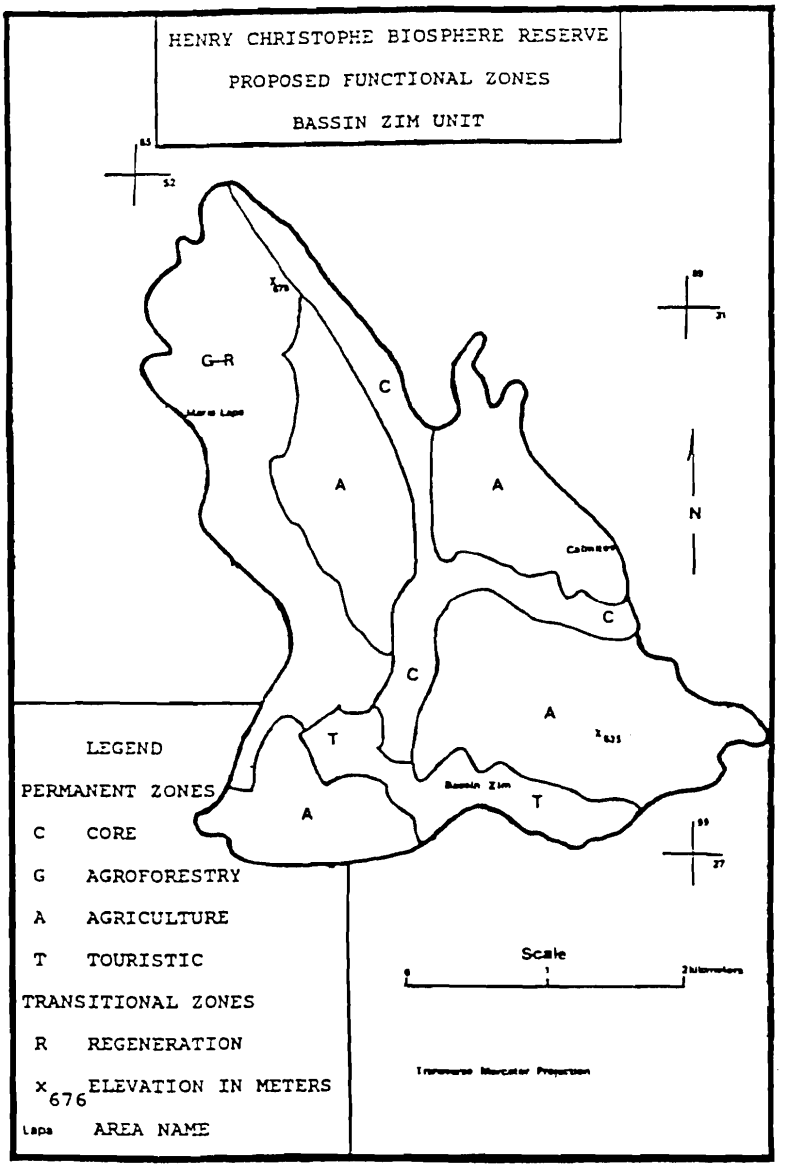


Tete Grande Riviere du Nord unit and functional zones

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5) The Bassin Zim unit

This 1,165-hectare unit (below) includes a waterfall in its watershed. The cascade is produced by an underground river that is lost in grottoes. The water is captured in areas by natural pools. Pictographs on the walls of local caverns of the area bear witness to pre-Columbian history. The objective of designing this unit is to promote tourism for the benefit of the local population, as well as to protect the natural flora and fauna which thrive in the area. Access to Bassin Zim is very difficult, unless one has an all-terrain vehicle. Therefore, promoting tourism in this area will facilitate communications. Protecting the watershed will also protect the hydroelectric potential of this cascade (Sedwitz and Canet, 1972).



Bassin Zim unit and functional zones

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Zoning

Functional zones are proposed according to: 1) land capability with respect to topography (slope percentage); 2) ecosystem diversity; 3) economic potential of the region. The design of functional zones in degraded areas requires a combination in time of two types: permanent, and transitional zones. Permanent zones are represented by the core, forestry, agroforestry, agriculture and special use zones, whereas transitional zones are represented by regeneration zones.

Functional zones definition

A. Permanent Zones

Agriculture Zones

Agricultural zones comprise 9,066 hectares or 24% of the biosphere reserve. These are areas where sustainable agriculture and production of staple and annual crops are carried out. Agricultural zones are located in area of relatively level terrain (slope 10-20%) and the possibility of irrigation or good rainfall distribution.

Agroforestry Zones

Agroforestry zones represent 9,659 hectares or 25% of the biosphere reserve. These are areas where agriculture and reforestation are carried out together. Coffee, cacao, fruit tree crops, fuelwood production and mangroves (because of potential production of oysters and wood) are included in this category. In some areas of traditional cattle raising, pastures can be added (agro-sylvo-pastoral zones).

Forestry Zones

These are areas where woody species can be exploited. Forestry zones can be at the periphery of the core zones, but usually are in areas with very steep slopes and play the role of buffer zones for the core areas. They all need to be regenerated and they represent 13,541 hectares, or 36% of the biosphere reserve.

Biosphere reserve functional zones are proposed according to topography, ecosystem diversity and economic potential of the region.

Core Zones

Core zones comprise 3,307 hectares or 9% of the biosphere reserve. These encompass the special areas where exploitation would result in degradation of the fragile lands and ecosystems. The core zones are represented in the Henry Christophe Biosphere Reserve by: 1) coral reefs and the Ile aux Rats which is the habitat of the West Indies manatee (Woods and Hermanson, 1987);

2) important watershed of the principal water bodies; 3) mountain summits and steep slopes where endemic species are found.

Special Use Zones

These zones are 1,637 hectares or 4% of the biosphere reserve. They include: 1) very valuable ecosystems; 2) renewable natural resources such as honey, fish and seafood which can be exploited within conservation norms while the habitat is protected. To these zones should be added densely populated areas such as in the La Citadelle and the Le Borgne units, and areas where people use rivers and springs for laundry, drinking water, and other domestic uses.

Touristic/Recreational Zones

These are the smallest portion of the biosphere reserve with 823 hectares (2%) where agriculture and agroforestry should not be undertaken. These are areas with historical monuments or with scenic potential. The touristic sites are divided into three categories: a) human historical sites built by man or which are sociologically and culturally important, 2) areas valuable because of their beauty, 3) recreation areas such as beaches, nature trails, caves and falls. They include the areas immediately surrounding the sites and access roads, where monument conservation programs and landscape regeneration could be undertaken to enhance the beauty of those sites. Some of these sites have already been studied or are in the process of being investigated. These sites represent the following historical periods: Pre-columbian period, Spanish and French colonization, and Independence to present.

Transitional zones are established in order to rebuild degraded areas when such factors as climate, landscape and watershed permit.

B. Transitional Zones

Regeneration Zones

These zones are established in order to rebuild degraded areas when factors such as climate, landscape and watershed permit. A regeneration area can become a permanent zone of any type.

Area in hectares of the proposed functional zones of the targeted conservation units

ZONES	1		2		3		4		5		TOTAL	
A	2983	26%	283	6%	4768	43%	625	6%	611	52%	9270	24%
G	1812	16%	1125	25%	3355	30%	3077	31%	290	32%	9659	25%
F	5170	43%	1914	43%	1841	17%	4616	47%	0	0%	13541	35%
C	1517	13%	646	14%	144	1%	825	8%	175	15%	3307	9%
S	94	1%	183	4%	690	6%	670	7%	0	0%	1637	4%
T	90	1%	360	8%	348	3%	0	0%	89	8%	887	3%
TOTAL	11666	30%	4511	12%	11146	29%	9813	26%	1165	3%	38301	100%

1 = Le Borgne; 2 = Mornes du Haut du Cap; 3 = La Citadelle;
4 = Tête Source Grande Rivière du Nord; 5 = Bassin Zim.

A = Agriculture; G =Agroforestry; F = Forestry; C = Core;
S = Special uses; T =Touristic/Recreational

Organization of the Henry Christophe Biosphere Reserve Project

In the Third World, many projects do not succeed because of a ill-adapted organizational structure. The foundation of an organization is very complex. There are many factors that affect organizational effectiveness. These are: 1) the mission of the project, 2) the environment in which the project will evolve, 3) the type of business and the technology used and 4) the size. In establishing the Henry Chistophe Biosphere Reserve Project, these components should be taken into consideration.

In the Third World, many projects fail because of ill-adapted organizational structures. Factors affecting organizational effectiveness must be taken into consideration in order to insure project success.

1) The mission of the project

The mission of the project is the conservation and management of natural resources in northern Haiti. It is an interdisciplinary project that will integrate several specialities, thus several types of technology, and the local population in a unique environment.

2) The environment

The Henry Chrisptohe Biosphere Reserve will evolve in an environment with serious administrative problems. Some changes should be made in establishing the project to adapt it to the reality of Haiti. The proposed project is located in northern Haiti, far from the centers of public administrations and decision making

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ministers in Port-au-Prince. Communications are difficult; resources are limited. It will also involve four types of services (agriculture, forestry, tourism, research), which are located in different ministries or departments (with different structures).

3) Types of business and technology used

The organization will offer to a small market (local population) a service. The technology is non-standardized (craft technology) because of the unique biological environment and the multiple disciplines required in this conservation strategy.

4) The size of the organization

It will be considered as a large size organization by Haitian standards. Many small business in Haiti employ five to ten people. This project will have more than 50 permanent technicians and workers.

Different Elements Involved in the Henry Christophe Biosphere Reserve Project.

The main issue in developing the project are the factors neccessary for the project to succeed. Some factors which must be taken into consideration are the perception of the population toward the project, the ownership of the resources on which the project will work, and the complexity of the relationships between the different organizations on site. These concerns are addressed below.

Care should be taken to insure that the local population feels that the project is helping to improve the quality of life.

Perception of the local population toward the project

Care should be taken to insure that the local population retains a positive attitude toward the project. The community should feel that the project is helping their members in improving their quality of life. A focus on saving animals will not succeed if the local people believe that the animals are better treated than they are. Therefore, the project should bring education, adaptive technology, training, and work. This is one of the reasons why agriculture, agroforestry and development of special skills are emphasized in the conservation program.

Ownership of the resources

Ownership is currently divided between the private and the public sector. Resources include water, coasts, flora and fauna, historic monuments, scenic sites, and land. All the resources, mineral water sources, and underground water are the property of the State by the Decree of October 10, 1974, and communique of DARNDR (currently, the Departement de l'Agriculture, des Ressourses Naturelles et du Developpement Rural) of March 18, 1979. Laws regarding the protection of the flora and fauna, although not clear in terms of property rights, acknowledge the state's right and concern for these renewable natural resources (Decree-Law of November 1941, Law of March 1st, 1944, Decree-Law of June 27, 1947). Part of the land is exclusively owned by the state by the law of July 26, 1927, which divides the public land into public and private domains (Erlich et al., 1985).

The ownership and diversity of the resources of the area lead to the important aspects of responsibility and authority, division of activities and specialization. The management and conservation of the resources demand an understanding of these factors, in order to coordinate these activities under an successful management plan.

Complexity of Relationships

It is important to consider the relationship of the biosphere reserve organization to other institutions in the country and with the government of Haiti. This concern is especially important because ownership of the resources is poorly understood, and technicians are underpaid and at times undermotivated. In fields like conservation, agriculture, and forestry in Haiti, the main supplier of technicians is the Ministry of Agriculture, Natural Resources and Environmental Protection (MARNPE). Each year, the college of Agriculture (Faculte d'Agronomie et de Medecine Veterinaire) of Haiti graduates 20 to 25 agronomists. All of them will be appointed by the Ministry of Agriculture to different services such as food crops, animal production, soil conservation, forestry, environmental protection, fisheries, and extension.

Resources of the area include water, coasts, flora and fauna, historic monuments, scenic sites, and land.

Many institutions have been working for years in the biosphere reserve region and have acquired a great deal of experience in the field. It is important to establish a link between many of these institutions (see following diagram) and the biosphere reserve project in order to avoid repeating mistakes, and more importantly to increase the chances of success and the acceptance of the project within Haiti.

Institutions working in natural resources and agriculture in northern Haiti.

Institution working in Northern Haiti	Field
*Food and Agriculture Organization (**FAO**)	Agroforestry Soil conservation Forestry Training
*Panamerican Development Foundation (**PADF**)	Agroforestry
*Ministere de l'Agriculture, des Ressources Naturelles et de la Protection de l'Environement (**MARNPE**)	Agriculture Soil conservation Extension Forestry Agroforestry
*Institut de Sauvegarde du Patrimoine National United Nations (**ISPAN/UN**)	Conservation of Historic monuments Archeology
*Office National du Tourisme	Site selection Public relations
*Universite du Roi Christophe	Education
*University of Florida	Archeology
Royal Caribbean	Touristic development

N.B. Institutions preceded by an asterix should be associated with the project.

Many institutions in Haiti have been working in the biosphere reserve region and have acquired a great deal of experience in the field.

Activities involved in the project

The management scheme for the Henry Christophe Biosphere Reserve must be interdisciplinary in approach in order to successfully integrate projects concerned with "production," "conservation," and "research." The organizational structure for the biosphere reserve should use a model integrates the various disciplines in order to achieve the goals of the biosphere reserve. Tourism, agriculture, forestry, development of artisanal activities are direct ways of generating cash, whereas conservation and research will increase income indirectly.

The different activities which should be involved in the biosphere reserve follow:

1. **Agriculture.** The principal task is to develop agricultural production in appropriate areas utilizing appropriate technology in order to increase the yield per unit, and therefore to generate more cash to the peasant.

2. **Agroforestry.** This division will produce fruit tree crops, fuelwood, and cash crops such as cacao and coffee. It will generate increased cash while the vegetation is protecting the soil.

3. **Forestry.** The task of this unit is to restore the landscape with appropriate tree species for future use. It is an independent unit which would interact closely with agriculture via agroforestry. This division will also be in charge of processing and marketing the products in order to maximize the income of the local people.

4. **Special skills program.** This program's objective is to develop artisanal and small enterprises. It will develop skills such as arts and crafts, shoemakers, tailors, bakers, food processors using local resources as much as possible. It will also be responsible for channeling the final products and regulating prices in order to benefit buyers and sellers.

5. **Tourism.** The task of this division is to provide access and facilities, and to develop touristic activities in the area.

6. **Protection of the monuments.** This unit is in charge of the protection and conservation of the national monuments and historic sites.

7. **Natural resource conservation.** The task of this division is to preserve and conserve the natural resources of the area for future use. It is involved in the restoration of degraded sites in an attempt to rebuild the natural aspects of the area. It will work closely with the forestry unit by using available and satisfactory technologies and skills.

8. **Research.** The local university (Universite du Roi Christophe) of the biosphere reserve region will be in charge of this aspect. The unit will be the contact for international and national exchange. As with other disciplines, it will be on site to coordinate research activities. These activities can be performed only by human resources: the employes and staff of Universite du Roi Christophe, Universite d'Etat d'Haiti, or others.

Management of the Henry Christophe Biosphere Reserve must be interdisciplinary in order to fully integrate projects concerned with "production," "conservation," and "research."

The members of the project

Members of the project (directors of divisions, technicians, workers, and other employees) are the building blocks of the organization. Technology, liaison, productivity and conservation cannot be implemented without them. They are a significant factor in the organization's effectiveness. The project's success depends directly on their performance. Some determinants of individual performance and of group performance must be considered in order to develop a successful organizational structure from among the proposed alternatives.

Determinants of individual performance

It takes many elements to achieve the goals of an organization. The institution should encourage its members to reach the standards of performance necessary to accomplish their work by understanding factors that influence performance such as motivation, satisfaction, and ability. Performance is influenced by the resources allocated and the effectiveness of the organizational system (plan and administrative structure).

Motivation is one of the most important factors influencing performance in any organization. Many studies of management techniques stress the fact that individual workers need to feel that they are being treated fairly and equitably by the organization. One of the most important factors in the attitudes of the workers is the feeling that they are receiving a good wage, and that they are being paid fairly in comparison to others. The project could learn from other projects by conducting job satisfaction surveys. It is questionable whether job satisfaction always leads to high performance. However, dissatisfaction is directly related to absenteeism and turnover, and therefore, to low performance.

Workers must feel that they are receiving a good wage, and that they are being paid fairly in comparison to others. In addition, they must have adequate physical facilities, equipment, and support in order to execute their work well.

Resources and Organizational Systems

In addition to understanding the individual, it is important that the organization provide its employees and associates with physical facilities, space, equipment, and the support system necessary to execute their work well. The type of organizational structure is also important in order to allow leadership, communication, participative decision making, and interpersonal exchange within the institution.

Proposed organizational structures and possible alternatives

Four models are presented in the literature on how to develop organizations: the mechanical, organic, craft, and mechanical-organic models. The mechanical model refers to rigid structures (bureaucracy) where standardized technology is used. The organic form or professional organization is suitable when the system of production is non-standardized and requires high levels of skills. The craft pattern meets local needs when products or services are produced in small quantity. Finally, the mechanical-organic model suits research and mass production (Hage and Finsterbuch, 1987).

The proposed biosphere reserve project involves non-standardized technology, and a small production and service for a small market that should meet local needs. The desirable model should be a flexible structure which will allow technicians and researchers to perform, and which will be adapted to the local environment. Thus an organic-craft organization model should be the most appropriate model to follow in developing a plan for the Henry Christophe Biosphere Reserve Project.

Some problems will be encountered during the development of the project due to its multi-disciplinary aspect. Examples of these problems are: 1) overlapping institutional responsibilities in Haiti, leading to problems such as the conflict that emerged during the development of national parks Pic Macaya and La Visite between the Division of Natural Resources of the Ministry of Agriculture and ISPAN; and 2) the traditional centralized structure of the public administration in Haiti, a structure that is not recommended for new organizations (Hage and Finsterbush, 1987).

The proposed organizational stuctures were selected because of their overall importance to the biosphere reserve. The suggested management strategies of the biosphere reserve includes three different structures, thus three alternatives are proposed for the administrative organization that will be responsible for coordinating the activities and interactions among the institutions. Each administrative plan has its own advantages and disadvantages.

The proposed biosphere reserve project involves non-standardized technology, as well as small-scale production and service which is intended to meet local small-market needs.

Alternative I: ISPAN* Plan

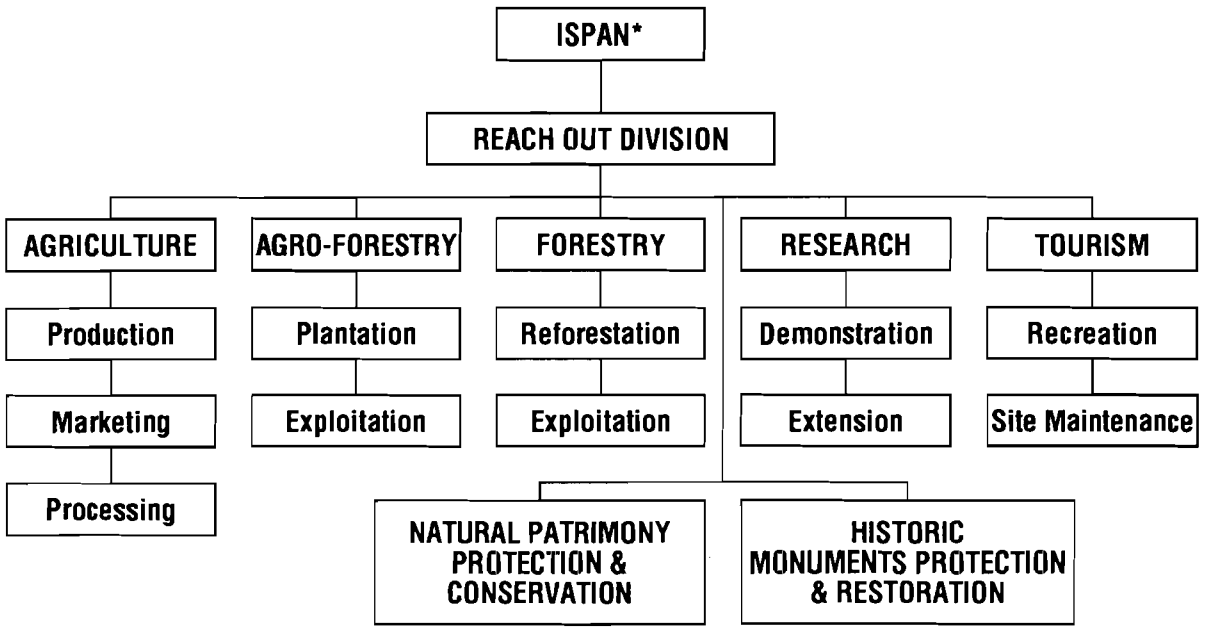
This structure proposes that an existing institution recognized by the government, the Institut de Sauvegarde du Patrimoine National (ISPAN), head the management of the Henry Christophe Biosphere Reserve. ISPAN is now a governmental institution with authority on national and natural patrimony, yet since its creation it had been mostly involved in restoration of historic monuments

in collaboration with UNESCO. This "educational" character puts it under the trusteeship of the Ministry of National Education although its mission goes beyond education. By giving to ISPAN its real mission, conservation of the national patrimony, the institution is organized in a broader sense and is called ISPAN* to differentiate it from the ISPAN division already working on monuments.

ISPAN* would be a semi-governmental institution. It would receive its budget from the Ministry of Finance and could also be funded and receive technical aid and consultation from any private, public, non-governmental voluntary organization. It could also subcontract with those previously-cited organizations for the purpose of consultation and to execute specific jobs.

In the plan, ISPAN* would be under the trusteeship of the Ministry of Finance, since this ministry owns the state land and whatever monuments or resources exist on state lands. ISPAN* would house an Outreach Division (ORD), and different functional divisions, among them the Division of Restoration and Conservation of Historic Monuments (DIRECHIM), and the Division of Protection and Conservation of Natural Patrimony (DIPCONAP) (below).

ISPAN* Plan organizational chart



The Outreach Division (ORD) is the hinge in running the Henry Christophe Biosphere Reserve project. ORD will be in charge of the coordination, the control and the success of the project. It would be the most suitable unit to build a system of communications. With this approach, a complete inventory and network could be developed which would include the physical system of the biosphere reserve and document the natural resources. By the same token, the system would also be in charge of collecting and channeling the appropriate information to the target function or institution when needed. This division, located between the managerial institution and the functional divisions, would permit a flat organization structure and avoid a long channel for the distribution of information.

ISPAN* would deal with functional divisions other than DIRECHIM and DIPCONAP (agriculture, agroforestry, research etc.). The on-site sections would interact with each other at their parallel leveld and ORD, which would channel all appropriate information to the concerned on-site sections.

Advantages. The advantage in this option is that ISPAN* is under a more dominant ministry, recieves authority, and meets its real mission. The flat structure of the organization allows easier communication within the system. The coordination, development of skills, and on-site actions are facilitated within the functional activities. Interactions between the functional areas would be facilitated because of their parallel levels and the experience of ISPAN in the region. The cost of the project is lower because ISPAN* will use the service of technicians already appointed by the Haitian Government.

Disadvantages. ISPAN* must coordinate the overall responsibilities. The ORD might require a rigid time pattern for receiving information from the functional areas. The technicians of the Ministry of Agriculture might not be attracted by the ISPAN* plan. The budget of both ISPAN and MARNPE is small, and salaries might not be alluring for the technicians. The new administration of ISPAN does not have a history of working in the area of natural patrimony, and it not clear that ISPAN will continue to work in the area of national parks and the conservation of the natural patrimony of Haiti.

The ISPAN* plan would provide for ease of communication. In this plan, the Outreach Division would channel information between managerial and functional divisions.

Alternative II: Land and Environment Plan

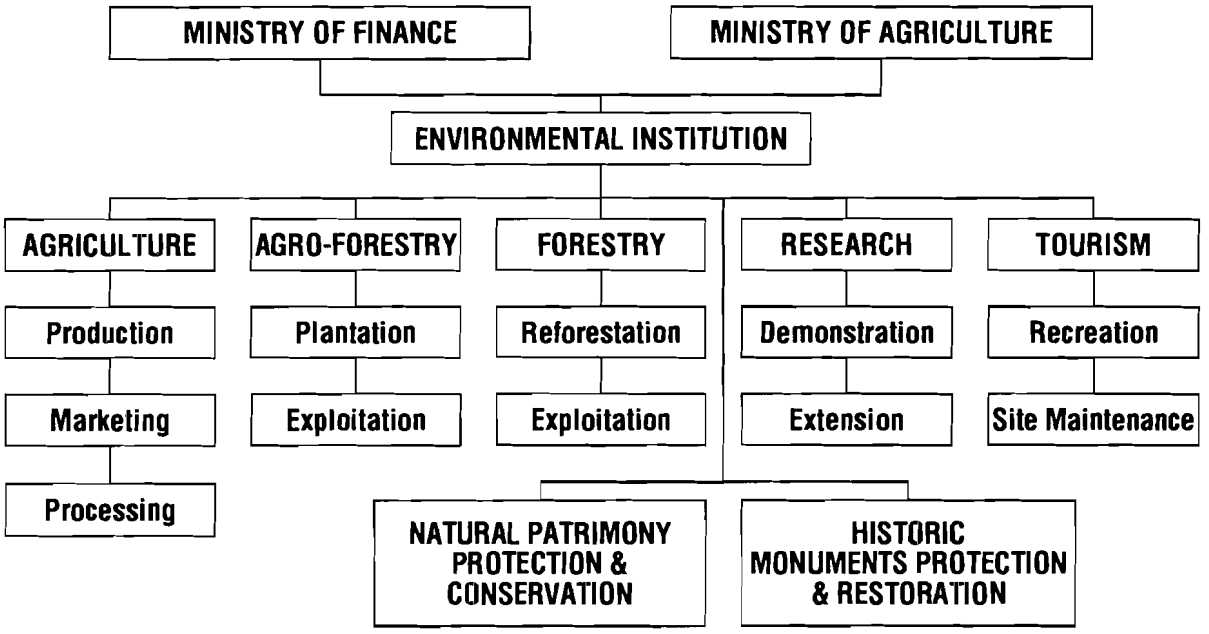
A non-governmental/non-profit environmental institution could be appointed by the Ministry of Agriculture and the Ministry of Finance with a common agreement to manage the project in the

area. The Ministry of Agriculture would be in charge of all protected natural areas, forestry, fauna, flora, development of agriculture and rural development. The Ministry of Finances would be responsible for the land. The Environmental Institution would serve as an executive technical agency on site. It would coordinate the work that would be performed by the various functional units (below).

Advantages. The advantage of such a structure is that all authority necessary to manage the system would be delegated by the two ministries to the agency. The land assigned to the biosphere reserve could be easily surveyed and the core zone physically delimited. Both contractors would appoint technicians on their own budget to work on site. This would be ideal if the Ministry of Agriculture would be allocated the land where the biosphere reserve would be developed. The Evironmental Institution would be dealing with an owner and a manager at the upper level, and with technicians that belong to other institutions at the lower level.

Disadvantages. The problem that might be raised is the issue of "authority." The technicians on site would have more than one boss, a situation that complicates coordination. The Environmental Institution would, on the one hand, be dealing with the Land

Land and Environment Plan organizational chart



Division of the Ministry of Finances, which needs to receive orders from an upper level. On the other hand, the agency would have to deal with many sections of the Ministry of Agriculture: Agriculture, Rural Development, Natural Resources (Forestry, Soil, Conservation, Environmental Protection). The organizational structure would be a "tall" one, which would hinder communications and flexibility of the decision making process.

Alternative III: Outreach Plan

In this alternative, an Executive Committee is proposed as the supervisory agency. The committee would contract with a non-governmental agency dedicated to the management of natural resources and protected areas to manage the biosphere reserve system. The Executive Committee would be formed by delegated members of two ministries and three non-governmental agencies committed to public well-being (page 162). The government members would be in part from the Ministry of Finance (Land Division) and Ministry of Agriculture (Natural Resources Division). The members of the non-governmental sector would be: one representative from a local university, a local church member, and a member of the tourism industry. The members of the committee would meet three times a year, and at other appropriate times, at the request of the non-governmental Agency. The agency would send periodic reports to the committee members of the Executive Committee.

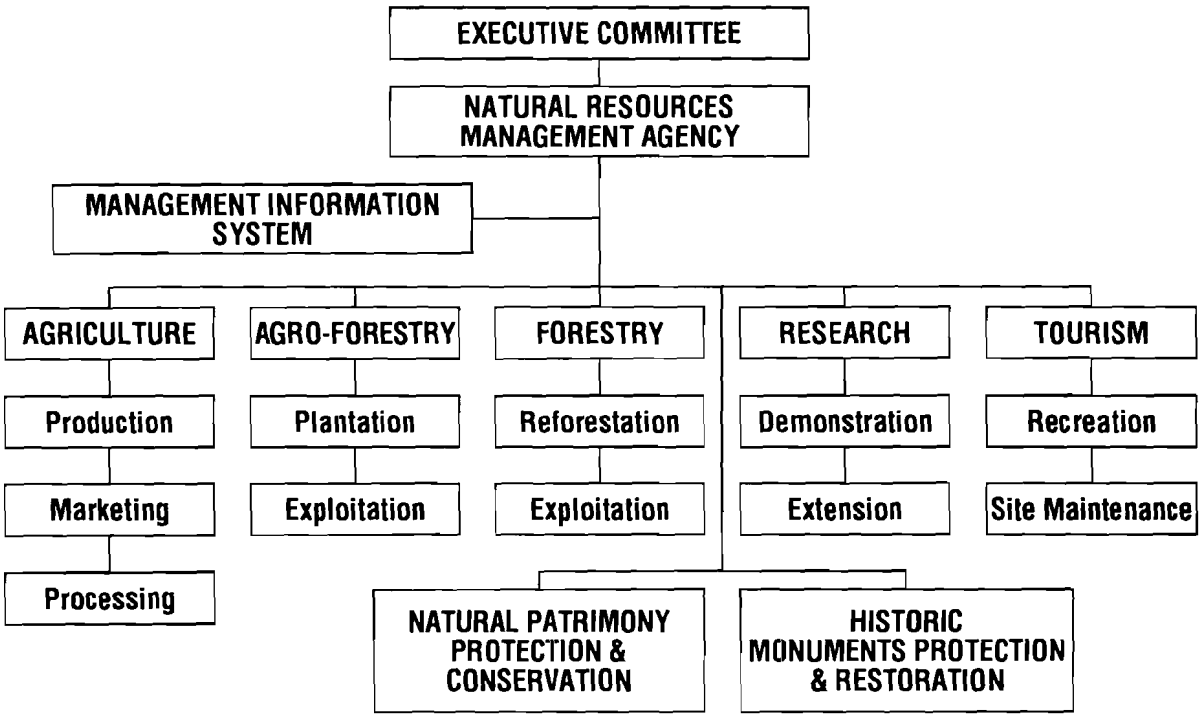
The Outreach Plan organizational structure proposes an Executive Committee as the supervisory agency. The committee would be comprised of representatives of governmental and non-govenmental agencies.

The non-governmental agency would work on site and be responsible for all of the functional activities of the project, and would coordinate activities. This agency would also have a management information system (Outreach Program) that would be similar to extension Programs at American Land Grant Universities and Colleges. This "Outreach Program" would create a data base which would make information available to all individuals and institutions associated with the biosphere reserve project.

Advantages. The advantage of this structure is that the agency would work in close collaboration with both the governmental and the private sectors. Authority and higher level of control of the biosphere reserve would be delegated to the agency. The structure of the organization is "flat," which facilitates communication.

Disadvantages. The disadvantage of such a structure is that the agency, in using the government technicians, will have to give them compensation (shelter on site, fees, stipend). This will increase the cost to the agency to get the job done properly.

Outreach Plan organizational chart



Integrated ten-year plan for the Henry Christophe Biosphere Reserve

The Integrated ten-year plan for the Henry Christophe Biosphere Reserve is divided in the following topics: 1) Administration and management; 2) Conservation; 3) Agricultural production; 4) Agroforestry; 5) Forestry; 6) Special skills development program; 7) Tourism; 8) Maintenance; 9) Research and Education. This plan is divided into two five-year phases. Phase I is designed for implementation, preservation of the core areas, regeneration of the needed zones, and improvement of agricultural and agroforestry techniques. Progress will be evaluated annually. Phase II is the production phase. Agriculture, agroforestry, tourism, and the stabilization of the core and regenerated zones will become fully operational.

Integrated management plan

The major features of the plan for the Biosphere Reserve Henry Christophe, and the recommanded time frame are proposed as follows:

Phase I

Year 1. Establishment of the Henry Christophe Biosphere Reserve.

This initial phase involves the establishment of a structure for the administration and management of the project. The project requires a flexible structure because of its complexity (multi-disciplinary aspect) and its newness. For this the Outreach Program will be most suitable. Each ministry and agency will designate a delegate to meet with the Environmental Institution. The agency will apply the "craft-organic model" of organization at the higher level. At the lower level, by group decision making, each discipline would choose what structure is most suitable for field work.

At this stage, topics of priority and their associated task descriptions would be designed with feasible and accessible goals. Two types of employees would be employed: 1) full-time permanent staff, and 2) temporary technicians, researchers, consultants, and workers (see following table). Public relations, inventory, and research (socioeconomic studies, soil analyses, marketing product and their channels), and legislation should be initiated at this stage. Headquarters should be established in each unit for the technicians. At the end of the first year, an evaluation should be undertaken and discussed with both the executive committee and the environmental agency.

The technicians needed would come from the agency, the Universite du Roi Christophe, and the public and private sectors.

Evaluations of accomplishments and difficulties will be performed in order to plan for activities in each successive year.

Year 2. Reformulation of problems and implementation

Based on the evaluation of Year 1, the following activities could be initiated: agriculture, agroforestry, forestry (nursery with endemic species and regeneration), boundary, surveys, and training for agents of the core zones. The first steps of monitoring the core zones can be initiated. Signs can be designed and placed where necessary. A special skills program can also be developed for extension agents. At the end of the Year 2, an evaluation should be undertaken to make projections for Year 3.

Year 3. Reformulation of priorities and production

From the evaluation of the previous year, priorities in forestry, agriculture and agroforestry should be clear. Facilities, such as roads, shelters, signs, exhibits can be developed in the touristic zones.

Year 4. Development of education and research

According to the evaluation of Year 3, fields where the need for education and research have been identified will be addressed. At the same time, all activities mentioned in the Year 3 program are still being developed. At the end of the period, an evaluation should be conducted.

Employee time frame

Function	Year 1 2 3 4 5 6 7 8 9 10
1 Director of project (permanent)	----------
1 Secretary (permanent)	----------
1 Socioeconomist (temporary)	-- -- --
1 Biologist (temporary)	------ -- ---
1 Legal consultant (temporary)	--
1 Consultant/artisan (temporary)	---
1 Agronomist (permanent)	----------
1 Forester (permanent)	----------
5 Assistant agronomists (permanent)	----------
5 Assistant foresters (permanent)	----------
5 Extension agents (permanent)	----------
5 Students/researchers (permanent)	----------
10 Core zone agents (permanent)	----------

At the end of Phase I (years 1-5) evaluation should analize social and regional benefits, and recommendations should be developed to clarify priorities.

Year 5. End of Phase I

At this time, some products of the agroforestry activities can be harvested. Other activities, such as grazing can be initiated. The evaluation at this level should analyze all of the previous years in terms of social and regional benefits, and recommendations should be developed to clarify priorities. The personnel mentioned above will still be on site. One consultant in socioeconomic studies and one in biological and conservation studies will be added to this group.

Phase II

Year 6. Monitoring of core and forest zones

During this period, all activities are being carried out, with an emphasis on the priorities stated in the evaluation. Monitoring of the core and forest zones can be developed.

Year 7 to Year 10. Maintenance and evaluation

Between Year 7 and Year 10, the project would be well established and would work to maintain all of the activities undertaken previously. Other activities will be added if necessary, according to socioeconomic and biological evaluations. The organizational structure might need changes to take into consideration the maturing nature of the project, and changing conditions in Haiti.

Conclusions

It is important to realize that not just any conservation strategy can be applied to Haiti as a blueprint. The Haitian culture, economic factors, the history of land use and the landscape must all be taken into consideration in establishing a management plan for conservation of natural resources in Haiti. A strategy of conservation should include two levels: a conservation plan and an administrative management plan.

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Conservation Plan: Antilles 2000 Modality

The topography of northern Haiti, and especially the pattern of wind and rainfall, give the region a different climate than the rest of Haiti, thus different biological zones. The landscape of northern Haiti has been subjected to different patterns of land use in the past, but because of economic factors and a demographic explosion, land not usually suitable for agriculture has been exploited. Only little patches of natural vegetation in various life zones remain, and even they are now threatened. These facts have been taken into consideration in designing the "Antilles 2000 Modality" for a multi-unit biosphere reserve, the Henry Christophe Biosphere Reserve. Our model stresses the conservation of natural resources in "islands" inside a broader area. It also includes management of the natural resources of areas of special concern such as a satelite island, a touristic, scenic and historic areas.

This concept offers two products to both the decision makers and to the local population. For the decision makers, it addresses situations to be exploited, such as tourism and history. It offers to the local population the insurance of being part of the program of management and conservation by contributing through the development of cash generating alternatives (agricultural and agroforestry practices, arts and crafts, tourism, etc.).

This plan can be expanded to other patches in the northern area such as Fort-liberte, and the Mornes of Puilboreau. It can also be applied to other departments in Haiti where additional patches of natural vegetation can be protected. The Antilles 2000 Modality should be applied with a flexible administrative management plan.

Administrative Management Plan.

It is important to implement the conservation strategy with an effective administration, because the conservation work must be done by people who are motivated and well-organized in order to perform well. The plan should be original, tailored to Haiti's needs and realities. It should also take advantage of every opportunity to reconcile the perception of decision makers with the conservation of natural resources and the needs of the local population for a better future.

The administrave alternative which best fits the need of the Antilles 2000 Modality is the Outreach Program. It is modeled after the Eastern Caribbean Natural Area Management Programme created in the Lesser Antilles (Putney et al., 1982). The program works with members of both the private and public sector. The plan provides for greater long-term continuity, because private technicians are likely to spend longer periods of time in their positions than are the ministers. It can operate with any type of government once the agency proves its importance. It also has a better chance of being accepted by the local population through the private sector. Because the agency is autonomous, it can hire the best technicians. The Outreach Program facilitates research through its extension program, as was done in the United States in 1862 with the establishment of Land Grant Colleges and Universities.

The conservation strategy must be implemented with an effective administration because conservation work must be done by people who are motivated and well-organized in order to perform well.

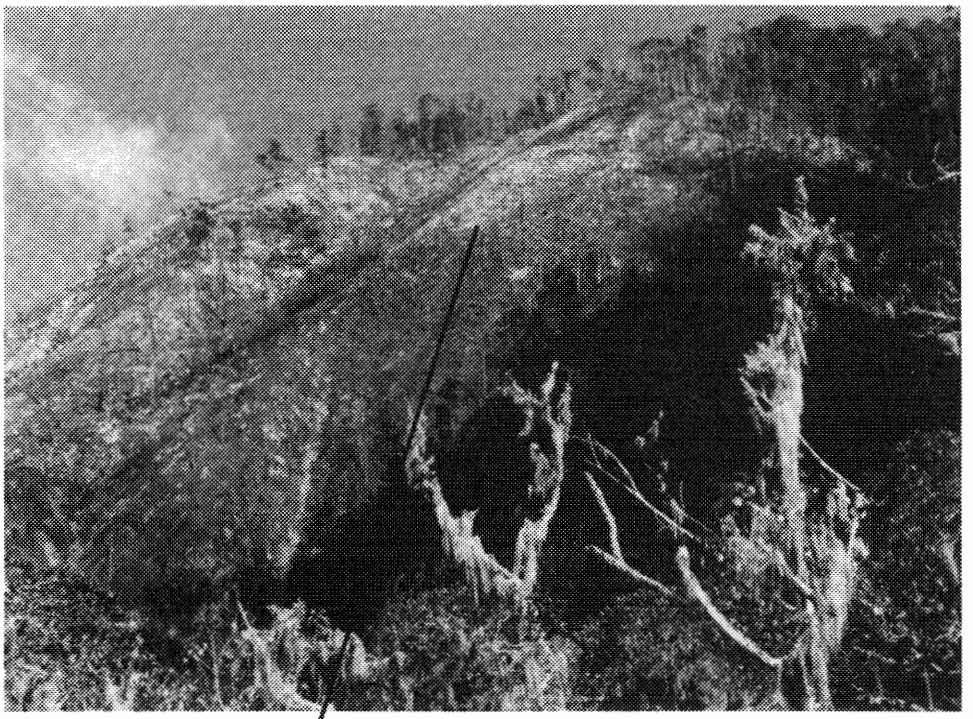
The flexible characteristic of the Outreach Program will allow improvement along the course of the project. It could also grow with the extension of the Antilles 2000 Modality throughout the country. Because both the Outreach Program and the Antilles 2000 Modality are designed to be responsive to a variety of situations, they can function hand in hand.

Projections: Implementation of the Antilles 2000 plan versus laissez-faire.

By the year 2000, if the Henry Christophe Biosphere Reserve is implemented, the vegetation in the units will be compatible with the respective land uses. The zones will be planted with adequate vegetation, the watershed will be managed and the local population will have alternatives for generating cash through tourism, arts and crafts, agriculture, and agroforestry.

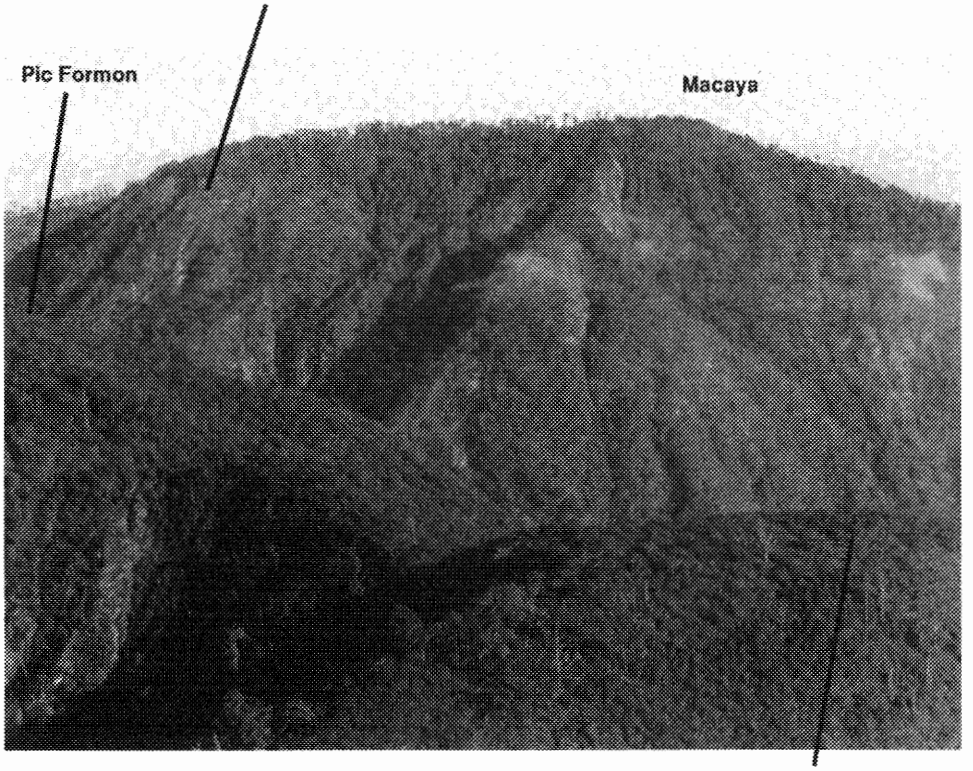
If the biosphere reserve is not implemented, at least in the unit, the vegetation will be up to 76% incompatible with land uses. This will lead to more degradation of the mountains in the area, and more soil erosion. Thus, the poorer people, will have no alternative other than to move into the small patches of native vegetation and exploit even steeper slopes. This will result in more loss of natural patrimony, it will further degrade water, and it will jeopardize human life. It is urgent that conservation measures should be undertaken to protect the remaining resources. It will not be an easy task, but we believe that the Antilles 2000 Modality and the Outreach Program together will be one of the most effective ways to conduct a conservation program in a country like Haiti where the political situation is not stable, where the public administration cannot meet the needs of technicians, and where the budget for conservation is almost non-existent. Conservation must be tied with economic development for the benefit of both the decision makers and of the local population. In this world where our common greeting is: "What's new?," it is imperative to come up with new approaches.

Action must be taken to preserve the remaining natural resources. Failure to take action will result in further loss of natural resources, degradation of water, and jeopardy to human life.



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.

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CHAPTER VI

Species Recovery Plans

Introduction

This chapter presents a model "Species Recovery Plans" for four endangered species in Haiti. The first is for the "living fossil" Giant Island Shrews 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.

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The other species recovery plans are for three species of birds. The Black-capped Petrel nests in the high montane forests of 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. The White-winged Warbler is 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. The Hispaniolan White-winged Crossbill is one of the most unusual birds of the Antilles, and its presence in Haiti is a relict of the last great Ice Age in North

America when the climate was much cooler and drier in Haiti. The species is dependent on large areas of mature pines. Recent studies indicate that there may be as few as 500 individuals surviving on Hispaniola.

The plans are presented here as an examples of how to prepare Species Recovery Plans. All four species are extremely endangered in Haiti. We recommend that a series of Species Recovery Plans be written for the endangered and threatened flora and fauna of Haiti. Species Recovery Plans will be among the most important planning documents that Parcs Haiti will have at its disposal.

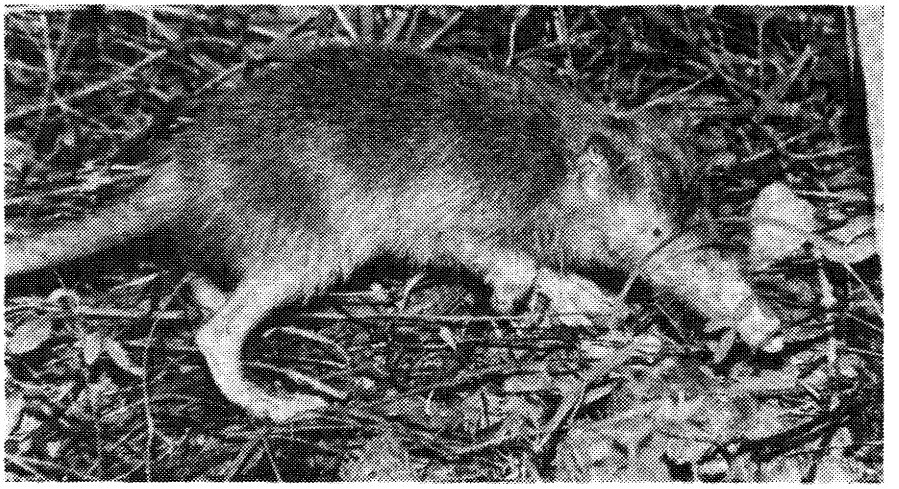
The concept of Species Recovery Plans is discussed in detail in *The Natural History of Haiti* (Woods and Ottenwalder, in press). All Species Recovery Plans follow a standard format, and need to include very specific information. There may be some overlap of information between the discussions in sections of this recovery plan and the in-depth discussions of birds and mammals in Chapters IV and V of *The Natural History of Southern Haiti* (Woods and Ottenwalder, in press). We have decided to include the Species Recovery Plans in this volume because Species Recovery Plans are going to be so important in developing programs in land stewardship in Haiti.



Devastated Solenodon habitat in the region of Duchity, Massif de la Hotte, southwestern Haiti

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RECOVERY PLAN FOR THE MASSIF DE LA HOTTE SOLENODON



Solenodon paradoxus

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 suggests that *Solenodon* was widely distributed in southwestern Haiti. At present, the future looks bleak for the 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 extinction.

Fossil evidence suggests that *Solenodon* was widely distributed in southwestern Haiti. At present, the future looks bleak for the Massif de la Hotte population.

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 to 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 by exotic mammals.

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).

The general objective of this conservation action plan is to reduce the status of the Haitian *Solenodon* from "Endangered" to "Threatened" within 15 years.

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 United States Department of Fish and Wildlife'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 their 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)*, have 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 the only known surviving population of *Solenodon* in Haiti today (Ottenwalder 1991).

Description

In Haiti, *Solenodon* is generally known with the name "Zagouti" (most commonly used), but might also be called "Nez Long" (locally). It is important note 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 characteristics (Ottenwalder 1991). According to the measurements analyzed is this study, the southwestern Haitian 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.

Solenodons are endemic to the Greater Antilles and are the most ancient representatives among the known native mammals of the West Indies.

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* (see photo, page 171). 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 ranges 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 and 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 is bare at the tip, with nostrils opening laterally. The skull is elongated, with a somewhat tubular rostrum. The foreclaws are well developed, and are 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 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 in the presence of a deep and rather broad groove, at the base of which end the ducts of the large submaxillary glands. The function of this groove is to conduct toxic saliva into a wound on prey, predators, or adversaries.

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 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, coarser hairs are scattered and arranged in single rows.

There is little information on the habitat of solenodons in Haiti.

Color varies from buff to blackish or reddish; it is 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 variation 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° 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 diagnosis 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.

Predation from exotic mammals, particularly dogs, is one of the known major causes of mortality, and therefore, for Solenodon decline.

Feeding habits. Solenodons are food generalists and opportunistic predators of the forest floor. They feed on leaflitter 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 likely be 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.

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 ground. 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 simply 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 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 borrow. They are, however, out-competed by the much faster introduced carnivores, such as dogs and cats, against which solenodons have few defenses.

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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. In addition to feces and urine marking, Solenodons 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.

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. Their low reproductive output is matched to a rather long life span of up to 12 years.

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Fossil and Historical Information

Little 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 Saint Fransisque, St. Michel de L'Atalaye (FMNH-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 (FMNH-VP Collection).

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, 1989b, Ottenwalder, 1991, FMNH-VP Collection). A carcass was reportedly found by Sanderson (1939) in 1937 near Fonds Parisiens, on the south shore of the Lake 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, 1983c) 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.

After searches in the 1970s covering all regions of the country, Solenodon was considered by Woods "functionally extinct in most of Haiti."

Massif de La Hotte's vestigial population is apparently confined to a 5-10 mile radius around the town of Duchity (see map, page 195), 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 Deron 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. Frequently, 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.

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, human populations are high and depend on traditional agriculture and forest harvest methods. Here, solenodons are killed and eaten when encountered, both by people and by feral dogs. Evidence of cooking and cutting blades is noticeable in the bones of animals examined from that area. Because of their low densities, exploitation of solenodons 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 using 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 past administration. As a result, its role as the government wildlife authority and wildlife enforcement agency presently appears to be in much disarray. Despite any well-intention efforts, effective enforcement by the government wildlife office in Haiti is hampered by insufficient material and human resources, which reflects the poor political support natural resource management policies have in this country.

In Haiti, *Solenodon* is not protected by any legislation, and native mammals are not covered by existing wildlife regulations.

Protected Areas. No living populations are known inside protected areas in Haiti. Pic Macaya have been considered one of the strongholds of *Solenodon* in Haiti (Woods, 1982c). 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 Hait: National Park Pic Macaya, and National Park La Visite (Woods, 1986). In the Macaya region, the most likely *Solenodon*-like habitats have been already devastated (i.e., Les Platons, 635 meters; Su Bois, 970 meters). To a lesser

extent, the same is true for the Duchity region (i.e., Catiche, Plaine Martin).

An impressive list of human disturbances, incompatible with the national park criteria, threatens the integrity of existing habitats and wildlife inside protected areas in Haiti (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.

Slash and burn, steep-slope crops farming, fuelwood 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 signs 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 the 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.

Successful recovery of Solenodon requires resolution of problems at a number of levels, beginning with their effective detection in the wild.

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 and 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.

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 is habitat vulnerability to human disturbance.

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 is 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 over a period of 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 were 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.

Many extinctions occur because species are driven inexorably to lower numbers. At very low population numbers, any one of several intrinsic or extrinsic factors can lead to extinction.

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; that is about 1.8 solenodons recorded per year. During the same time interval in the same areas, remains of at least 95 (5/year) Hispaniolan Hutias (*Plagiodontia aedium*) were secured using identical search methods and efforts. These data suggest a ratio of almost 3 *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.

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* has gone through a number of local extinctions since the arrival of western men 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 their 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:

Available information suggests that, in Haiti, *Solenodon* has gone through a number of local extinctions since the arrival of western men 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.

a) How much longer (length of time) will they 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 idealized population is one in which all individuals mate randomly, each sex have 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.

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.

Lack of information concerning population size and genetic variation for any of the known surviving population of *Solenodon* in the wild, however, prevent 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

Objective

To ensure immediate survival of the Haitian *Solenodon* by:

(1) Establishing the location of existing populations and their habitats;

(2) Establishing 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) halting 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 its distribution. If possible, surveys should also be conducted in the Massif de la Selle, particularly Morne d' Enfer, to determine whether *Solenodon* still survives 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 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 additional management activities which could 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 its 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.

With this objective, 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 potential areas with 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 that would be required for eventual translocation efforts in the future.

The protected area should be selected on three basic criteria: on the confirmed existence of populations, on 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 as a result of soil compaction caused by grazing livestock.

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 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 boundaries and to delimit the extent of the area being protected, as well as a deterrent to 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 natural, vandalic, or accidental 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 strategies 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 ap-

propriate, *Solenodon*-safe methods. These areas should be fenced and monitored to insure 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 their 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. Relationships of protected area staff with police and army militias should be cordial enough, though not excessive, to prevent involvement or association of the protected area with changing administrations in Port-au-Prince, which has been a significant problem in the last six years.

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.

Their endangered status 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 develop for all procedures requiring the trapping, capture, handling, and tranquilization of 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 examining of free-living animals to determine seasonal presence and habitat preference of pregnant females in the population, 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 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 Northern 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. It would be successful only if 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.

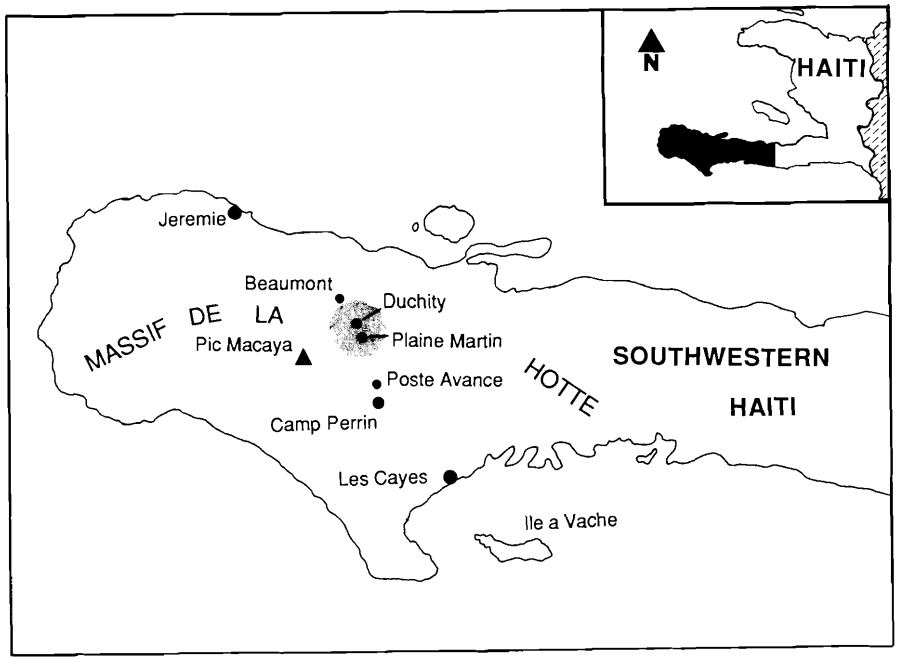
Until now, all past efforts to establish viable populations of *Solenodon* in captivity have failed. Mortality has been high and only one captive-bred young has ever been recorded. Techniques and protocols for captive propagation should be developed as soon as possible.

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.

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

RECOVERY PLAN FOR THE BLACK-CAPPED PETREL



The Black-capped Petrel was formerly widespread in the West Indies, but is now restricted to the highlands of Hispaniola and Cuba.

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, 1978; 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 "Chat 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.

Today the Black-capped Petrel is believed extirpated in Jamaica, Guadeloupe and Dominica (and perhaps also in Martinique).

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.

In the Massif de la Hotte, where petrel colonies were unknown, a breeding colony was discovered on the south-facing cliffs of Pic Macaya, and a second possible colony was discovered on the northwest face of Pic Formon.

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 Foret 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.

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).

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.

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.

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.

The nesting habitat of Black-capped petrels in Haiti is confined to steep, virtually inaccessible areas.

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.

Petrel breeding colonies occur only 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

Black-capped petrels are nocturnal at breeding sites, and breeders presumably return to the same site each year.

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.

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.

Nesting takes place during the winter months. Eggs are laid mostly during January and February. A single white egg is laid.

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 (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).

Introduced mammals, both feral and wild, have been repeatedly blamed for the partial decline of petrel populations in Jamaica, the Lesser Antilles, Bermuda, the Galapagos, and Hawaii.

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, 1928; 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, 1983), 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 has decreased the value of remaining nesting habitat and has increased 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, 1987). 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.

Other potential threats to the petrels and their breeding colonies in Haiti include soil erosion and subsequent landslides as a result of deforestation due to wood harvest and fires on their actual nesting sites.

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 landslides 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.

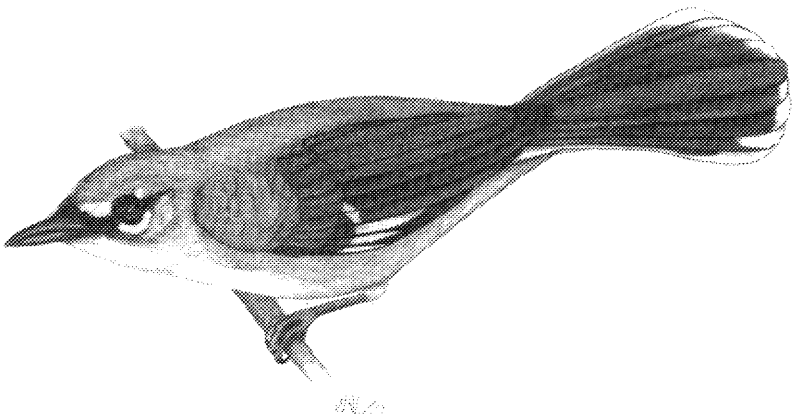
4. **Conduct natural history studies.** Little is known of the natural history of Hispaniolan petrels. Information about their reproduction and ecology is fundamental to the success of the recovery plan.

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.

RECOVERY PLAN FOR THE WHITE-WINGED WARBLER



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 (1978), and vulnerable by Stockton de Dod (1987).

Taxonomy

The White-winged Warbler is endemic to Hispaniola and is one of the few endemic species of warblers of the West Indies.

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).

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.

White-winged warblers are unknown from most of Haiti. Historically, they appear to have been restricted to the southern peninsula, where the species was apparently common and more widely distributed early in the century.

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.

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-12:00 PM) 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.

Today, the White-winged warbler is the most endangered species of bird in Haiti.

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*.

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.

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*. 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

White-winged warblers appear to be a species of low resilience, whose population levels are very sensitive to habitat disturbance.

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.

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.

White-winged warblers appear to be very rare and endangered in Parc National Pic Macaya, and they may have already been extirpated in Parc National La Visite.

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.

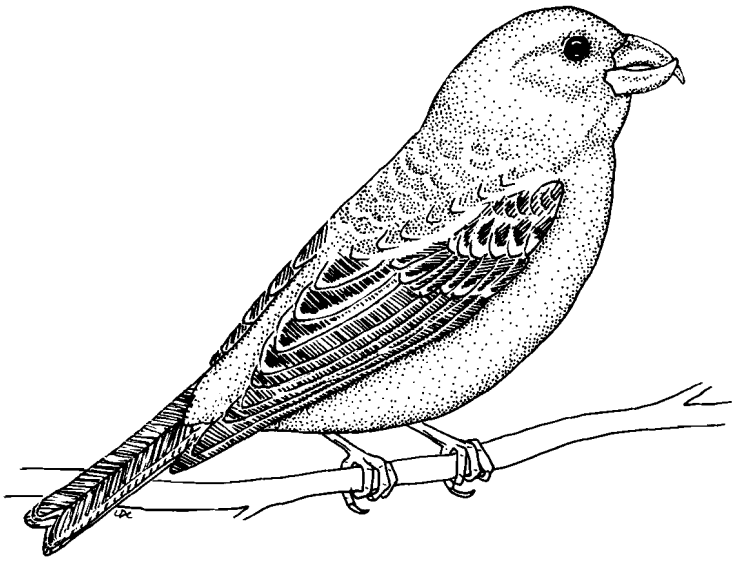
   4.2 **Investigate the feeding habits.** Foods habits should be determined. Basic food items need to be known in order to provide for habitat management to maintain and enhance food prey, and to determine if food availability a limiting factor to the population growth or dispersal.

   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.

RECOVERY PLAN FOR THE HISPANIOLAN CROSSBILL



INTRODUCTION

Taxonomy

The Hispaniolan crossbill is known only from the Dominican Republic and Haiti.

The Hispaniolan crossbill is known only from the Dominican Republic and Haiti (Hispaniola). It was described as *Loxia megaplaga* by Riley in 1916, from specimens obtained at El Rio, in the Cordillera Central of Dominican Republic. Wetmore and Swales (1931) accorded *megaplaga* full specific rank, in view of morphological differences and geographic separation from other White-winged crossbills, but it has been considered (AOU 1957, 1983) an isolated resident subspecies of its closest relative, the North American White-winged crossbill (*Loxia leucoptera*). However, recent studies by Benkman (MS) indicate that the Hispaniolan population should be recognized as a distinct species on the base of morphology and foraging ecology. In agreement with Benkman (MS), the Hispaniolan crossbill is acknowledged here as a distinct, endemic population of Haiti and the Dominican Republic, and will be referred to in this recovery plan as *L. megaplaga*. Isolation in Hispaniola presumably dates back to at least the Pleistocene (Wetmore and Swales, 1931).

Description

The Hispaniolan crossbill is approximately 6" (150 cm) in total length. The species is easily distinguished by the crossed mandibles and two white wing-bars. The males are rosy-red coloured, with blackish tail and wings, whereas the females are chiefly dusky, with the rump and underparts washed with greenish yellow. Subadults are blackish above, streaked with whitish; wings and tail are as in adults, and underparts are whitish with blackish streaks.

L. megaplaga, also called White-winged crossbill, is known in Haiti as Bek Kwaze, Bec-Croise, and Gros Bec; in the Dominican Republic it is known as Pico Cruzado, Periquito, and Turquesa.

Historical Range

Historically, the Hispaniolan crossbill has been recorded relatively few times, mostly in the Dominican Republic (Cordillera Central only). In Haiti, the species has been recorded only once and from one region, Morne la Selle on April 1927, when it was collected by Wetmore and Swales (1931), who also found bone remains of the bird in owl pellets in a nearby sinkhole known as Trujin. A flock of birds seen flying above pines in the same area were suspected by Bond (in Wetmore and Swales, 1931) to be crossbills, but he was not certain.

In the Dominican Republic, crossbills were collected early in the century in the Cordillera Central at El Rio above Jarabacoa during the fall of 1916, in Loma Rucilla in February-March of 1917, and in Loma La Pelona in March, 1917 (Wetmore and Swales, 1931).

Present Distribution

The known present range of *L. megaplaga* in Hispaniola includes Cordillera Central and Sierra de Baoruco in the Dominican Republic, and the Massif de la Selle and the Massif de la Hotte in Haiti. Attempts to find the species in Sierra de Neiba (Dominican Republic) have been unsuccessful (Bond, 1976).

The known present range of the Hispaniolan crossbill includes the Cordillera Central and Sierra de Baoruco in the Dominican Republic and the Massif de la Selle and the Massif de la Hotte in Haiti.

In the Massif de la Selle, four crossbills were seen near Furcy by D. N. Mirecki on 26 August 1976 (Bond, 1980). Woods and Ottenwalder (1986) recorded Hispaniolan crossbills on Morne La Visite between 1982 and 1985. Crossbills were first observed in the Massif de la Hotte in 1984. Two flocks of 12-15 birds were recorded by Woods and Ottenwalder (1986) on the top of Pic Macaya in January of 1984 and 1985, and in Pic Formon and the saddle between Pic Formon and Pic Macaya in November, 1985. How-

ever, the breeding status of the species in this latter mountain range is uncertain.

Status

The Hispaniolan crossbill has never been common. In the Cordillera Central, where all known specimens in collections except one have been collected, Wetmore and Swales (1931) considered crossbills "local in occurrence" and "numerically probably not abundant" during a search for the species early in the century. In late February, 1988, Benkman (MS) observed only four birds during a three-day hike (50 km) between La Cienega and Pico Duarte, the same area where R. H. Beck collected 31 specimens in 1917 (Wetmore and Swales, 1931). Benkman (MS) saw no crossbills in this same area in late January, 1991. Only three crossbills were observed by Ottenwalder (1988) during bird surveys conducted between 7-13 July, 1988 across the Cordillera Central, from Sabaneta (San Juan Province, on the south) to Moncin (in the north), including the National Parks Jose del Carmen Ramirez and J. Armando Bermudez. In Sierra de Baoruco, Benkman (MS) found only four crossbills after a three-day search for the species in January, 1991. In 1989 and 1991, Benkman (MS) recorded a total of eight crossbills in about 150 kilometers of trails surveyed through pine forests, concluding that the species is very uncommon even in the most productive pine forests.

In Haiti, Woods and Ottenwalder (1986) recorded only five crossbills in fifty hours of walking transects in Morne de la Selle. The total crossbill population of Hispaniola has been recently estimated by Benkman (MS) as 570 individuals.

Hispaniolan crossbills are restricted to discontinuous areas of mountain forests of *Pinus occidentalis*, a fire-adapted endemic species.

Habitat

Hispaniolan crossbills are restricted to discontinuous areas of mountain pine forest, *Pinus occidentalis*, a fire-adapted endemic pine species, usually found at high elevations in the Dominican Republic and Haiti (Kepler et al., 1975). Riley's type specimen was collected at 1,250 meters, and all other known collecting localities in the Cordillera Central and la Selle are at 1,500 meters (Wetmore and Swales 1931). In Sierra de Baoruco, it has been found at 1,600 (Stockton de Dod, 1978) and 1,475 meters (Kepler et al., 1975). Mid-elevation pine forests between 850 and 2,300 meters (Subtropical Lower Montane Wet Forest life zone) are probably the best cone-productive pine habitat for crossbills (Benkman MS). Kepler et al. (1975) described the habitat at a disturbed site in

Sierra de Baoruco as open *P. occidentalis* forest; where the canopy was approximately 20 meters high, with a 0-3 meter understory of bracken fern (*Pteridium aquilinum*), herbs, and pine-duff. At slightly higher elevations, the pines merged into denser moist limestone forest, and only smaller trees remained, as the area had been logged. In southern Haiti, Woods and Ottenwalder (1986) recorded crossbills only in areas of mature pine forests.

Life History

Little is known of the natural history of Hispaniolan crossbills. In part, observations about their biology have been prevented by their low densities. Like other crossbills, the Hispaniolan species is nomadic, moving in small flocks between patches of localized food (Wetmore and Swales, 1931; Kepler et al., 1975; Benkman, MS).

Food and Feeding Behavior. The feeding ecology of *L. megaplaga* has been discussed by Benkman (1989, MS). The Hispaniolan crossbill is confined to pine forest because it is specialized for foraging on seeds in the cones of *P. occidentalis*, and presumably because it is unable to compete with other species for other types of food. Availability of *P. occidentalis* seeds varies during the year as well as between years. Pine cones begin opening between January and March, although some seeds remain in the cones into the summer. Hispaniolan crossbills probably forage on a given cone crop from July or August, when the seeds and cones are still developing, until the following July when most of the seeds have been shed. Between September and December, seeds in the closed cones are relatively difficult to extract, and from June to August only a few seeds remain in the cones, and seeds in developing cones are difficult to extract. Because few seeds remain in the cones more than a year, crossbills need to find a new cone crop each year. Locally, *P. occidentalis* produces a good crop about every three years, but good cone crops are usually followed by two years of small or no cone crops. This annual variation in cone production and occasional cone failures requires crossbills to find new cone crops most years. Cone production does not fluctuate in synchrony among all areas due to the elevational gradients in temperature and rainfall in the large Hispaniolan mountains, promoting asynchrony in cone production; otherwise most crossbills would starve in some years. However, Benkman (MS), who found very few cones, seeds, and crossbills in January 1991 in three different areas of the Cordillera Central, has pointed out that cone failures may be extensive in Hispaniola.

Little is known of the natural history of Hispaniolan crossbills. In part, observations about their biology have been prevented by their low densities.

Nesting. Information about of nesting of crossbills is only known from a single nest recorded at Sierra de Baoruco, Dominican Republic (Kepler et al., 1975). The pair was first observed carrying nest materials on 2 April, at which time the nest was a flimsy open platform of loosely-woven pine twigs, foliose lichens, and Old Man's Beard lichen (*Usnea* sp.). The nest was situated approximately 15 meters high in a 20-meter pine, and was located about 3 meters from the trunk needles in a area where branches and clusters of pine needles partly obscured it. While searching for nest materials, the pair remained in close proximity, although the female undertook the greater share of the work. In size and shape, the nest of the Hispaniolan crossbill appears to differ little from that of North American white-winged crossbills, *L. leucoptera*. Benkman (MS) recorded a female regurgitating pine seeds to a fledgling in March, 1988. In Hispaniola, crossbills begin nesting in January, when pine cones begin opening, and may continue nesting until May (Wetmore and Swales, 1931; Kepler et al., 1975; Benkman, MS).

Predation, Diseases, and Parasites. There is little information concerning predators, parasites and diseases of Hispaniolan crossbills. Remains of *L. megaplaga* were identified in pellets of the Hispaniolan Barn owl (*Tyto glaucops*) from a sinkhole on Morne de la Selle (Wetmore and Swales, 1931).

Reasons for Decline and Present Threats

Destruction of pine forest habitat appears to be the major cause of decline of the Hispaniolan crossbill in both Haiti and the Dominican Republic. Despite protective legislation, extensive areas of mature pines have been devastated in these two countries by indiscriminate logging, clear-cutting, and both vandalic and unintentional fires. Long-term exploitation of these forests has resulted in a drastic reduction of the former range of the native pine in the island. Mid-elevation pine forests in the Subtropical Lower Montane Wet Forest life zone (between 800 and 2,300 meters) is probably the best habitat for crossbills (Benkman, MS) but it has been seriously affected by shifting agriculture in the Dominican Republic (Hartshorn et al., 1981) and Haiti (Ehrlich, 1985).

Destruction of pine forest habitat appears to be the major cause of decline of the Hispaniolan crossbill in both Haiti and the Dominican Republic.

Furthermore, introduction of exotic pine species (e.g., *P. oocarpa*, *P. caribea*) as reforestation alternatives for the native *P. occidentalis* represents an additional threat to the survival of crossbills. Benkman (MS) has pointed out that although Hispaniolan crossbills may at least occasionally forage on *P. oocarpa*, it is doubtful that *P. oocarpa* would provide a sufficiently reliable seed crop to support Hispaniolan crossbills over the long term.

Like other island crossbill populations, Hispaniolan crossbills have specific requirements for their survival. They appear to be a species of low resilience, whose population levels are very sensitive to habitat disturbance. Crossbills will fluctuate in abundance depending on the size of cone crops, increasing in numbers during years of large cone crops and declining in years of extensive cone failures (Benkman, 1989, MS). Extensive cone failures could cause crossbills to become highly vulnerable to extinction. Furthermore, the severity of cone failures will increase as the geographical and altitudinal ranges of mature cone-producing pine forest decrease.

Conservation Measures Taken

The cutting, transport, and selling of wood is regulated by legislation passed by the Haitian Government in 1955 and 1962. After ratifying the recommendations of the Convention for the Protection of Nature and Wildlife Preservation in the Western Hemisphere, hunting was regulated in Haiti and nine categories of birds were protected by a decree enacted in 1971. It is unclear, however, whether the Hispaniolan crossbill is listed or not. Unfortunately, none of this legislation is known to be effective or enforced.

A decree passed in 1983 created the first protected natural 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 pressures inside the parks, and continued political instability in Haiti represent the major challenges for the future of protected areas in this country. Crossbills are uncommon in La Visite and Pic Macaya National Parks, but their breeding status is still uncertain in the Massif de la Hotte.

Crossbills fluctuate in abundance depending on the size of pine cone crops, on which they forage. Numbers increase during years of large cone crops, and decrease in years of crop failures.

RECOVERY

Recovery Objective

The primary objective of this recovery plan is to restore the Southern Haiti Hispaniolan crossbill 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 *L. megaplaga* is poorly known. In order to attain the recovery plan objective, data is needed on the ecology and life history of the Hispaniolan crossbill, 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 in southern Haiti of an annual average of 500 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 in obtaining basic data on pine cone productivity and crossbill population ecology.

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.

Extensive cone failures could cause crossbills to become highly vulnerable to extinction. And, the severity of cone crop failures will increase as the ranges of mature cone-producing pine forests decrease.

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 Hispaniolan crossbill may become extinct in the wild.

Recovery Narrative

1. Determine status of the population

Recovery of the Hispaniolan crossbill 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 Hispaniolan crossbills have been known since their discovery. Present numbers are reportedly very low throughout Hispaniola. 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 Hispaniolan crossbill 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 Pic Macaya National Park to determine if the species is indeed breeding in this protected area and mountain range. It is of great concern that a management plan be 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 Hispaniolan crossbills should be analyzed as well. Efforts should emphasize the identification of which factors are currently limiting population size.

2. Determine status of the habitat and habitat requirements.

Information concerning the distribution, extent, and status of the habitat is fundamental to the recovery plan.

Furthermore, the habitat needs to be characterized in order to determine the pine successions that are essential to the Hispaniolan crossbill and should be preserved.

2.1 Document distribution, status, and amount of remaining habitat.

An inventory of the habitats in areas known to support populations of Hispaniolan crossbills should be carried out. Information concerning the present status of the habitat, including disturbance levels, successional stage of plant communities, potential threats, and sizes of forest fragments should be one of the priorities of the recovery plan.

2.2 Determine habitat requirements for the species.

The structure of habitats supporting Hispaniolan crossbills should be investigated. 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 for the Hispaniolan crossbill 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 mature pine habitats 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.

The remaining small population of Hispaniolan crossbills should be protected promptly. Habitat destruction or modification within Parc National Pic Macaya and Parc National La Visite should be prevented. Surveillance by park wardens should be increased in the 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 Hispaniolan

crossbill. New areas around the present habitat should be incorporated and protected immediately.

As a basic conservation strategy for the protection of the Hispaniolan crossbill, Benkman (MS) recommended that the probabilities of crop failures be reduced throughout remaining pine forests of Hispaniola. The present size of the two existing national parks of Haiti is probably too small to contain enough mature pine stands to maintain resident populations of crossbills. Additional protection of large tracts of mature forest over a wide range of elevations and geographic locations (e.g., la Selle and la Hotte in Haiti, and Cordillera Central and Sierra de Baoruco in the Dominican Republic) will be necessary to reduce the possibility of the crossbill from becoming extinct. Other techniques recommended by Benkman (MS) include the protection of the ridges radiating from protected areas, and protection of the areas that consistently produce the most cones and hence support the most crossbills (e.g., mid-elevation pine forests in the Subtropical Lower Montane Wet Forest life zone between 800 and 2,300 meters). Mature forests are important because they are more likely to produce a crop during a given year and older trees produce more cones than younger trees (Benkman, MS). Thus, mature pine forests should be protected immediately, disturbed pine stands should be allowed to regenerate, and regenerating pine forests should be allowed to mature.

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 Hispaniolan crossbill and its habitat in the national parks of Haiti.

4. Conduct natural history studies.

Little is known of the natural history of *L. megaplaga*. 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 to provide for the possibility of habitat management to maintain and enhance food prey, and to determine if food availability is a limiting factor to population growth or dispersal.

4.3 Evaluate the genetic variability of the population.

Evaluation of the genetic diversity of Hispaniolan crossbills 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 Hispaniolan crossbill. At present, information which is essential for the development of these models is not available.

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 Hispaniolan crossbill may become extinct in the wild.

It is unknown how many Hispaniolan crossbills 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.

CHAPTER VII

Project Summary, Action Plan, and View to the Future

1. Summary of National Parks and Biosphere Reserves in Haiti

The concept of protecting the natural areas of Haiti goes back at least to the law of 17 August 1955. The official creation of "Parcs Nationaux Naturels" was a decree published on 23 June 1983, which set aside "Morne La Visite du Massif de la Selle" (2000 hectares) and "Morne Macaya du Massif de La Hotte" (2000 hectares) in addition to eight sites selected as "Parcs Nationaux" and "Sites Naturels" in the decree of 18 March 1968. These ten sites, but most especially Parc National La Visite and Parc National Pic Macaya, represent the components of the national parks of Haiti. Since 1983, the Florida State Museum has worked on a contract with USAID to complete an inventory of Parc National La Visite and Parc National Pic Macaya, and to develop a management plan for each park, as well as for the national parks program. Between 1983 the parks were under the joint administration of ISPAN (then under the Institut National Haitien de la Culture et des Arts or INAHCA) and the Ministere de l'Agriculture, des Ressources Naturelles et du Developpement Rural (MARNDR).

A. Location

Parc National Pic Macaya. The area now designated as Parc National Pic Macaya is located 36 kilometers NW of Les Cayes and

195 kilometers W of Port-au-Prince at latitude 18 21' N and longitude 74 01' W. The park is situated around the two dominant mountains of the region, Pic Formon (2,219 meters) and Pic Macaya (2,347 meters) and includes the large and deep ravine between these two mountains that serves as the headwaters of the Ravine du Sud. The plain south of Pic Formon (Plain of Formon and Plain of Durand) are also included in the park as are the rocky (karst) hills along the southern boundaries of these plains.

The two high peaks tower above the surrounding plains (which are between 1,000 and 1,500 meters in elevation) and a series of mountain ridges, and receive moist air blowing inland from the Golfe de la Gonave to the north (via the northeast trade winds) or the Caribbean to the south (via sea breezes). The result is an area of extremely high rainfall (in excess of 3,000 mm/year). Parc National Pic Macaya is the source of four major rivers of southern Haiti (Riviere de Port-a-Piment, Riviere des Roseaux, Ravine du Sud and Riviere l'Acul). Extreme deforestation in the area affects the stability of these rivers, and the rich agricultural lands below (Cohen, 1984; Lowenstein, 1984). Parc National Pic Macaya serves the dual role of conserving the national patrimony by protecting numerous endemic species of plants and animals, and by protecting the watersheds of four of the most important rivers of Haiti which spread outwards from the park like the spokes of a wheel.

Access to Parc National Pic Macaya is difficult. The journey is via a route to the south from Port-au-Prince passing through Les Cayes, 196 kilometers west. Beyond Les Cayes the route is on a gravel road to Le Duc, and then a rough dirt road to Le Pretre, which crosses the Riviere l'Acul. Beyond Le Pretre, the route ascends to the plateau of the Plain of Formon by a series of sharp switchbacks to the town of Les Platons. The entire trip from Port-au-Prince is 129 kilometers, with the 33 kilometers from Les Cayes to Les Platons being the most difficult portion. Beyond Les Platons a new and very rough road has been constructed by the MBR project ten kilometers across the southern edge of the Plain of Formon to the location of the Park Headquarters at Caye Michel.

The area now designated as Parc National Pic Macaya is located 36 kilometers north west of Les Cayes and 195 kilometers west of Port-au-Prince at latitude 18 21' N and longitude 74 01' W.

Because access to the park is so difficult and the location is so distant from Port-au-Prince, we recommend that after the park is underway, an area of the upper Plain of Formon be leveled for a grass landing strip for small airplanes.

Parc National La Visite. The area now designated as Parc National La Visite is located 22 kilometers south of Port-au-Prince in the Massif de la Selle in the area of latitude 18 20'30" N and longitude 72 20' W. The park is situated along the crest of the Massif de la Selle between Morne d'Enfer (1,900 meters) and

Morne Kadeneau (2,155 meters). The highest spot in the park is Morne Cabaio (2,282 meters) on which there is a benchmark. The boundaries of the park have not been officially designated. The official (by decree) size of the park is 2,000 hectares. The natural boundaries of the plateau area of the park and the steep cliffs north of the La Selle Escarpment enclose an area of 4,500 hectares. The region of Morne d'Enfer is a natural extension of the park which includes uninhabited areas to the west of Morne La Visite and the existing boundary of the park along the mountain road from Furcy. This area should be included in the park because it serves as a reservoir for species and habitats that have been severely degraded in the eastern areas of the park. The combined area of Morne d'Enfer to Morne Kadeneau is an area of 6,300 hectares.

Access to Parc National La Visite is via the mountain highway from Port-au-Prince via Furcy and Ca Jacques. An alternative access route departs from Port-au-Prince and follows the route to the south on the road to Jacmel. Beyond Jacmel, the route passes through Marigot before ascending the southern slope of the Massif de la Selle to Marche Seguin which is near the southern boundary of the park. The route from Furcy passes through the park to join the route via Jacmel at Marche Seguin. The route via Furcy is 55 kilometers between Port-au-Prince and Parc National La Visite, and normally takes four hours to drive, while the route via Jacmel is 150 kilometers and over six hours driving time. Both routes are rough and the unpaved mountain sections are frequently damaged by heavy rains. The grade on the route by way of Furcy is abnormally steep. Improvements will have to be made to both of these routes before safe and regular access to the parks by visitors will be possible.

The area now designated as Parc National La Visite is located 22 kilometers south of Port-au-Prince in the Massif de la Selle in the area of latitude 18 20'30" N and longitude 72 20' W.

B. Purpose

The purpose of the national parks has never been clearly stated. The law of 17 August 1955 regulated cutting, transporting and selling wood, and the Rural Code of Francois Duvalier (28 May 1962) strictly controlled forest resources and activities in forest reserves. The decree of 23 June 1983 creating "Parcs Nationaux Naturels" lists eight park related responsibilities for MARNDR that can be summarized as:

1) protecting ecological conditions;

2) undertaking an inventory of plants and animals;

3) studying the characteristics of endemic species in relation to geology, soils, climate, etc.;

4) identifying areas having important ecological characteristics;

5) preserving national parks from physical deterioration;

6) supervising and working with the scientific community in studies in the parks and natural sites;

7) disseminating information concerning the parks and sites;

8) making the facilities of the parks available to visitors.

We have synthesized these statements, as well as our many conversations with personnel from the governmental and private sectors into the following list which we believe represents the purpose of the Parcs Nationaux Naturels program in Haiti.

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;

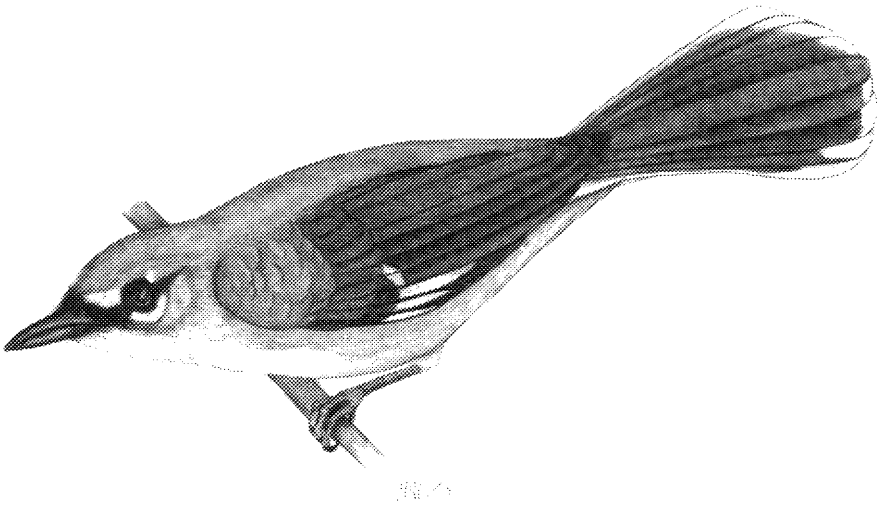
   B) the increased possibility that wise decisions of long-range importance can be made concerning the utilization and development of the natural resources of Haiti.

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 the 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.

C. Resources

The geological and biological resources have been surveyed and are discussed in detail in several places. First, they are presented as companion volumes to the Stewardship Plan of 1986. These reports were: 1) Geological setting; 2) Floristic study; 3) Butterflies; 4) Malacology; 5) Herpetofauna; 6) Birds; 7) Recent and extinct mammals. The natural features are also presented in *The Natural History of Southern Haiti* (Woods and Ottenwalder, in

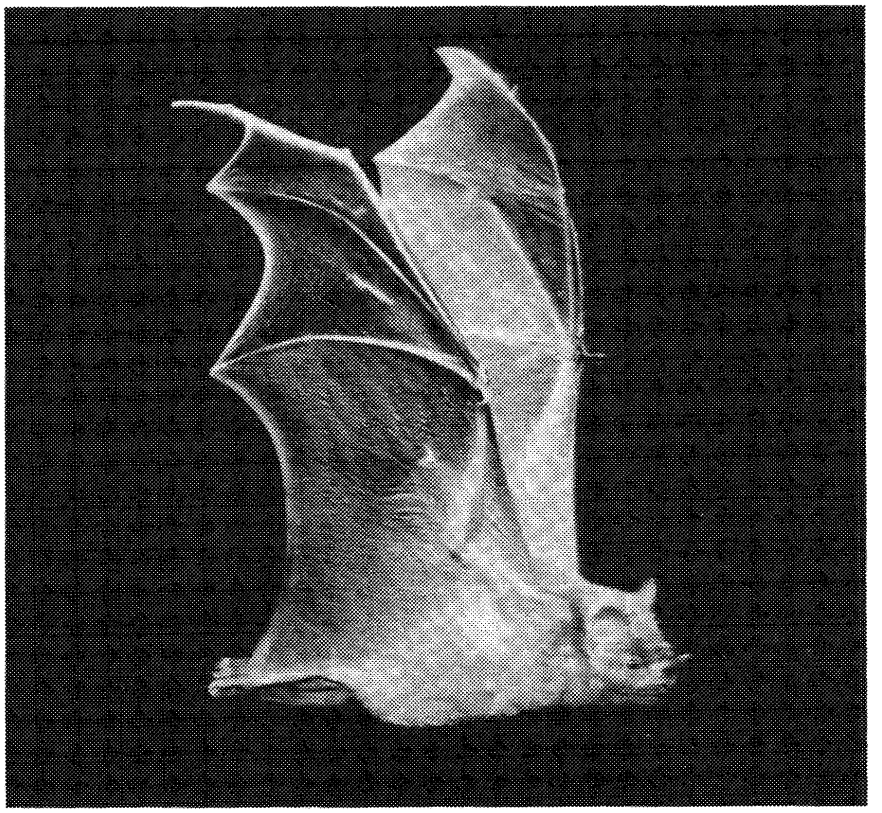
press). In summary, these reports indicate that the national parks are of great importance because they have so many unique features. The geology of both parks reveals details about the past of Haiti when it was more than one island and when the tops of the mountains were shallow marine environments. The great ravine of the Ravine du Sud between Pic Formon and Pic Macaya is part of an enormous fault that cuts across the southern peninsula of Haiti from Tiburon to the Cul-de-Sac plain. The floristic features indicate that Parc Macaya has 69 vascular plants that are endemic species, and Parc La Visite has 36 endemic vascular plants. The total vascular plant flora of Macaya includes 130 species that are endemic to Hispaniola, which is 28% of the flora of the park. Among flowering plants, the degree of endemism of Parc Macaya is even greater with 124 species endemic to Hispaniola (34% of total) and 68 endemic to the park itself, which is 19% of the flowering plants of the park. In La Visite, among the flowering plants, 85 species are endemic to Hispaniola (34% of total) and 35 species are endemic to the park itself, which is 14% of the flowering plants of the park. In terms of endemism, Macaya is more important than La Visite. The importance of Macaya is even more dramatically pointed out when just orchids are analyzed (orchids are not included in the previous lists). Of the 133 species of orchids known to occur in Parc Macaya, 38 are endemic to the Massif de La Hotte itself. Only twelve species of orchids were collected in Parc La Visite.



White-winged Warbler

There are 67 species of birds recorded from Parc National La Visite. 65 species of birds are recorded from Parc National Pic Macaya.

There are 67 species of birds recorded from Parc La Visite. Seventeen of these are endemic to Haiti, so 81% of the endemic birds of the country are found in La Visite. There are 65 species of birds recorded from Parc Macaya. Four important endemic



Jamaican Fruit-Eating Bat

species are missing from Macaya, so Parc Macaya is more limited in importance in terms of the preservation of endemic species than is Parc La Visite. Both parks have significant populations of the Black-capped Petrel. The most endangered species in both parks are the White-winged Warbler, the White-winged Crossbill, and the Black-capped Petrel.

Sixteen (94%) of the 17 species of endemic terrestrial mammals known to occur in Parc National La Visite within the last 3,000 years have become extinct.

There has been a great loss of mammals in Parc La Visite. Of the 17 species of endemic terrestrial mammals known to occur in the parks within the last 3,000 years, 16 (94%) have become extinct. The bats have fared almost as poorly. Eight bat species are known to have occurred in Parc La Visite, but only four still occur within the boundaries of the park, a 50% loss. In Parc Macaya, 17 species of endemic terrestrial mammals are known, but 15 have become extinct (88%). Fourteen bat species still occur in the park. Five species of bats of the Macaya fauna are vulnerable to extinction if caves are disturbed and habitat is destroyed (Morgan and Woods, 1986). The loss of endemic mammals in both parks is dramatic, but not unique. The average loss of endemic species throughout the Caribbean during the past 3,000 years has been 88% (Woods, et al., 1986). It is clear, however, that the loss in Parc La Visite is greater than the loss in Parc Macaya, and that La Visite is a very disturbed area. One species of mammal, the La Hotte Hutia

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(*Rhizoplagiodontia lemkei*) is restricted to Parc Macaya. An intense effort to find additional new species of mammals in the Macaya and La Visite areas was first thought to be unsuccessful, but during the past few months a new species of Solenodon has been found. This rare mammal is truly a living fossil. It is likely that five species became extinct in the last 30 years (Woods, et al., 1986), which is the period of greatest habitat loss in the Macaya area (Cohen, 1984).

D. Management

We have presented a detailed outline of our recommendations for the management of each park, and for the creation of a national parks system in this volume. We prefer the term stewardship rather than management since we believe the latter concept implies an active state of manipulation and alteration. Stewardship can be passive, and can allow the ecosystem to recover and maintain itself without extensive manipulation. Both parks are highly disturbed areas, however, and in the initial stages of creating the parks an active program will be necessary.

Zones

The zones of each park fall into two categories, each of which is divided into three areas. One zone is associated with specific activities, and requires constant attention and an active role by national park personnel and visitors alike. This zone is called the "Designated Use Zone," and it is subdivided into the following areas.

We use the term stewardship rather than management, because the stewardship can be passive, allowing the ecosystem to recover and maintain itself without extensive manipulation.

1) "Recreation Areas" are where visitors can camp, hike, observe scenic vistas and enjoy special features of the parks. These areas are designated for each park on the maps and text of the "Stewardship Plan."

2) "Education Areas" are where national parks personnel have created a special enriched environment to educate visitors about the special features of the parks. These areas include nature trails, special signs at designated locations, site exhibits and the public areas of the Park Headquarters.

3) "Maintenance and Service Areas" are where national parks personnel work and store equipment and supplies necessary to improve the quality of the park. These areas include the work areas near the Park Headquarters, the depots where equipment is stored, the security areas where guards work, the living quarters of the Park Headquarters, the stables and facilities for

horses, mules and donkeys used in the functions of the park (tourism included), the garages and shops associated with the vehicles and machines.

The second zone of the parks is associated with restricted activities, and is called the "Limited Visitation Zone." The primary goal of activities in this zone is conservation of the soil, water, flora and fauna. The largest and most important region of this zone is the "Biological Preserve Area." No exploitation of any kind should be allowed in areas so designated. When areas are of potential importance to the conservation of specific organisms, soils or watersheds, but are currently degraded, then an active role is required to restore the habitat to a condition where it can be regarded as a Biological Preserve Area. These areas, each of which will be designated as a "Restoration Area," are where active management is necessary with the long-range goal of improving quality so that future management will not be necessary. The last area of the Limited Visitation Zone is where research is permitted on a limited and carefully controlled basis. This area should be distinct from Biological Preserve Areas, and is designated as a "Research Area."

All of these zones and areas are discussed in the text of the Stewardship Plan.

E. Construction Controls

The construction of all structures, trails and signs should be supervised by a central office of the national parks program where a record is kept of all construction activities. A central file in the Park Headquarters should contain work plans, information on costs and photographs of completed projects. A routine inspection of all projects in the parks should be completed by the Director at least once a year, and on a regular basis by each Park Supervisor.

The construction of all structures, trails and signs should be supervised by a central office of the national parks program where a record is kept of all construction activities.

F. Roads

Clearly, access to the parks is an important feature, and these roads must be maintained and improved before an active tourism program is possible. Great care must be taken in the improvement of the Parc Macaya access road, however, since a good road would open the region up and remove the last barrier--isolated location--to the exploitation of the interior of the Massif de La Hotte. We do not recommend the improvement of this road until an active national parks program is in place with personnel committed to the supervision of all activities in Parc National Pic Macaya.

The existing road to and through Parc National La Visite is adequate for the present (but should eventually be improved). Additional roads are necessary to the camping facility and Park Headquarters. These roads can follow an existing rough trail and an old logging road. The old logging road should be upgraded to allow vehicles to pass to Tete Opaque. No roads should be constructed to Morne d'Enfer.

4. Administration

A. Suggested Annual Budget

The total budget for the national parks program over a five-year program includes: 1) set up costs for the Central Office in Port-au-Prince; 2) set up costs for each park; 3) signs; 4) exhibits; 5) publications; 6) training personnel; 7) research; 8) operating the Central Office in Port-au-Prince; 9) operating parks; 10) operating vehicles; 11) salaries in the Central Office; 12) salaries in parks. The total for these items over a five-year period is $2,514,790. We believe that research is a very important component of the implementation of a national parks program. Without research it will not be possible to write Species Recovery Plans for the endangered and threatened species of Haiti. The cost of the proposed research plan is $165,000 over a five-year period, or 6.6% of the total budget. Research projects also serve as effective ways to train the staff of Parcs Haiti. Personnel from the staff of the national parks program should work closely with all researchers, and that this should serve as an important part of the training process for all national parks personnel during the first five years. The staff should also participate in the publication process of the results of the research.

Access roads to the parks must be improved and maintained before an active tourism program is possible.

B. Routine Maintenance Schedule

A regular schedule should be established to insure communication between the parks and the central office in Port-au-Prince. The Park Supervisors should spend three weeks in the parks and one week in the central office. Within the parks a regular schedule should be established for the following components.

1. **Access Roads.** A work crew should be assigned to improve the quality of the access road to each park. After the roads are in suitable condition to allow safe and routine access to the parks, they should be "maintained" on a monthly basis to remove fallen rocks and to insure proper drainage.

2. **Trails.** The trails through the areas of each park where vegetation is dense, and especially in Parc Macaya where trails become overgrown with cutting bamboo *Arthrostylidium haitiense* and sharp spined blackberries *Rubus* spp., should be cleared every six months. In steep areas, care should be taken to landscape the trails at the same time to prevent erosion.

3. **Park Headquarters.** The Park Supervisor should develop a checklist for regular maintenance of the toilets, sinks, septic tank, cisterns, stove, refrigerator, propane gas and public quarters.

4. **Central Office.** The Director should develop a checklist for regular maintenance of all equipment, supplies and the building. The Director should delegate this authority to the Assistant Director for Administration.

5. **Vehicles.** The Director should develop a schedule to insure that all vehicles are maintained on a regular basis. Each vehicle should receive a thorough inspection every three months.

C. Infrastructure

The national parks "program" should be organized as a discrete unit with the ability to make decisions on policy, management and budget. All aspects of the park should be under the direct control of the Director.

The location of the national parks program within the structure of the GOH has never been clearly designated. We recommend that the best solution is to name the program **Parcs Haiti** and make no reference to a department, service or institute. Parcs Haiti should be a free-standing unit of the GOH under the supervision of a board of trustees designated as the **National Parks Advisory Council (PANAC)**. The organization of the program is diagramed below.

The national parks program should be organized as a distinct unit with the ability to make decisions on policy, management and budget.

National Parks Advisory Council (PANAC)
- Director of Parcs Haiti (Chairman)
- Director of ISPAN
- Director of Direction des Ressources Naturelles (MARNDR)
- Director of Office of Tourism
- Director Societe Audubon d'Haiti (SAHPE)
- Prominent Private Citizen
- International Representative

"Parcs Haiti"
Central Office
Component Parks and Natural Sites

The National Parks Advisory Council (PANAC) would be responsible for meeting with the Director of Parcs Haiti once a year, and assisting the Director to improve funding, develop long-range goals, and resolve points of conflict.

The actual administration of all aspects of national parks in Haiti should be the responsibility of the Director of Parcs Haiti.

The organization of Parcs Haiti can be accomplished in any one of three ways.

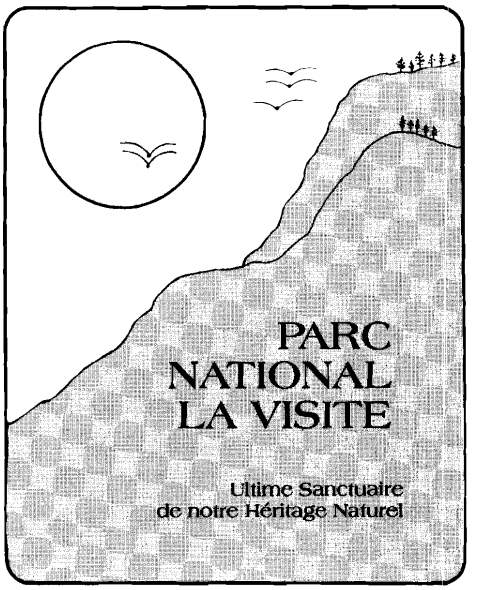
1). We recommend creating a new program within Haiti, which should be named **Parcs Haiti.** During the first year a Director, as well as a complete staff for each park (Park Supervisor, seven park guards, 15 park workers), and a complete office staff should be hired. The additional two positions (Assistant Director for Education and Recreation; Assistant Director for Conservation and Research) are important to the development of the parks and parks program, and require some technical abilities. If individuals with the interest and training for these positions do not exist in Haiti, then international personnel could be used to fill the positions on an interim basis (two to five years). The University of Florida, IUCN, Parks Canada, U.S. National Parks Service and World Wildlife Fund should be consulted for advice as to whom to hire. The University of Florida-Florida Museum of Natural History would be willing to coordinate this process.

2). The second possible way to create Parcs Haiti would be to contract out the complete operation of Parcs Haiti to an international organization concerned with conservation and national parks. This concept has the advantage of being able to draw upon the experiences of a group which specializes in national parks work, and it would allow a strong national parks program to quickly begin protecting the national parks of Haiti (which is very important). This group could also serve a valuable teaching function. The technique has the potential disadvantage of bringing foreigners into conflict with the GOH on sensitive environmental matters, and being perceived as imperialistic. On balance, we feel that this is a good idea and should be implemented if our primary recommendation is not possible. This organization should be under the supervision of the same National Parks Advisory Council (PANAC) discussed above. The IUCN, Parcs Canada, or the University of Florida-

Our primary recommendation for the creation of a national parks program in Haiti is the creation of an entity called "Parcs Haiti" with the authority and commitment to protect the natural patrimony of the country.

Florida Museum of Natural History are logical choices for this group. The group contracted to run the national parks program for a period of five or ten years could work closely with SPE.

3). The third possibility for creating Parcs Haiti is to allow the SPE to run the national parks program of Haiti under the World Bank Environmental and Forestry Project. If the WBP project starts up, then the funding and administrative structure are already in place. However, it will take a long time for SPE to achieve the technical skills necessary to run the national parks in Haiti, and we recommend that an outside NGO or international organization be employed to assist SPE. We also recommend that SPE use the name "Parcs Haiti" if it does assume complete responsibility of the national parks of Haiti.



Parcs Haiti could be a new governmental program; it could be operated through a contract with an international organization; or, it could be operated by the Service de la Protection de l'Environnement under the World Bank Environmental and Forestry Project.

Our primary recommendation for the creation of a national parks program in Haiti is the creation of an entity called "Parcs Haiti" with the authority and commitment to protect the natural patrimony of the country. Any of the three alternative ways of creating Parcs Haiti would accomplish these goals, and be able to implement a national parks program. The decision on which program to follow should be made as soon as possible. The decision should be made by a majority vote of the seven individuals discussed as the National Parks Advisory Council (PANAC) which can meet on a one-time basis to make this decision, or can become a permanent group advising the national parks program (Parcs Haiti).

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D. Personnel

The organization of Parcs Haiti is diagramed below.

PARCS HAITI
Director
Assistant Director for Education and Recreation
Assistant Director for Conservation and Research

Central Office
Secretary
Librarian-Secretary
Chauffeur
Commissar
Office Guardian

Parc National La Visite	Parc National Pic Macaya
Park Supervisor	Park Supervisor
Guardian Headquarters	Guardian Headquarters
Cook	Cook
Park Guards (7)	Park Guards (7)
Park Workers (15)	Park Workers (15)

E. Logistics

The Central Office in Port-au-Prince would coordinate all aspects of the program in national parks. All files, plans, publications, correspondence and budget information should be maintained there. The Director would interact upward with the National Parcs Advisory Council, of which he would be Chairman, laterally with other programs, and would supervise all activities of Parcs Haiti. The Assistant Directors will work with the Director and regularly tour the parks and make reports. The Park Supervisors will implement the directions from the Central Office and supervise the personnel in each park. The Park Supervisors should spend one week each month in Port-au-Prince planning and working with the Central Office staff. A radio communications network should exist between the Central Office and each park, and there should be regular discussions between the Park Supervisors and a designated person in the Central Office.

The Parcs Haiti Central Office would be located in Port-au-Prince. The Central Office would coordinate all aspects of the program in national parks.

The Director of Parcs Haiti should meet with the National Parks Advisory Council (PANAC) at least once a year.

5. Interpretation and Research

The programs in interpretation and research are two of the most important elements of the national parks program. Interpretation is the responsibility of the Assistant Director for Education and Research. Research is the responsibility of the Assistant Director for Conservation and Research.



Hispaniolan Hutia or "Zagouti" -- recommended national mammal

A. Interpretation

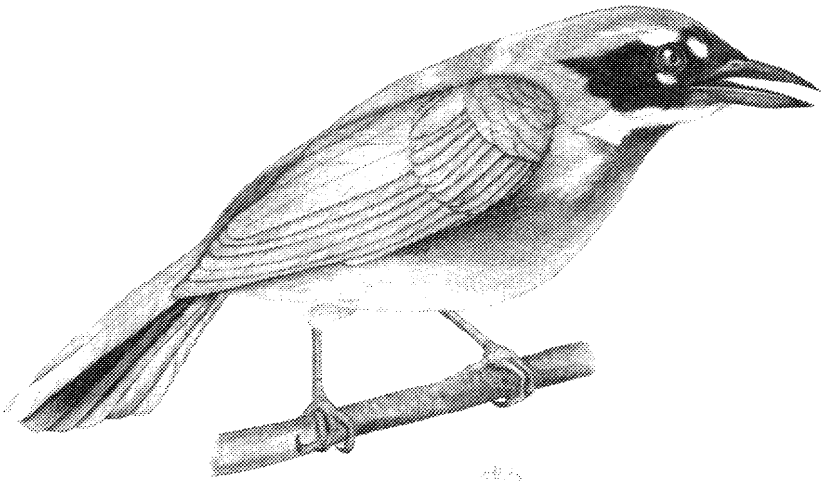
We recommend the following as part of a program in interpretation.

1. A series of temporary exhibits in the Central Office (year one).
2. Informative signs at entrance to each park (year one).
3. A brochure on the parks that promotes the most important features, provides a list of important species, discusses the rules of the park and the purpose and concepts of the parks (year one).
4. Four exhibits in the Park Headquarters at Morne La Visite (year two)
5. Two exhibits in the Park Headquarters at Macaya (year two).
6. Two permanent exhibits in the Central Office Park Headquarters (year two).
7. Nature trails with educational signs in each park as designated on the maps in the Stewardship Plan (year two).
8. Information signs at designated locations off the road beyond Furcy and along the road to Jacmel (year two).

The programs in interpretation and research are two of the most important elements of the national parks program.

9. Training the Park Supervisors to be interpretive naturalists (continual).

10. Developing a slide-tape presentation (French, Creole, and English versions) for use in informing the public of the national natural patrimony and the value of the parks (year one).



Grey-crowned Palm Tanager - recommended national bird

11. Designating national species, and promoting a better understanding of these species. We recommend the following.

a). The Hispaniolan Hutia = "Zagouti" (*Plagiodontia aedium*) - National Mammal

b). The Grey-crowned Palm Tanager = "Oiseau Quatre Yeux du Sud" (*Phaenicophilus poliocephalus*), **or** the Hispaniolan Trogon = "Calecon Rouge" (*Prioteles roseigaster*) - National Bird

c). The "Bwa Tromble" (*Didymopanax tremulum*) **or** the Hispaniolan Pine = "Bwa pen" (*Pinus occidentalis*) - National Tree

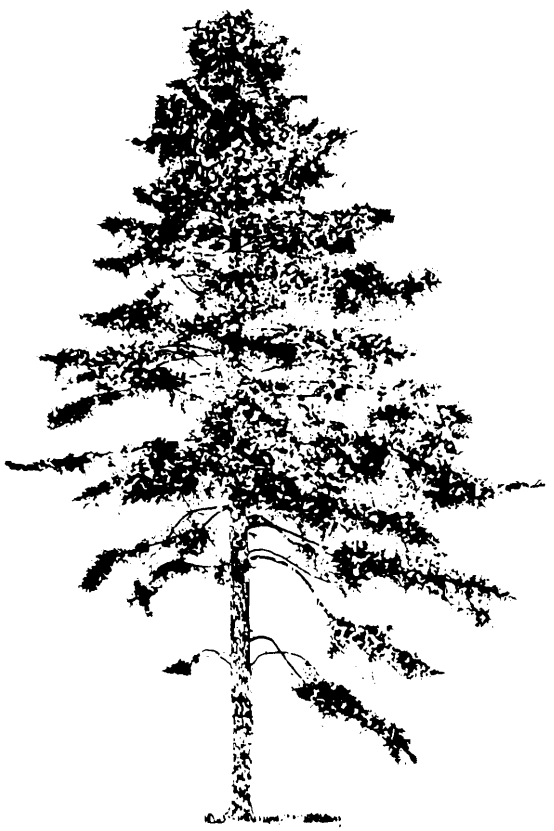
d). "Ti Crapo Morne" (*Eleutherodactylus wetmorei*) - National Frog

e). "Couleuvre Bois" or "La Madeleine" (*Uromacer frenatus*) - National Snake

f). "Tortue l'Etang" (*Trachemys decorata*) - National Turtle

g). Iguana (*Cyclura cornuta*) - National Lizard

Designation of national species can help to promote better understanding of Haiti's flora and fauna.



Hispaniolan Pine
Recommended national tree

d). Fuchia or "Belle Fleur Morne" (*Fuchia pringsheimii*) - National Flower

e). Karst topography = "Casse Dent" - National Geological Landscape

These important elements of the natural patrimony of Haiti can be promoted on postage stamps, in newspaper articles, and by conservation posters. They can also be topics of discussion in schools. Some are already portrayed on the "Connaitre et Proteger la Richesse Naturelle d'Haiti" conservation poster done by the University of Florida MBR project.

12. There should be a regular weekly newspaper feature on the national parks written by the Director of Parcs Haiti or by special contributors. This feature should be in a prominent place in at least one newspaper, and should also be featured in the English language "Haiti News."

13. Writing booklets on the special features of each park based on scientific results from inventories and on-going research projects (years two and three).

Research

Research is one of the most important elements of the development process for the national parks program. An active research program will generate data on which management decisions must be based. The research program will also provide data on the national natural patrimony (endemic species, many of which will be new). A third and very important aspect of the research program is that by actively involving the staff of Parcs Haiti in the research activities (field work, analysis, publications) one of the most important and difficult aspects of the training program is completed (i.e., training in specific topics) at the same time that data and publications are being generated. Research personnel can also be required to lead training sessions while they are in Haiti. The most important research goals are outlined below. The costs of these programs are listed in the budget sheet and in the Stewardship Plan.

An active research program will generate data on which management decisions must be based.

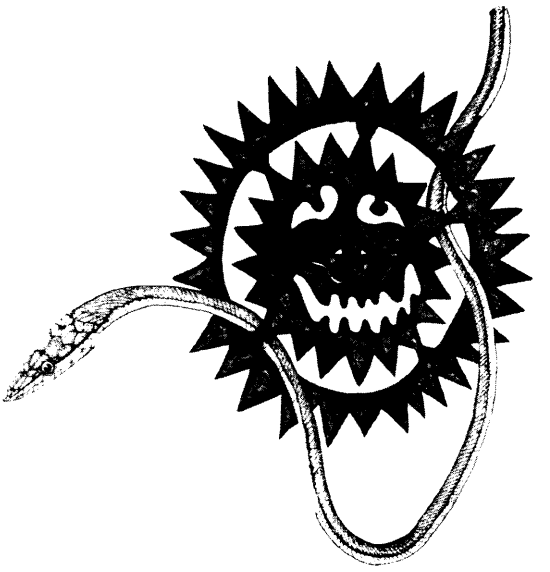
1. Publication of previous data from inventory (year one).

2. Research on the composition and requirements of the major plant communities (five-year study).

3. Research on the basic biology of the endemic mammals and endangered species (five-year study).

4. Biology of the Black-capped Petrel (three-year study).

5. Regular inventories of avifauna (five-year study).
6. Meteorological studies (five-year study).
7. Invertebrate faunal studies (five-year study).
8. Habitat requirements of herpetofauna (three-year study).
9. Publication of the above data (in year five).



"La Madeleine"
Recommended national snake

6. Park Headquarters and Stations

The facilities of the parks program are very important. Not only do they provide a working environment for Parcs Haiti personnel and colleagues, they also demonstrate the existence of a viable parks program. This is especially important within the boundaries of Parc National Pic Macaya and Parc National La Visite where the Parc Headquarters buildings, depots and outposts demonstrate that the parks are official and that authority exists in the region. Park facilities should be constructed at the earliest possible date (with existing funds, or in the first year of the new five-year budget).

The facilities of the parks provide the working environment for personnel; they also demonstrate the existence of a viable parks program.

Location

1) **Central Office.** This structure should be distinct from either ISPAN or MARNDR at Damien. It can be located in Port-au-Prince or Petionville. We feel it would be desirable to build a facility for the parks at the designated National Botanical Garden. The existing plans for the Park Headquarters could be modified as plans for the Central Office.

2) **Park Headquarters at Parc National La Visite.** This structure should be located near the cascade in the central part of the park above the campground. This location is in an attractive wooded area (Bois Cascade), and is central to all activities in the park.

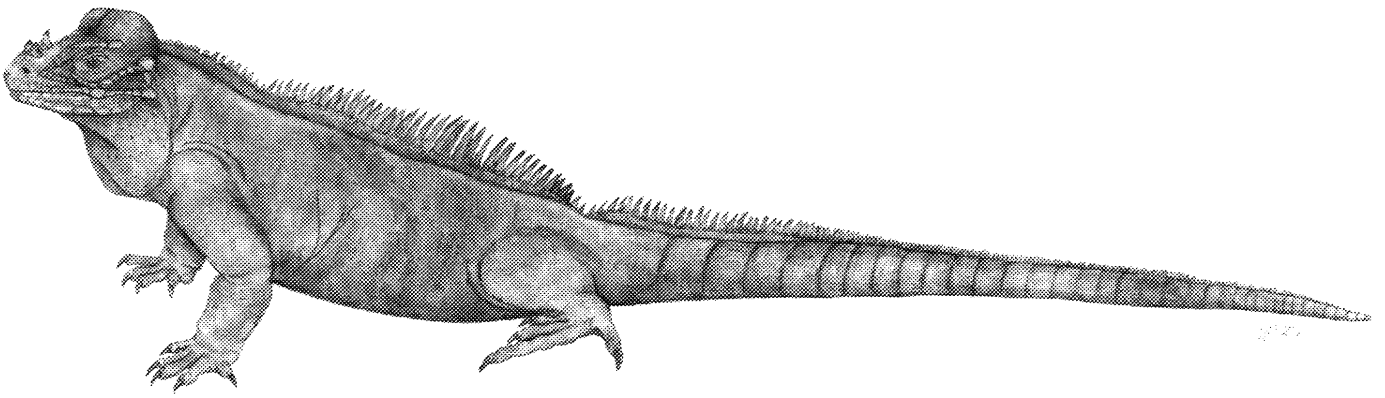
3) **Depots** and maintenance areas for Parc National La Visite will be in the existing buildings at the Scierie.

4) An existing caye can be rented or purchased at Tete Opaque as an **outpost.**

5) **Park Headquarters at Parc National Pic Macaya.** This structure has been completed as part of the MBR project. It is located at the edge of the Rak Bwa forest on the upper Plain of Durand. The name of this facility is Caye Michel.

6. **Depots** and maintenance facilities have been completed at Parc National Pic Macaya in the area of the Park Headquarters at Caye Michel.

7). An inexpensive caye should be constructed at 1,000 meters elevation in the ravine of the Ravine du Sud as an outpost. It should be modeled after Madame Robert's caye that the inventory team used (year two).



Iguana - Recommended national lizard

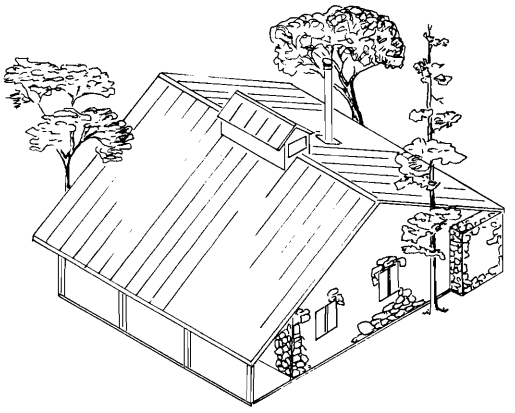
Parcs Haiti should make a special effort to improve the quality of life in the region around the parks in the Massif de la Selle and Massif de la Hotte.

8). An inexpensive caye should be located on the north side of the park near 700 meters beside the Riviere La Guinaudee. An existing caye can be rented or purchased. This caye would serve as an outpost.

9). An inexpensive caye should be located on the west side of the park near the end of the UNICORS/COSAR road in the valley of the Riviere Trois Sources. This caye would serve as an outpost for park guards, and would help protect the very vulnerable and important western side of Park Macaya from exploitation.

Type and Construction

The plans for a Park Headquarters have been drawn up and are available (submitted to INAHCA, MARNDR, and USAID on 17 December 1985). These plans can be used for the Park Headquarters at Parc National La Visite. The plans call for a basic stone or cement block structure with a large front porch and central room for public meetings. There are four rooms around the central room to serve as office, laboratory, living and depot space. In the rear of the building are rooms for cooking, eating and a bathroom. The water supply for the headquarters is via two 300 gallon cisterns that gather rainwater off of the rear roof of the building. This design is very flexible, and the function of rooms can change as the program grows. There is a loft for sleeping or storage. A variation of this plan was used by the University of Florida MBR in the design and construction of the Park Headquarters (Caye Michel) at Parc National Pic Macaya.



A Design for Park Headquarters

The Park Headquarters would provide office space for the Park Supervisor, a work room, a sleeping room for the Park Supervisor, sleeping space for visiting scientists and technicians, and a guest room for visitors from the Central Office.

The building should to be constructed out of rock or cement. Wood is used for the interior supports. The roof is metal. All materials are available at the site or in Port-au-Prince. A materials list is provided with the plans.

One of the main goals of the parks is to improve the quality of the environment and of the associated watersheds.

7. Integration of the Parks with Region

Parcs Haiti should make a special effort to improve the quality of life in the region around the parks in the Massif de la Selle and Massif de la Hotte. If the parks are going to be successful they must be viewed as being of local importance as well as in the national interest.

A. Jobs

The personnel from the parks should be hired from the region. The available jobs associated with each park are listed below. Regular jobs = R; Occasional jobs = I.

	Number of positions
1. Park Guards	7 (R)
2. Park Workers	15 (R)
3. Headquarters Cook	1 (R)
4. Headquarters Guardian	1 (R)
5. Other building guardians	3 (R)
6. Guides (estimate)	10 (I)
7. Special project workers (estimate)	10 (I)

Twenty-seven jobs will be generated in each region by the permanent staff of the parks. Additional jobs will be available as the Park Headquarters is being constructed at Parc La Visite, and during phases of reforestation. Jobs will also be generated as recreation and tourism increases. Some of the jobs will be as guides, while others will be associated with renting horses and donkeys to visitors and selling supplies. The amount of money in the region will increase because of regular salaries being paid to Parcs Haiti personnel, and more money means an increased demand for supplies. This will provide more jobs in the service sector of the region (store owners, farmers).

Since there has not been a tradition of natural science, conservation or national parks in Haiti, it is necessary and important to implement an active training program for all national parks personnel.

B. Watershed Management

One of the main goals of the park is to improve the quality of the environment and of the associated watersheds. This will have some impact on residents on the plains and along the rivers below the parks. More water will be available for human consumption and irrigation. The quality of the water will improve. The rate of soil erosion will decrease. The danger of flooding to inhabitants

living near rivers will decrease. All of these will be possible because major reforestation projects will be undertaken in each region.

C. Model Programs

The following model programs are proposed for the region of each park in association with Parcs Haiti.

1. Communal Firewood Forest Project.
2. Reforestation and Fruit Tree Propagation Program in cooperation with MARNDR and PVOs in region.
3. Technical Assistance Program coordinated by the Park Supervisors.
4. Local artisan, handicraft and recreation program coordinated by the Assistant Director for Education and Recreation.

8. Recommended Training Programs

Since there has not been a tradition of natural science, conservation or national parks in Haiti, it is necessary and important to implement an active training program for all national parks personnel. After careful reflection, we believe that the most cost effective and appropriate training program is for seminars and workshops to be conducted in Haiti. Each workshop or training session should last about two weeks and be conducted by a carefully chosen international individual or group. There should be four training sessions per year (every three months). These training sessions should take place in the Central Office and within the parks. There could be more frequent training sessions during the first year of the program, and fewer as the program develops.

The concept of a biosphere reserve is to promote a balanced relationship between people and the natural environment.

A. Individuals

Everybody associated with the parks should receive training of some kind. The nature and duration of the training are listed in the following table.

B. Location and Training

With the exception of the Director, who should be encouraged to participate in the international parks seminar, all training should

be in Haiti. In this way, specific training is possible and all staff of the Parcs Haiti program can receive some benefit from the instructors and training sessions. In addition, research biologists can be involved in the training sessions. This is economical, and encourages individuals to focus their training on the Parcs Haiti program rather than use the training as a stepping stone to a higher position in Haiti or to leave Haiti. It is important to create as much long-term stability in the Parcs Haiti program as possible.

C. Specific Courses and Topics

The need for specific topics will be identified with greater precision as the staff is hired and the background of the Parcs Haiti staff are known. At the initial stage we can identify the following topics which are of major concern.

National Parks Topics

1. History of National Parks and National Parks Policy
2. Biosphere Reserves
3. Administration of National Parks
4. Personnel Management and Decision Making
5. Financial Accounting and Data Management
6. Public Relations and Advertising
7. Museum Studies and Interpretation
8. Principles of Recreation and Tourism

Biosphere reserves consist of core areas surrounded by zones of cooperation or "buffer zones." Core zones are completely protected areas; buffer zones are areas in which a variety of resource uses may take place.

Research and Conservation Topics

1. Biological and Geological History of Haiti
2. Collecting Techniques - Botanical
3. Collecting Techniques - Zoological
4. Ecological Methods
5. Cartography, Photo Interpretation and Remote Sensing
6. Major Features of Haiti - Botanical
7. Major Features of Haiti - Zoological

8. Major Features of Haiti - Geological, Hydrological, Meteorological

9. Analysis of Data, Statistical Techniques and Publication Techniques

Some of these 16 topics can be combined into one training session, while others (such as "major features of Haiti") represent more than one training session. The training sessions can be organized as distinct one- to two-week workshops and seminars. All research staff should be required to present training sessions as part of their research activities, and to include selected Parcs Haiti personnel in specific aspects of their research activities.

9. Concluding Comments on Parcs Haiti and Biosphere Reserves

The concept of a "Biosphere Reserve" has been approved by UNESCO under the Man and the Biosphere Program (MAB). Biosphere reserves are examples of the major landscapes of the world complete with characteristic landforms, flora and fauna as well as the various patterns of human use and adaptation of the region. The concept of a biosphere reserve is intended to promote a balanced relationship between people and the natural environment. The emphasis in biosphere reserves is demonstrating the value and need for conservation and the link between wise land use policies and conservation and sustainable development. We believe that the concept of a biosphere reserve is very well suited to the nature of the national parks in Haiti, and we encourage Parcs Haiti to proceed with the implementation of a biosphere reserve program.

Biosphere reserves consist of core areas, which are lands already under some form of protection. In the case of Parcs Haiti, the core areas are Parc National Pic Macaya, Parc National La Visite (and the various sites listed in the decree of 23 June 1983). In biosphere reserves, core areas are surrounded by zones of cooperation, in which a variety of resource uses may take place, such as forestry, ranching, farming or tourism. In these zones, solutions to man-environment problems are sought by involving local people. This is often done by including selected local residents in the discussion process, often via a committee made up of Parks personnel and local residents. The zone of cooperation is analogous to the "Buffer Zone."

The concept of a national park surrounded by a buffer zone, as discussed in the Stewardship Plan lends itself well to the principles of a biosphere reserve, especially considering the complicated land

The World Bank Plan was designed to protect the natural resources of Haiti. The project has been suspended because of the unsettled political situation in Haiti.

use practices in and around the national parks and the need to resolve the problems of land use and land tenure in the region. This was the plan followed by the MBR project. We believe that the habitats of Parc National La Visite and Parc National Pic Macaya are unique and are worthy of inclusion in the biosphere reserve program of the world's major landscapes. In 1985, there were 243 biosphere reserves in 65 countries. Parcs Haiti should begin from its conception to organize the national parks program, and especially the two great national parks of Haiti as biosphere reserves. The idea could be to link them all into one big, multi-part biosphere reserve that would include both national parks and the freshwater lakes of the Cul-de-Sac Plain. This biosphere reserve, which could be called the Macaya La Selle Biosphere Reserve, has biological importance because this entire ecosystem was part of the old "South Island." Or, the Macaya Biosphere Reserve and La Selle Biosphere Reserve could be separate entities. From the biological point of view, uniting them together as the same biosphere reserve makes the most sense. Biologically and historically significant areas in northern Haiti could be grouped together in a second biosphere reserve, which would be named the Henry Christophe Biosphere Reserve. This distinction makes sense, since all of northern Haiti had a very different geological and biological history from southern Haiti.

View of the Future: The Proposed World Bank Project

The University of Florida Macaya Biosphere Reserve Project began in 1987 and was expected to continue through August, 1993. However, due to the political situation in Haiti, and the international embargo, the project ended on May 31, 1992.

In 1990, a plan was developed by USAID, UFMBRP, and the World Bank Environmental and Forestry Project to work together to assist Haiti in developing a first class environmental program. This plan was scheduled to begin in 1991. The World Bank Project was designed to protect the natural resources of Haiti. This project was planned to draw on the experiences of the University of Florida activities in Haiti, and to build on the programs developed in the national parks at Parc National Pic Macaya and Parc National La Visite as well as the planned Macaya Biosphere Reserve. The World Bank Project is still pending. It has been suspended--we hope temporarily--because of the unsettled political situation in Haiti. USAID, the University of Florida and MARNDR are working together to try to "bridge" the present transitional situation with a time in the future when programs such as the World Bank Project will make it possible to have a strong program in land stewardship and conservation in Haiti. The USAID is working to design an ongoing project in soil and water conservation in the Macaya area, and the University of Florida is working on a project in environmental education and wildlife conservation via a grant from the MacArthur Foundation. These activities are described in the next section of this chapter. The present section describes the planned

World Bank Environmental Project in detail. We hope that the project outline presented here will provide a clear picture of the possible future direction of programs in natural resources and environmental protection in Haiti.

The University of Florida Macaya Biosphere Reserve Project (UF-MBRP) has worked as a NGO contractor for USAID in the buffer zone south and west of Pic Macaya National Park, and in the southern half of the park itself. This project was initiated on October 1, 1987, and was originally expected to continue receiving funding from USAID through August, 1993. However, political guidelines of USAID have prevented the UF-MBRP from working in association with the Government of Haiti (GOH) for most of the life of the project, and the MBR project was not continued beyond May 31, 1992. The activities of the UF-MBRP include: (i) sociocultural inventories of the southern district of the park and adjacent districts (buffer zone); (ii) zoning the southern regions of the park and buffer zone; (iii) analysis of land use trends; and (iv) development of an agricultural and agroforestry extension program in the southern Macaya region. Since the GOH has the administrative responsibility for all state lands, and since Parc National Pic Macaya is on public domain state lands under the administrative control of MARNDR, the management of the Pic Macaya Project has been complex (and flawed). The situation is further complicated by the mission of the USAID project, which defines the geographical limits of its Targeted Watershed Management Project as south of Pic Macaya. The existing UF-MBRP, therefore, is technically only concerned with half of the existing national park and associated buffer zone.

The Proposed World Bank Project and the Environmental Protection Service

The Service de la Protection de l'Environnement (SPE) was first created by Administrative order in 1984, and was legally recognized by the "Conseil National de Gouvernement" Decree of 1987. The intention of the Division of Natural Resources (DRN) of MARNDR in creating the SPE was to place the supervision of all national parks in Haiti under the SPE, but this was not done at an earlier time because of a lack of resources and funding. However, the Forest Resource Service (SRF) assumed responsibility for the park at la Visite in 1988 instead of SPE, because SRF had funds available and SPE did not.

In 1990, at the time the World Bank Team was designing the project the SPE had three professional staff members (including the Chief). These three people were assigned to two sections:

The Service de la Protection de l'Environnement would use its role as the information center on renewable natural resources, and its trained staff and available data bases to constantly monitor and evaluate land use trends throughout the country.

a). Section on Research and Inventories;

b). Section on Preservation and National Parks.

The World Bank Project was designed to enhance these two existing sections, and to add one additional section:

c). Section on Cartography and Information Services.

The new section would be responsible for centralizing the data collected by the inventories, and the information collected by the other two sections, and making it available in the form of data bases and Geographic Information Systems (GIS).

One additional section of the SPE existed on paper, the Section on the Prevention of Pollution, but it did not have any staff members assigned to it in 1990. This section would not be enhanced as part of the World Bank Project.

Although two of SPE's three professional staff members have training in conservation and management of natural resources, the SPE does not have the financial resources and staff number necessary to initiate and complete an inventory of Haiti's fragile ecosystems, develop the decision making skills necessary to manage these fragile ecosystems, and supervise staff that would be assigned to remote locations in the existing national parks. As a result, SPE has not yet been able to assume full responsibility for the management of the existing national parks. It is important, therefore, that the SPE be strengthened as a Service so that it has the resources to assume all of its assigned duties in managing parks and protecting the environment.

Satellite imagery would be used to periodically monitor country-wide land use trends, and the distribution of ecosystems.

Objectives and Strategy of the Proposed World Bank Project

A. Objectives

The objectives of the environmental protection component of the World Bank Forestry and Environmental Protection Project are to strengthen the Service de la Protection de l'Environnement (SPE) to enable it to:

a). **Generate Data on National Land Use Patterns.** Data collected by aerial photography, satellite imagery, and ground survey teams would be used to evaluate land use trends, and to identify areas of special concern.

b). **Inventory Forest Resources on a National Scale.** Forest areas would be surveyed throughout the country to compile data on the forest resources, remaining areas of forest cover, the total available forest biomass, and the rate of deforestation.

c). **Identify New National Parks and Forest Reserves.** Data gathered by the land use survey and the inventory of forest resources would be used to identify candidate ecosystems for a new national park, as well as to identify forests which should be designated as forest reserves to be managed by the SRF.

d).**Manage the Two Existing National Parks and Create One New National Park.** The SPE would assume immediate responsibility for the management of the existing national parks at Morne la Visite and Pic Macaya, and would complete the activities necessary to add one additional national park to the system by year four of the project.

e). **Preserve Endangered Plant and Animal Species.** The SPE would compile data on threatened, rare, and endangered species, and establish a program to protect these species.

f). **Establish and Manage Databases on Renewable Natural Resources.** The SPE would enter the data from baseline sociocultural and environmental profiles of candidate ecosystems, as well as other data on the environment and the status of forest resources gathered in the course of the project, into various data bases for general access.

g). **Monitor Long-term Land Use Trends Throughout the Country.** The SPE would use its role as the information center on renewable natural resources, and its trained staff and available data bases to constantly monitor and evaluate land use trends throughout the country.

The forest types delineated on the satellite images would be sub-sampled to produce more specific information on the forest resources (crown cover, species, density, and biomass volumes).

B. Strategy

The above objectives would be achieved through the following project actions.

a). The SPE would be provided with offices and buildings (central office, Macaya field office, and la Visite field office), transportation, equipment, training, operating funds, and salaries (on a declining basis).

b). An internationally-recruited "Resident Ecologist" (as full-time consultant for 5 years) would assist the Chief of Service of SPE and other SPE staff members in the implementation of all programs assigned to the SPE. Short-term consultants would

be financed under the project for up to a total of 15 man-months in the areas of: (i) anthropology/sociology; (ii) conservation biology; and (iii) remote sensing (aerial photography and satellite imagery) to assist the SPE carry out various special survey and management tasks.

c). The SPE would conduct inventories of renewable natural resources to identify candidate areas for the establishment of one additional national park and of future forest reserves to be managed by the SRF.

d). The SPE would immediately assume administrative responsibility for the national parks at Pic Macaya and Morne la Visite, and implement the management plans by: (i) assigning supervisory staff and establishing local facilities; (ii) employing park rangers to prevent illegal exploitation; and (iii) create land use zones.

e). For the management of the park areas and surrounding buffer zones, the concept of "biosphere reserves" would be implemented.

f). Endangered species of plants and animals would be protected by: (i) improved enforcement of current laws requiring permits to collect and/or export plants and animals; (ii) better cooperation and communication between the SPE and enforcement agencies; (iii) establishment of nursery programs to propagate and grow endangered plant species from both lowland and upland habitats; and (iv) provision of habitat for threatened animals in the national parks.

g). Access by the public to the parks would initially be discouraged by not improving roads linking the parks to major population areas during the life of the project.

Sociocultural surveys in selected regions would be used to inform planners of the level at which wood harvesting is sustainable by documenting rates of wood production, patterns of harvesting and utilization.

h). The SPE would develop a data base on the natural resources of Haiti that would allow the Service to document the status of present environmental conditions, and to track future changes. Some of the activities that would allow SPE to fulfil this mission would be: (i) inventories of ecosystems and forest resources of Haiti via aerial photography, satellite imagery, and ground surveys; (ii) sociocultural inventories and environmental profiles of special designated areas; and (iii) inventories of forest biomass and potential productivity.

Major Project Components of the Proposed World Bank Project

The activities that would be undertaken by the SPE are as follows:

A. National Land Use Assessment

Satellite imagery would be used to periodically monitor country-wide land use trends, and the distribution of ecosystems. The Landsat (EOSAT) Thematic Mapper (TM) as well as the SPOT system will be used. This would provide a fairly detailed inventory of land use patterns and land resources. Manual interpretation of these images would include "geocoding" the images, and entering data on urban areas, barren ground, brush lands, major rivers, coastal wetlands, roads, forest cover (three crown density measures), sand, agricultural areas, water, wetlands, and rural villages. Because the topography in Haiti is so steep, and the area of the country is relatively small, resolution becomes an important consideration. The SPOT system provides higher resolution, and it therefore will be used (along with aerial photography) for more detailed analyses. The ground truthing for the analysis of the satellite images will be conducted by the SPE inventory team. The local SPE staff would be trained in interpretation and validation with the assistance from a short-term consultant.

Flight surveys (aerial photography) would be utilized to determine local land use patterns, the locations of specific renewable natural resources, and to document activities in areas of special concern such as core zones in national parks, and inventory areas. Some aerial photographs exist, such as the outdated photographs at the Geodetic Institute, and the photographs of the Pine Forest Reserve obtained by the SRF which include a small section of the national park at la Visite. The existing photographs are not recent enough, nor do they cover areas of primary concern of the SPE (la Visite, Macaya, Environmental Profile Areas), so additional aerial photographs and flight surveys will be contracted by the SPE to fill in the gaps in the available data, and to provide additional data needed to identify candidate areas, to study forest resources, and to document land use trends. Initially, aerial photographs would be interpreted by the firm performing the flight surveys as part of the contract. Once they have the proper training, they would be interpreted by the staff of the SPE.

Permanent observation plots would be installed in ecologically-representative sites. Data on species composition, growth, natural succession, and the propagation of indigenous species would be gathered and monitored.

B. Forest Resources Inventory

Forest Attributes. The forest types delineated on the satellite images would be sub-sampled to produce more specific information on the forest resources (crown cover, species, density, and biomass volumes). An aerial survey and ground inventory of the chosen forest types would provide data on forest cover and density attributes. The SPE would produce biomass tables for every forest class. Biomass and area totals for all classes would be summed to represent total biomass availability.

Patterns and Nature of Wood Harvesting and Utilization. An essential question for forestry planners in Haiti for each forest type is: at what level and for what products is current wood harvesting sustainable? Data generated by aerial photographs and satellite images (land use and forest type) provide valuable information on proper forest classifications. Biomass tables for each forest substratum provide information on potential wood availability. This information alone, however, presents an inaccurate picture of actual wood use, wood production, and true trends in the availability of forest resources; therefore, additional sociocultural inventories would be carried out under the project.

Sociocultural Inventories of Forest Resource Utilization. Sociocultural surveys in selected regions would be used to inform planners of the level at which wood harvesting is sustainable by documenting rates of wood production, patterns of harvesting and utilization, all of which are geographically and forest-type specific. Sociocultural surveys of wood use would be carried out with the assistance of short-term consultants for each forest stratum to describe local wood consumption patterns, specifying the types, amounts, and purposes of wood utilized, and the use of other tree products and utilizations (shade, forage, medicinal, etc.). The sociocultural information would help planners document the causes and rates of forest depletion and degradation. Upon the completion of the inventory by the SPE, the SRF staff would continue a more detailed analysis of national wood production and consumption patterns, and initiate planning activities for future forestry investments.

Environmental profiles would be made to establish baseline environmental data on each area being considered either as a future national park or as a forest reserve.

Long-Term Forest Inventories on Observation Plots (Ecosystem Monitoring). Permanent plots would be installed in ecologically representative sites in each of the forest reserves and national parks. These would be designated as "research zones." The goal is to establish at least one research zone of 100 hectares in each national park and forest reserve. The research zones will be fenced and/or guarded to protect them from illegal exploitation. Data on species composition, growth, natural succession, and the propagation of indigenous species would be gathered and monitored.

C. Creation of a New National Park and Additional Forest Reserves

Sociocultural Inventory of Candidate Areas. The SPE staff would carry out the sociocultural inventory of each candidate area using the Rapid Rural Assessment method. The information to be gathered would include: (i) demographics of the population living within and adjacent to the proposed reserve or preserve; (ii) the nature of the use of natural resources; (iii) patterns of access and authority on the site; (iv) land tenure arrangements; (v) ownership of the resources; (vi) the economic benefits accrued by user populations; and (vii) descriptions of local agricultural strategies. The inventory would also identify existing or potential conflicts that might result from management interventions, and would recommend alternative methods that should be used to mitigate or avoid conflict, maintain user welfare, and integrate users and local residents into the plan for the protection of the ecosystem. A Social Science Specialist would assist in these aspects of the sociocultural inventory as a short-term consultant.

Environmental Profiles of Candidate Areas. The purpose of the environmental profile would be to establish baseline environmental information on each area being considered either as a future national park, or as a forest reserve. Each profile would describe the major biotic and abiotic features, their status, and would recommend measures to preserve biological diversity.

New National Parks. The procedure for establishing the new national park and future forest reserves would be as follows. (i.) The SPE would conduct intensive sociocultural surveys and environmental profiles to determine the suitability of each candidate area. (ii.) The SPE would prepare a document describing and summarizing the information on forest cover, forestry potential, natural resource components, status of important endemic flora and fauna, existing patterns of human occupancy and land use, and land tenure characteristics for each candidate area. The document would include a recommendation as to the best land use strategy for each candidate area (i.e., national park or forest reserve). (iii.) The Director of the DRN would review the recommendations with the SRF and SPE and decide which recommendations would be implemented under the project. The SRF would manage areas designated as forest reserves. The SPE would manage all national parks. (iv.) The designation of the area as an official national park would occur after the MARNDR prepares a draft Decree for consideration by the Council of Ministers. The Decree would identify which sites would be transferred into the public domain as national parks or forest reserves under the MARNDR. Following the approval of the Decree by the Council, it would be published in *Le Moniteur* and would become official. (v.) The SPE would

Part of the process of demarcation of national parks would be the establishment of clearly marked land use zones where management activities will be undertaken by the SPE.

arrange for the delimitation of the designated national park area, and the legal transfer of the surveyed area to the jurisdiction of MARNDR.

D. Management of National Parks

Haiti's existing natural national parks and forest reserves are: Parc National Pic Macaya (5,500 hectares), Parc National la Visite (3,000 hectares) and the Pine Forest Reserve (27,871 hectares). The SPE would manage the two national parks (which are "preserves"), while the management of the Pine Forest Reserve (which is a multi-use "reserve") would remain under the SRF. The following activities would be implemented by the SPE under the project for each of the two existing national parks, and for the one additional national park that would be established by year four.

Delimitation of National Parks. The SPE would contract the Direction Generale des Impots (DGI) for a survey to delimit each national park with funding provided under the project A technician from the SPE would accompany the DGI survey team to advise the DGI as to where the boundary should be located relative to existing natural and man-made features of the area (i.e., to avoid problems of including existing farms or excluding ecologically important features). The SPE would provide the DGI survey team with tents, camping equipment, and logistical support while the team is in the field. The SRF would be responsible for making arrangements to survey and delineate forest reserves.

Until an adequate protective infrastructure is established, access to the parks via well-developed, direct roads would be discouraged in order to provide an extra measure of protection for the parks .

Demarcation of National Parks. SPE work teams, under the supervision of the park supervisor, would place concrete monuments and metallic signs at regular intervals along the perimeter of each national park. Signs would be posted at the junctions of major trails and access roads. Three guard houses would be built in each national park to shelter the park rangers, and to provide a symbolic presence for the authority of the SPE in the management of the parks. A total of 18 kilometers of fences would be erected in vulnerable or exposed areas to protect core and research zones. Part of the process of demarcation would also be the establishment of clearly marked land use zones where management activities will be undertaken by the SPE. The boundaries of these zones would be marked by paint on trees or wooden posts.

Supervision of the National Parks. For each park an agronomist would be assigned as the Park Supervisor. The Park supervisor would be responsible for all activities in the park, and would also supervise the activities of the NGO Agroforestry Extension project in the area. A forest technician would be appointed as the super-

visor of the park rangers. This technician would have received training in ecology, flora and fauna, and park management in order to qualify him to supervise the activities of the rangers.

Protection of the Resources of the National Parks. The SPE would employ park rangers who would be carefully selected, appropriately trained by Ecole Moyenne d'Agroforesterie (EMAF), regularly paid, and consistently supervised (i.e., conditions similar to those of the forest rangers of SRF). The park rangers would patrol the lands within the park boundaries, staff check points to control the entrance and exit of vehicles and pedestrian traffic, and encourage compliance with park regulations, laws, and zoning guidelines. Park rangers would undertake other protective services as designated by the supervisors of each national park, and would stay in regular contact with their supervisors via radio. At the completion of the project, a total of 32 park rangers would be employed.

Limitation of Access Roads as a Management Tool. Access to the parks via well-developed and direct roads would be discouraged during the project in order to provide an extra measure of protection for the parks until an adequate protective infrastructure is established. The national parks, especially la Visite, have potential as tourist attractions. However, access roads are necessary before this potential can be realized. The existing road from Port-au-Prince to Morne la Visite provides the most direct access to the park; however, it has been impassible to vehicles since 1988. The SPE has determined that this road should not be rebuilt during the period of the project, and that it is necessary to keep this road closed to vehicles until the park infrastructure is well established. Otherwise, irreparable harm could be done by illegal wood harvesters and transient cultivators who make seasonal gardens. The SPE would rebuild the access road from the south of the park at la Visite because access via the town of Seguin can be controlled. The SPE would also rebuild the service roads through the park and to Unit II of the Pine Forest Reserve at Morne Rouge. The SPE would not build a major access road into the north side of Parc National Pic Macaya because of the same concerns. The strategy is to develop the infrastructure of each national park before developing easy access to the parks.

One of the major problems faced by the SPE is the presence of farms within the boundaries of the national parks.

Management of "Occupied" Lands within Park Boundaries. One of the major problems faced by the SPE is the presence of farms within the boundaries of the national parks. Some of the problems created by the presence of farms in the parks are: (i) farmers who expand existing gardens into new areas; (ii) livestock which are grazed in inappropriate areas; (iii) slash and burn garden plots in remote areas; and (iv) the introduction of dogs, cats, rats, and the mongoose, all of which follow humans into a region and do great

harm to endemic animals. These problems are most significant at the la Visite National Park, where farmers living within the park were given a letter from MARNDR in 1983 notifying them that they were to leave the park by 1985. Since that date, farmers in the la Visite park have not paid leases on the land they occupy. The relocation of these farmers was not carried out because they were notified that they would receive land outside the park in exchange for the land they currently occupied. Under the project, the SPE would resolve this problem as follows. Lease fees would not be collected from any farmers who have already received relocation notices. The land within the boundaries of each park would be zoned for proper use at the earliest possible date. Lands within the boundaries of the parks which were determined to be suitable for agriculture would be zoned as "agricultural zones" or "multiple use zones." Peasants who live and farm in these areas would be allowed to remain. In areas within the national parks which are zoned for preservation (i.e., "core zones" and "research zones"), peasants would receive a letter similar to the one that was used by MARNDR at Parc National la Visite notifying them that they would be relocated. In the special case where a farmer living within the boundaries of Parc National la Visite received an eviction notice in 1983, but the land he occupies is zoned for agriculture by the SPE under this project, the eviction notice would be voided, and a new lease agreement would be written using the above guidelines.

Relocation of Peasants from Core Zones. The letter of eviction must be accompanied by a detailed proposal for compensation for loss of land(s) that is currently occupied. The SPE favors paying the peasants a one-time payment for "damages," and thus providing them with the means to lease lands at another location. Payments will only be made to farmers who can document that they were holders of leases for the land, or occupied the site for at least five years, in order to avoid public perception that land and money can be gained by occupying national park lands, as has been the case in the national parks program in the Dominican Republic.

Eviction of peasants from within national park boundaries must be accompanied by detailed proposals for compensation for the loss of lands.

Management of Leases. In areas of the national parks zoned for agriculture, agroforestry, or multiple use, land leases would be used by the SPE as a management tool. Leases would be written by the SPE with the assistance of legal counsel, and would define which land use activities are allowed and which are not. Leases would initially be for periods of one year, and would not commit the SPE to allowing the peasants to lease the land indefinitely. If a farmer is found to occupy land in an area that is zoned for agriculture, agroforestry, or multiple use activities, and if the Park Supervisor feels that the presence of the farmer does not compromise the management plan for the park, a long-term lease

would be established. Long-term leases would encourage farmers to invest in their holdings and to take advantage of the extension services provided by the project. These long-term leases would be for ten years, but would give the SPE the authority to cancel the lease annually if the land use conditions of the lease were violated by the farmer. The supervisor of each park would be responsible for the administration of the lease program in that park.

Lease Fees. There are no legal guidelines within MARNDR as to where money collected from leases on MARNDR land should be deposited. Revenues from fines and the sale of contraband forest are deposited in the Fund for Reforestation (1972 law) that is being administered by the SRF. The fees collected from leases and from fines in the national parks would also be deposited in the Reforestation Fund. These funds would be used in accordance with existing law, and would be handled in the same way that leases are to be handled in the Pine Forest Reserve.

Supervision of the Agroforestry Projects Surrounding Each National Park. The DRN would contract with NGOs to provide agroforestry extension in the national parks and in the buffer zones surrounding the national parks at la Visite and Pic Macaya. In the case of Pic Macaya, extension activities would have been initiated in the area north of the park, since the UF-MBR Project was already working in a similar capacity in the buffer zone south of the park. This part of the World Bank Plan would have to be amended due to the termination of the University of Florida USAID sponsored project on May 31, 1992. The objective of the Agroforestry Extension contract is to provide agricultural extension services to peasants living near the park to reduce the danger of environmental degradation within the park, and to increase local standards of living. The NGOs would also operate agricultural extension services to design recommendations for agroforestry and soil conservation techniques that would be used to establish conditions for leases, and to verify that conservation treatments on leased lands have taken place. The SPE would supervise the agroforestry extension activities through the Supervisor of each national park (resident agronomist).

The preservation of biological diversity is difficult in Haiti because of the extent of deforestation that has already taken place.

Biosphere Reserve Plan. The SPE would develop an extended management plan for both the park and buffer zone as the first step in expanding the UF-MBR Management Plan to the north slope of Pic Macaya. In developing this plan, the SPE would modify the management plan developed by the University of Florida under a contract with USAID for the national park at Pic Macaya to include: (i) information on biosphere reserve land use zones; (ii) activities that would be appropriate for the surrounding buffer zone; and (iii) the recommendations contained in the existing UF-MBR Management Plan.

E. Identification of the New National Park and Forest Reserves

The SPE would identify approximately 30,000 hectares that would be suitable as candidate areas for the new national park to be established in the fourth year of the project, and as candidate areas for future forest reserves. The method of selection and establishment of these areas is described in detail above. The major ecosystems to be investigated are as follows.

a). Mangroves: Because of their inter-tidal location, mangrove ecosystems play an essential role in the reproductive cycles of numerous aquatic species, and provide habitat for economically important species of crustaceans. In addition, threatened species such as the Greater Flamingo and West Indian manatee occupy bays and lagoons associated with mangrove habitats. Although a majority of the original mangrove stands have been eliminated, forests remain in the bays of Acul and Caracol (near Cap-Haitian), the Cayes region (Aquin Bay, Ile a Vache), the north coast of the southern peninsula (Baraderes and Corail). The most substantial remaining forest is in the Artibonite River Delta (south of Gonaives and west of l'Estere). Although mangrove forests are within the public domain, rights of access and harvest are often allocated to private individuals. Preliminary studies indicate that the Caracol and Artibonite areas are the best candidates for protection because they have the largest concentrations of threatened and endangered species. Preliminary plans by the SPE indicate that this ecosystem has the highest priority as a candidate for the new national park.

b). Broadleaved Forest: Though much of Haiti was originally covered with this forest type, most of the Broadleaved stands have been converted to coffee plantations and multi-purpose agricultural plots. Important Broadleaved forests remain south of the town of Borgne, on the Morne Brigand and Boucan Michel and west to the headwaters of the Anse-a-Foleur watershed and in the Pic Macaya area. Some of these are on state land, especially west of Pic Macaya, and could be attached to the Macaya Biosphere Reserve as part of Parc National Pic Macaya.

In order for stewardship efforts to be successful, there must be a sufficient number of agroforestry technicians on the staff of the SPE.

c). Semi-arid Forest: This forest community, which is characterized by the dominance of *Prosopis*, has historically been the source of most of the charcoal produced in Haiti; vast areas of semi-arid forest have become degraded through over-harvesting. Remnants of natural stands remain on the edges of the Etang Saumtre (in the Cul-de-Sac plain), Grand Gosier (southeast Haiti), near Cotes de Fer (southern coast of Haiti), and on the western end of Ile de la Gonave. All of these lands are within the public domain.

d). **Arid-land scrub**: This ecosystem is characterized by cactus, succulents and thorny shrubs. The zone which most characterizes this vegetation type is found along the coast between the towns of Anse Rouge and Gonaives (Savane Desolee). The cactus and scrub resources are rapidly being depleted for charcoal and fuel uses. This land is apparently within the public domain.

F. Preservation of Endangered Species

The preservation of biological diversity is difficult in Haiti because of the extent of deforestation that has already taken place. Special efforts would need to be undertaken to preserve some of the country's most endangered plant and animal species. SPE staff would propagate and grow endangered species of the lowland endemic plants such as *Attalea crassipatha*, *Geonoma oxicarpa*, and *Zombia antillarium* at the MARNDR-owned Levy Farm near Camp Perrin. A similar program for upland species such as *Juniperus eckmanii* would be undertaken in conjunction with SRF at the nursery in the Pine Forest Reserve. The SPE would develop special programs to improve the habitat for threatened species by including these activities in the management plan for the existing national parks (for example, by providing nest boxes for birds who normally nest in cavities in mature trees).

The SPE would also protect endangered species and preserve biological diversity by: (i) developing "recovery plans" for endangered species and species of special concern, and include the activities and recommendations contained in these recovery plans in the management plans for each national park and forest reserve; (ii) enforcing current wildlife regulations and laws by requiring permits and licenses to hunt, collect plants and animals, and export any native species of plant or animal; (iii) drafting additional legislation to protect the native flora, fauna, and threatened habitats of the country; and (iv) seeking international assistance from organizations such as the International Office of the Nature Conservancy, or Wildlife International, to purchase special parcels of threatened ecosystems which serve as habitat for rare, threatened, or endangered plants and animals.

Since there are not enough agroforestry technicians currently available in Haiti, agroforestry technicians will need to be trained at the Ecole Moyenne d'-Agroforesterie.

G. Phasing of the SPE Project

One of the requirements of the project is to have a sufficient number of agroforestry technicians on the staff of the SPE to carry objectives of the project. Since there are not enough agroforestry technicians currently available in Haiti to staff the project,

agroforestry technicians will need to be trained at the EMAF. During the first year of the project, the SPE will immediately need to hire two agroforestry technicians to work on the inventory team. These technicians are currently available. There are not enough agroforestry technicians available to be assigned to the existing national parks and to Levy Farm, since the first graduating class from EMAF will not be available until the third year of the project. At that time the SPE will hire eight agroforestry technicians (la Visite = 2; Macaya = 4; Levy Farm = 1; Inventory Team = 1). In the fourth year of the project, an additional national park will be established by the SPE, and two additional agroforestry technicians will be hired (for a total of 12 for the SPE for the project). During the first two years of the project, while the agroforestry technicians are being trained by EMAF, the agronomists assigned to each national park and to Levy Farm will serve in an expanded role that will include supervising the park rangers and plant propagators. The expanded duties of the supervisors would also provide the opportunity to increase their experience at all levels in the operation of the national parks, and to increase their abilities to supervise and manage their respective parks.

Other proposed phases of the project are as follows. During the first year, all activities at Parc la Visite will begin, but only half the guards will be hired at Parc Macaya. In year two, the remaining guards will be hired at Parc Macaya. In year three, all of the agroforestry technicians will be hired for the existing parks, and the staff of each park and Levy Farm will be operating at full staff levels (see above). In year four, one additional national park will be added to the SPE system of protected areas, and a full staff will be hired. The agronomist that will supervise this park will have been employed by the SPE since the first year of the project, and will have previously been assigned to the Levy Farm. This person will begin duties as supervisor of the new national park with three years of SPE experience, and with a knowledge of management techniques based on previous experience with the national parks program.

The recent political events in Haiti have thrown efforts to protect the natural patrimony and natural resources of the country into turmoil.

MacArthur Foundation Conservation Project "Bridge"

As part of the original "View of the Future" of Haiti, another grant was put in place to help make the World Bank Plan work more effectively. This grant was awarded to Charles Woods to help support conservation activities in Haiti. The original goal of the MacArthur Foundation Haiti Conservation Project was to help "Bridge" between the ongoing USAID, UFMBR, MARNDR programs. However, all of these programs have now been suspended or terminated. Therefore, the MacArthur Foundation

Conservation Project becomes even more of a "Bridge." It is a bridge across the environmental disaster that is occurring in Haiti as a result of the embargo and difficult economic conditions that now face the country.

The current goal of the MacArthur Foundation Haiti Conservation Project is to help "Bridge" the gap between the UF MBR Project which closed down on May 31, 1992, and the time in the future when new conservation projects will emerge--a time when current political and economic difficulties in Haiti are resolved, and the international embargo is lifted. The activities undertaken by the UFMBR project are summarized in the three volumes of the MBR Project Final Report (*Final Project Report*; *The Natural History of Southern Haiti*; and *Stewardship Plan for National Parks and Natural Areas in Haiti*). The recent political events in Haiti have thrown efforts to protect the natural patrimony and natural resources of the country into turmoil. The infrastructure that supported the National Parks of Haiti has collapsed. The World Bank Environmental and Forestry Project has be suspended. Local farmers in the countryside are degrading the natural resources of the region at an increased--almost frantic--rate. Because the World Bank Project has been put on hold, MARNDR does not have the resources to continue to protect Parc National Pic Macaya. A "Bridge" is desperately needed to help preserve what remains of Haiti's natural patrimony in the Macaya area. A "Bridge" will also make it possible for the pieces to be picked up when conditions in Haiti become normal once again. The major activities of the MacArthur Foundation Project are summarized below. These activities will change as conditions in Haiti change. The project is planned to run from August, 1991 - August, 1994.

The goal of the MacArthur Foundation Haiti Conservation Project is to help "bridge" the gap between the UFMBR Project which closed down on May 31, 1992, and the time in the future when new conservation projects will emerge--a time when current political and economic difficulties in Haiti are resolved, and the international embargo is lifted.

Summary of Proposed MacArthur Foundation Activities

1). Continue to support the Parc National Pic Macaya and the Planned Macaya Biosphere Reserve "infrastructure" (buildings/nursury) at Formon/Durand until there is a long term GOH or PVO program in the area. Since it now appears that PADF will be able to work in the area, some of these activities (as indicated below), will be assigned to PADF. The Education and Conservation Specialist will visit Formon on a weekly basis to continue to demonstrate the presence of an official GOH project, and to carry out educational and administrative activities for the MacArthur Conservation Project.

a). Guardians will continue to be paid (PADF will assume responsibility for half of the Guardians for mutually-shared facilities);

b). A nursery man will continue to be employed (PADF will assume full responsibility for this position and for all reforestation activities when it becomes active in the area);

c). Some trees will continue to be propagated (PADF will take over this responsibility as part of its project);

d). Signs will be checked and secured. The signs will be the responsibility of UF/MacArthur.

2). Continue some conservation activities in the Formon area, and along the south side of the Pic Macaya region. PADF will carry out these activities in the MBR area, and UF/MacArthur will have the responsibility for the area of Parc National Pic Macaya. The Education and Conservation Specialist will be present in the Formon region on a regular basis, and will coordinate all activities there between the Director and the Project Coordinator, PADF, and USAID, as well as MARNDR.

a). Some reforestation activities will continue to be carried out in critical areas where erosion is a major factor (to be assigned to PADF).

b). Check dams will be maintained, and additional check dams will be built at critical areas (PADF in MBR, UF/MacArthur in Parc National Pic Macaya).

c). Additional signs will be placed out in areas of special concern (UF/MacArthur).

3). Biological Conservation activities will continue in the area of Pic Macaya, the Rak Bwa Broadleaved Forest near Formon/Durand, and the hill country between Catiche and Pic Macaya. The Director will train the Project Coordinator and the Education and Conservation Specialist to carry out these activities. Some activities will also requrie the assistance of a specialist in endemic fauna.

a). Writing a Species Recovery Plan for all living species of *Solenodon* ("living fossils"). This activity is very important since these creatures are the rarest native mammals of Haiti, and perhaps the entire West Indies;

b). Writing a Species Recovery Plan for the White-winged Warbler, a very rare ground-nesting warbler that is endemic to Hispaniola, and may survive only in the Pic Macaya area;

c). Writing a Species Recovery Plan for the Black-capped Petrel. One of the last surviving colonies of this nearly extinct bird is on the south face of Pic Macaya near the summit.

d). Writing a species recovery plan for the Zagouti. This species is now very endangered in the area of the MBR, and is now extinct in northern Haiti;

e). Beginning a long term bird-banding project in the Rak Bwa Broadleaved Forest near the project headquarters at Formon. This sub-project is seen as a way of involving local Haitian volunteers and PVO groups in a plan for natural resource monitoring, and is a vehicle for training Haitians in the principles of wildlife conservation. It is also a way of establishing a program that could attract North American volunteers, and attract the attention of North American organizations such as the Audubon Society. A similar plan has been very successful in Belize, where the Massachusetts Audubon Society has adopted Belize as a major focus of interest and fund raising.

This sub-project will operate under the official Bird-Banding Permit of Charles Woods, and will build on his past bird-banding work in Haiti, so that it is starting from a point of strength, and will be using an existing data base on migratory birds.

4). The Director and Project Coordinator will be in Haiti on a regular basis to "lobby" for environmental concerns in the Macaya area, and in the areas of the other national parks of Haiti. The Education and Conservation Specialist will be in Haiti on a permanent basis, and will design and implement educational programs, and also lobby for environmental issues. The target of these constant lobbying efforts will be:

a). MARNDR

b). FAN

c). Audubon Society of Haiti

d). Private individuals with an interest in the environment

e). International Agencies working in Haiti (AID, OAS, EEC, UN, World Bank, Canadian Govt., etc.)

f). Tourist organizations

g). Educational groups, especially the University of Cayes.

5). Charles Woods will work with the data generated by the project over the last decade to publish a body of literature and educational materials that can be used in Haiti to promote conservation and the wise use of natural resources. These materials will be used in the MacArthur Foundation Environmental Education activities, and will be available to the next generation of individuals, GOH programs, or international organizations that will be working to save the remaining natural resource base--and to prevent the total economic and ecological collapse--of Haiti. Some of these will include the following:

Posters

a). Distributing the Conservation Poster, "Connaitre et Proteger la richesse naturelle d'Haiti," on Haiti which was produced as part of the present AID-sponsored project (MBRP) with financial assistance from the MacArthur Foundation;

b). Creating a second Conservation Poster that will be a "companion" poster to the above two posters, and which can be used in schools and workshops for educational purposes. This poster will include text and clearly labeled messages that will allow for discussions and learning sessions (now being planned and scripted);

c). Creating a third Conservation Poster that will concentrate on only the Macaya Area, and rely on photographs and text (now underway);

d). Working with a well-known Haitian artist (Andre Normil) to create a "Haitian Painting" that will be turned into an attractive poster. This poster will feature a mixture of real Haitian plants and animals mixed together with the traditional non-Haitian plants and animals featured in most Haitian art. This poster will be widely distributed in Haiti, especially to tourist facilities. We hope that it will create an interest in native plants and animals. If we are lucky, it will also start a movement in Haiti where local artists will increasingly include local plants and animals in their paintings.

Educational Books and Booklets

a). A booklet with color photos and important environment information on the National Parks of Haiti (in French).

b). A book on propagating 12 native trees of the MBR, *Arbres et Arbustes de Macaya.*

c). A book on the *Mammals of Haiti* (living and extinct) which will include substantial information on wildlife conservation (English, but with a long French abstract, and French and Creole names).

d). A book on the *Birds of Haiti*, with many photos and color plates. This book will be suitable for use as a field guide by local people and tourists who want to visit the parks. It will include a substantial section on conservation of birds and habitats.

e). A book on the *Natural History of Haiti*. This book will be an expanded version of the book that is being published as part of the final report of the MBR project (*The Natural History of the Macaya Area*). Both books can serve as source books on all aspects of the "Natural History" of Haiti.

f). Other books and booklets which are determined to be appropriate and important, including a possible book on the *Useful Trees of Haiti*.

g). An educational coloring book in conjunction with the "Connaitre et Proteger la Richesse Naturelle d'Haiti" conservation poster.

Conservation Video

a). A conservation video, using VCR technology, will be created that will show video scenes of natural areas in Haiti, including views of the natural forest in the most remote sections of the parks, and scenes of the parks from the air. We will have copies of this video with French, Creole, and English sound tracks. We hope that it will be shown on Haitian TV, and other places where attitudes towards the natural environments and natural resources of Haiti can be improved.

The production of these posters, books, and booklets will be done out of the office of Charles Woods, using the facilities of the Florida Museum of Natural History in Gainesville. The computers and existing MBR data bases at the Museum/University will be used in the preparation of these materials.

6). The project will work with MARNDR to try to protect the park. The project does not have enough resources to support activities that are not very specific to the goals of the MacArthur Project, which are to:

a). Protect the existing national parks.

b). Educate people about the importance of natural resources in Haiti.

c). Create species recovery plans, and a useful published literature on natural resources. These will improve the chances of success for future programs in natural resource management in Haiti.

d). "Bridge" the gap between the existing USAID/MBR program, and possible future programs (including the important World Bank Environmental and Forestry Project).

Personnel Supported by the MacArthur Foundation Grant

Charles Woods

Project Director (at no cost to the project, since all salaries and benefits paid by the University of Florida). Most of his time will be spent at the Museum coordinating the scientific, educational, administrative parts of the project and planning and executing the conservation posters and environmental books, but he will work in Haiti on a regular basis, and will conduct all conservation biology activities.

Florence Sergile

Technical/Administrative Coordinator. Beginning June 1, 1992 her salary and benefits will be paid by the MacArthur Foundation Grant (until another outside source of funds is found). This additional cost was unplanned for, and will stretch the activities of the project to the limit. However, her position is an important one, and her training in Agriculture (BS at Damien), Biosphere Reserves (MS at UF), and Natural Resource Management (on the job training with the UFMBR project for five years) make her invaluable. She is a native of Haiti, speaks French, Creole, English, and Spanish perfectly, and knows the infrastructure of Haiti. During the course of this project Florence will be trained in the principles of Conservation Biology and Environmental Education. Florence will spend half her time in Haiti, and half her time at the Florida Museum of Natural History. It will be Florence's responsibility to seek additional funding to support activities of the project. She will work with a variety of funding agencies, PVOs, and private individuals in Haiti.

Jean-Rony Merisier

Education and Conservation Specialist. Beginning June first his salary and benefits will be paid by the MacArthur Foundation Project. Mr. Merisier is also a native of Haiti, speaks French, Creole, and English well, and knows the infrastructure of Haiti. He has served as a teacher, project administrator, and "Agroformateur"(agroforestry specialist). For the past two years he served as an Agroformature for the MBR project. Mr. Merisier's duties will be to implement the educational program, and to work with GOH and private organizations in Haiti to help bridge between the present poorly-defined program and the future programs in conservation and natural resource management (as well as the emerging program in national parks). One goals of the MacArthur Foundation Project is to train Mr. Merisier to take a major role in future work in conservation in Haiti. Mr. Merisier will be in the area of the project in Formon on a regular basis. During the important transitional period through the summer of 1992, he will visit in Formon on a weekly basis.

Local Guardians and a Nurseryman at Formon. These individuals will be paid for initially by MacArthur Foundation Grant, and then shared jointly and paid for jointly by PADF and the MacArthur Foundation after the PADF project begins.

Guardian at the Project Headquarters at Les Cayes (Paid for by MacArthur Foundation Grant)

Chauffeur to be used as needed (Paid for by MacArthur Foundation Grant).

Volunteer Field Biologist to be working on site at Formon/Macaya (basic living expenses to be paid for by MacArthur Foundation Grant).

Facilities to be used by MacArthur Foundation Grant

1). The Project Headquarters in Les Cayes. This facility will serve as the:

Project Office
Project Depot
Project Conference Room
Project Residence Facility
Vehicle Maintenance and Storage Facility

2). The Small White House at Formon/Durand. This project house will serve as the field residence for Merisier, Sergile,

Woods, etc., when they are in the field at Formon. It will also serve as the field depot for signs, equipment, materials and literature for the MacArthur Foundation Conservation Project.

3). The Large House at Formon/Durand (Kay Michel). This building will be shared with PADF. It was designed by the UFMBR Project as the Headquarters Building for the Parc National Pic Macaya. If the World Bank Project becomes active, we will coordinate activities in the building so that there is a place for SPE/World Bank/MARNDR/Parcs Haiti or whomever else is taking a major role in the administration and supervision of Parc Macaya. There is ample space for PADF to use as an office and depot. In general the facility at Kay Michel can serve as:

Office Space
Field Depot
Center for Field Research (Species Recovery Plans)
Field Residence and Meeting Facility for Volunteers and Project Related Staff, as well as PADF staff.

4). Office, publication, educational, and research facilities of Charles Woods at the Florida Museum of Natural History/University of Florida, Gainesville, Florida. This facility will be the overall center of administration/coordination for the MacArthur Foundation Conservation Project.

Phone: 904-392-1721;
Fax: 904-392-8508.

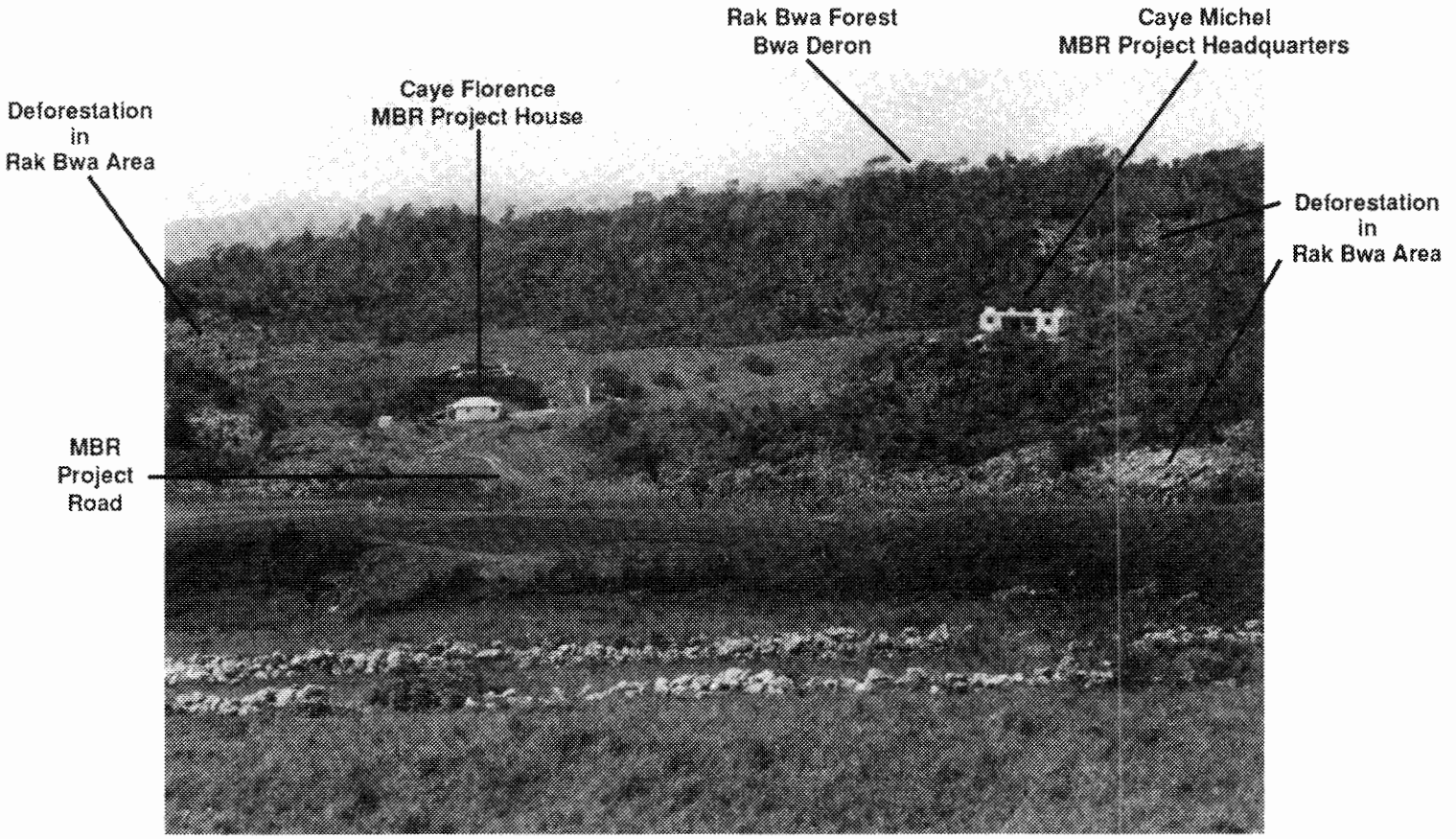
Financial

The funds for the grant are managed by the University of Florida Research Foundation (Private). Funds for the grant are disbursed via checks from this Foundation account. There is also a bank account in Haiti in Gourdes at the Bank of Boston in Port-au-Prince in the name of "Dr. Charles A. Woods Conservation Fund." This bank account is used only for financial matters relating to the MacArthur Foundation Conservation Project.

Address of Project

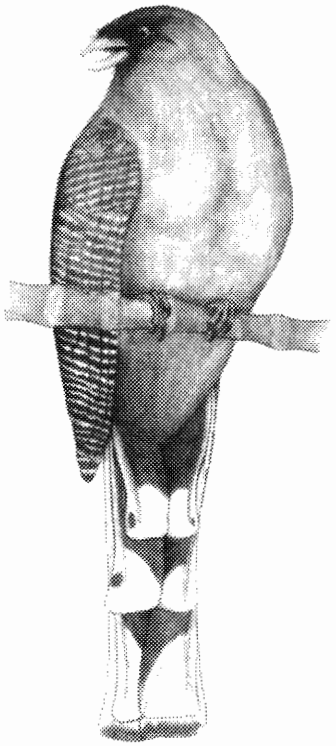
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In Haiti
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Deux Mapous
Les Cayes, Haiti
Phone: 509-8-6-0496 (fax at same number)



View of MBR Project Area
April 1992

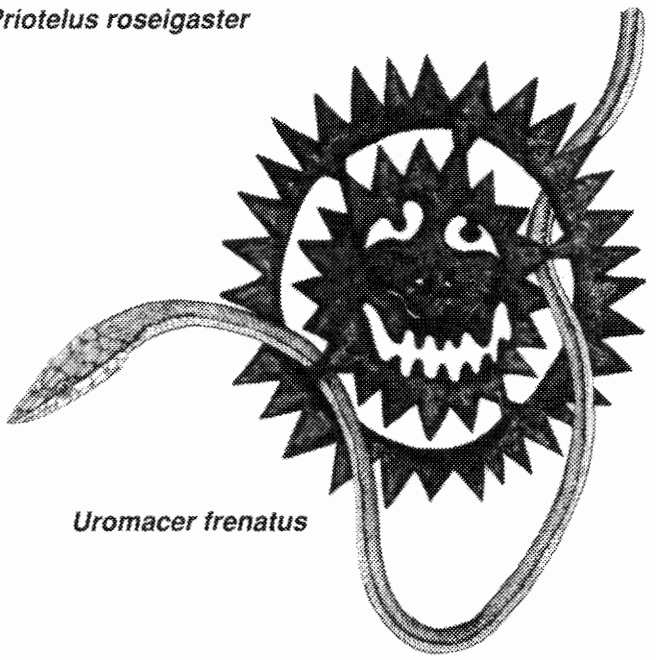
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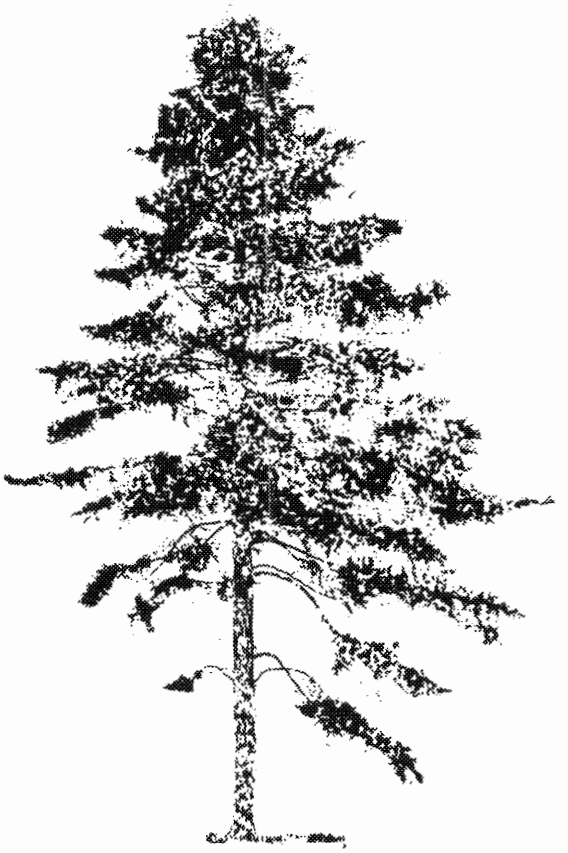
Priotelus roseigaster



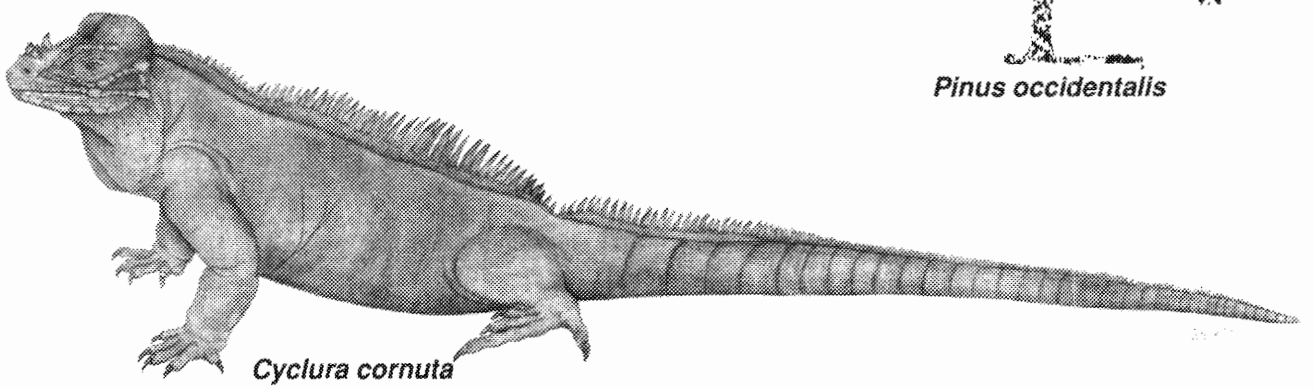
Plagiodontia aedium



Uromacer frenatus



Pinus occidentalis



Cyclura cornuta

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and

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APPENDIX I
FLORA

ENDEMIC FLORA OF PARC NATIONAL PIC MACAYA

Species	Status		
Agavaceae			
Agave antillarum Desc.	H		
Apocynaceae			
Asketanthera picardae (Urb.) Woodson			HO
Arecaceae			
Coccothrinax cf *montana* Burret.	H		
Araliaceae			
Dendropanax selleanus (Urb & Ekm) S.C. Smith		HS	
Didymopanax tremulum Krug & Urb.	H		
Asteraceae			
Baccharis myrsinites (Lam.)Pers.	H		
Erigeron domingensis Urb	H		
Eupatorium flavidulum Urb. & Ekm.			HO
Eupatorium microchaetum Urb. & Ekm.		HS	
Eupatorium porphyrocladium Urb. & Ekm.			HO
Eupatorium stigmaticum Urb. & Ekm.	H		
Eupatorium urbanii Ekm.			HO
Mikania cyanosma Urb. & Ekm.			HO
Mikania dissecta Urb. & Ekm.			HO
Narvalina domingensis Cass.	H		
Senecio hotteanus Urb. & Ekm.			HO
Senecio stenodon Urb.			HO
Vernonia buxifolia Cass	H		
Vernonia ekmanii Urb.			HO
Vernonia saepium Ekm.			HO
Begoniaceae			
Begonia plumieri DC.	H		
Begonia pycnantha Urb. & Ekm.	H		
Bignonaceae			
*Tabebuia conferta** Urb.			HO
Blechnaceae			
Blechnum tuerckheimii Brause	H		
Bromeliaceae			
Guzmania ekmanii (Harms) Harms	H		
Pitcairnia elizabethae L.B. Smith		HS	
Tillandsia hotteana Urb.	H		
Campanulaceae			
Lobelia hotteana Judd & Skean			HO
Siphocampylus sonchifolius (SW) McVaugh	H		
Celestraceae			
Maytenus cf. *hotteana*			HO

SPECIES	STATUS		
Cyatheaceae			
Alsophila hotteana (C.Chr. & Ekm.)Tryon			HO
Dennstaedtiaceae			
Hypolepis hispaniolica Maxon	H		
Elaeocarpaceae			
Sloanea castor Urb. & Ekm.			HO
Ericacea			
Lyonia rubiginosa(Pers.) G. Don var costata (Urb.) Judd			
Euphorbiaceae			
Hyeronima domingensis Urb.		HS	
Phyllanthus myriophyllus Urb.			HO
Sapium haitiense Urb.			HO
Flacourtiacaeae			
Barnara splendens Urb.	H		
Lunania mauritii Urb	H		
Gesneriaceae			
Gesneria aspera Urb & Ekm		HS	
Gesneria fruticosa (L.) Kruntze	H		
Gesneria aff. *hypoclada* Urb & Ekm		HS	
Rhytidophyllum bicolor Urb.			HO
Guttiferae			
Garcinia barkeriana (Urb. & Ekm.) Alain	H		
Illiciaceae			
Illicium ekmanii A.C. Smith	H		
Labiatae			
Hyptis schusteri Urb		HS	
Salvia cf *arborescens* Urb. & Ekm.	H		
Salvia paryskii			HO
Salvia sp nov			HO
Lauraceae			
Ocotea pulchra (Ekm. & O.Schmidt) Alain			HO
Ocotea sp. nova			HO
Malpighiaceae			
Bunchosia haitiensis Urb. & Niedenzu			HO
Malvaceae			
Hibiscus hottensis Helwig	H		
Melastomataceae			
Calycogonium apiculatum Urb. & Ekm.			HO
Calycogonium calycopteris (L.C. Rich) Urb.	H		
*Calycogonium torbecianum**Urb. & Ekm.			HO
*Ekmaniocharis crassinervis** Urb.			HO
Henrietta barkeri Urb. & Ekm.		HS	
*Mecranium alpestre** Urb.			HO
Mecranium birimosum (Naud)HS Triana		HS	
Mecranium haitiense Urb.			HO
Mecranium microdictyum Urb. & Ekm.			HO
Mecranium revolutum Skean & Judd			HO
*Mecranium tricostatum** Urb. & Ekm.			HO
Mecranium tubercolatum Urb.		HS	
Meriania brevipedunculata Judd & Skean			HO
Meriania parvifolia Judd & Skean			HO

SPECIES	STATUS		
Melastomataceae (continued)			
Meriania squamulosa Urb & Ekm.			HO
Miconia apiculata Urb. & Ekm.			HO
Miconia barkeri Urb. & Ekm.			HO
Myconia hypiodes Urb. & Ekm.			HO
*Miconia macayana** Judd & Skean			HO
Miconia ossaeifolia Urb. & Ekm.			HO
Miconia sp. nova			HO
Miconia subcompressa Urb. & Ekm.	H		
*Miconia xenotricha** Urb. & Ekm.			HO
Ossea alloeotricha Urb.			HO
*Ossea curvipila**Urb. & Ekm.			HO
*Ossea woodsii**Judd & Skean			HO
Ossea setulosa Urb.			HO
Pachanthus cubensis A. Rich. subsp. *blancheanus* (Urb.) Borhidi			HO
Pachyanthus hotteana (Urb.& Ekm) Ekm.	H		
Myricaceae			
Myrica picardae Krug & Urb.	H		
Myrtaceae			
Calyptranthes hotteana Urb. & Ekm.			HO
Calyptranthes numumularia Berg.		HS	
Calyptranthes cf. *ternifolia* Urb. & Ekm.			HO
Eugenia christii Urb.			HO
Eugenia formonica Urb. & Ekm.			HO
Eugenia tiburona Urb. & Ekm.			HO
Myrcia tiburoniana Urb. & Ekm.			HO
Myrsinaceae			
Ardisia fuertesii Urb.	H		
*Myrsine magnoliifolia** (Urb. & Ekm.) Alain			HO
Wallenia acquifolia Urb & Ekm		HS	
Wallenia ekmanii Urb.			HO
*Wallenia formonensis** Judd	H		
Oleaceae			
Haenianthus oblongatus Urb.			HO
Onagraceae			
Fuchsia pringsheimii Urb.	H		
Pinaceae			
Pinus occidentalis Sw.	H		
Piperaceae			
*Peperomia dominicana*D.C.	H		
Peperomia michelensis Trel.			HO
Piper oviedoi Urb		HS	
Poaceae			
Arthrostylidium haitiense (Pilger) Hitchc & Chase (Poaceae)	H		
Danthonia domingensis Hack. & Pilger	H		
Polygonaceae			
Coccoloba pauciflora Urb.	H		
Polipodiaceae			
Grammitis apiculata (Klotzsch) Seymour	H		

SPECIES	STATUS		
Rosaceae			
Rubus selleanus Helwig.	H		
Rubiaceae			
Exostema cf *picardae* Urb.		HS	
Peratanthe ekmanii Urb	H		
Psychotria alpestris Urb. & Ekm.			HO
Psychotria liogieri Steyermark	H		
Rondeletia formonica Urb. & Ekm.			HO
Stevensia hotteana Urb. & Ekm.			HO
Rutaceae			
*Amyris apiculata** Urb. & Ekm.			HO
Zanthoxylum haitiensis (Urb.) Jim)nez			HO
Sabiaceae			
*Meliosma abbreviata** Urb.			HO
Meliosma recurvata Urb.			HO
Sapotaceae			
Micropholis polita (Griseb.) Pierre subsp. *hotteana* Judd			HO
Selaginellaceae			
Selaginella leonardii Schmidt	H		
Selaginella plumieri Hieron	H		
Solanaceae			
Brunfelsia picardae Krug & Urb.	H		
Cestrum bicolor Urb.			HO
Cestrum coelophlebium O.E. Schulz.	H		
Cestrum filipes Urb. & Ekm.			HO
Cestrum hotteanum Urb. & Ekm.			HO
Cestrum inclusum Urb.	H		
Cestrum picardaae Alain	H		
Solanum formonense O.E.Schulz			HO
Solanum hotteanum Urb. & Ekm.			HO
Staphyleaceae			
Turpinia picardae Urb.		HS	
Synplocaceae			
Symplocos hotteana Urb & Ekm.			HO
Theaceae			
Cleyera ternstroemioides (O.Schmidt) Kobuski			HO
Ternstroemia barkeri Ekm.& Schmidt			HO
Thymeliaceae			
Daphnopsis crassifolia (Poir) Meissn.	H		
Urticaceae			
Pilea baltenweckii Urb.	H		
Pilea distantifolia Urb.			HO
Pilea domingensis Urb.	H		
Pilea formonensis Urb. & Ekm.			HO
Pilea hepatica Urb.& Ekm.		HS	
Pilea leptocardia Urb.		HS	
Pilea serpyllacea (HBK) Liebm.			HO
Pilea sp.nov. aff. *P. formonensis*			HO
Pilea stolonifera (SW) Wedd		HS	
Pilea torbeciana Urb. & Ekm.			HO

SPECIES	STATUS
Verbebaceae	
Aegiphila subopposita Urb. & Ekm.	H
Viscaceae	
Dendrophthora carnosa Urb. & Ekm.	HO
Dendrophthora versicolor Urb. & Ekm.	HO
Zingiberaceae	
Renealmia densiflora	HO

* Rare species very restricted in distribution within the park. Especes rare de distribution restreinte dans le parc.

H = Endemic to Hispaniola; HO = Endemic to Massif de la Hotte; SH = Endemic to Massif de la Hotte et de la Selle.

ENDEMIC FLORA OF PARC NATIONAL LA VISITE

Species	Status		
Agavaceae			
Agave antillarum Desc.	H		
Aquifoliaceae			
*Ilex blancheana** Judd			S
Ilex fuertesiana (Loes.)Loes.	H		
Araliaceae			
Didymopanax tremulum Krug & Urb.	H		
Asteraceae			
Baccharis myrsinites (Lam.)Pers.	H		
Erigeron dissectus Urb	H		
Eupatorium cabaionum Urb. & Ekm.			S
Eupatorium illitum Urb. & Ekm.	H		
Eupatorium microchaetum Urb. & Ekm.		SH	
Eupatorium sp. nov.			S
Gnaphalium eggersii Urb. & Ekm.	H		
Gnaphalium selleanum Urb. & Ekm.			S
Mikania tripartita Urb. & Ekm.			S
Senecio buchii Urb.			S
Senecio picardae Krug & Urb.	H		
Begoniaceae			
Begonia domingensis DC.	H		
Begonia platyptera Urb.			S
Blechnaceae			
Blechnum tuerckheimii Brause	H		
Boraginaceae			
Cordia dependens Urb. & Ekm.	H		
Cordia picardae Urb.			S
Tournefortia selleana Urb.& Ekm.			S
Bromeliaceae			
Tillandsia hotteana Urb.	H		
Buddlejaceae			
Buddleja domingensis Urb.	H		
Campanulaceae			
*Siphocampylus caudatus** McVaugh			S
Siphocampylus sonchifolius (SW)McVaugh		SH	
Cucurbitaceae			
Melothria domingensis Cogn.	H		
Cupressaceae			
*Juniperus ekmanii** Florin			S
Cyperaceae			
Carex ekmanii Kuk	H		
Cyperus pricardae Boeckl.	H		
Dryopteridaceae			
Diplazium fuertesii Brause	H		
Ericacea			
Lyonia buchii Urb.	H		
Lyonia microcarpa Urb. & Ekm			S
Lyonia rubiginosa (Pers.) G.Don var.*costata* (Urb.)Judd	H		

Species	Status		
Ericacea (continued)			
Lyonia truncata Urb. var. *truncata*			S
Euphorbiaceae			
Sapium buchii Urb.	H		
Ditta sp. nova			S
Phyllantus lindenianus Baill. var *inaequifolius* (Webster) Webster			S
Gesneraceae			
*Gesneria bullata** Urb. & Ekm			S
Gesneria ekmanii Urb.		SH	
Gesneria hypoclada Urb & Ekm		SH	
Gesneria viridiflora (Decaisne)Kuntz subsp. *acrochordonanthe* L. Skog		SH	
Rhytidophyllum sp. nov			S
Guttiferae			
Hypericum fuertesii Urb.	H		
*Hypericum millefolium** Urb. & Ekm			S
Labiatae			
Hyptis schusteri Urb.		SH	
Salvia bahorucona Urb.& Ekm.			S
Salvia foveolata Urb. & Ekm.			S
Salvia selleana Urb.			S
Lauraceae			
Ocotea acarina C.K. Allen			S
Loranthaceae			
Dendropemon bistratus Urb	H		
Dendropemon pycnophyllus Krug & Urb	H		
Malpighiaceae			
*Bunchosi**a ekmanii* Urb. & Ekm			S
Malpighia macracantha Urb. & Ndz.			S
Melastomataceae			
Meriana involucrata (Desr.) Naud.	H		
Miconia ferruginea (Desr.) DC			S
Miconia lanceolata (Desr.) DC	H		
Miconia luteola Cogn.			S
*Miconia rigidissima** Urb & Ekm.			S
Miconia selleana Urb. & Ekm.	H		
Miconia subcompressa Urb. & Ekm.	H		
Miconia favosa (Des.) Naud.		SH	
Myricaceae			
Myrica picardae Krug & Urb	H		
Myrtaceae			
*Calyptranthes densif**olia* Urb & Ekm.			S
Calyptranthes nummularia Berg.		SH	
Calyptranthes pitoniana Urb & Ekm.	H		
Eugenia lineata (Sw.) DC.	H		
Eugenia picardae Krug & Urb.			S
Myrsinaceae			
Ardisia fuertesii Urb.	H		
Ardisia picardae Urb			S
Myrsine nubicola Liogier	H		

Species	Status	
Onagraceae		
Epilobium coloratum Muhl. ex Willd.	H	
Fuchsia pringsheimii Urb.	H	
Fuchsia triphylla L.	H	
Pinaceae		
Pinus occidentalis Sw.	H	
Piperaceae		
Peperomia leonardii Trel.	H	
Poaceae		
Andropogon urbanianus Hitchc.	H	
Arthrostylidium haitiense (Pilger) Hitchc & Chase (Poaceae)H		
Danthonia domingensis Hack. & Pilger	H	
Podocarpaceae		
Podocarpus aristulatus Parl.	H	
Polygonaceae		
Coccoloba picardae Urb.		S
Pteridaceae		
Pteris hispaniolica Maxon	H	
Rosaceae		
Rubus argentifrons Bailey	H	
Rubus haitiensis Bailey	H	
Rubus selleanus Helwig.		S
Rubiaceae		
Galium brevipes Urb.	H	
Mitracarpus decumbens Urb.		S
Psychotria liogieri Steyermark	H	
Rondeletia carnea Urb.& Ekm.		S
Rondeletia christii Urb.	H	
*Rondeletia domatiata** Urb.		S
Psychotria baltenweckii Urb.		S
Rutaceae		
Zanthophyllum tetraphyllum (Urb & Ekm.) Jimenez		S
Sabiaceae		
Meliosma impressa Krug & Urb	H	
Sapotaceae		
Brumelia subintegra Urb. & Ekm		S
Selaginellaceae		
Selaginella leonardii Schmidt	H	
Simaroubaceae		
Picrasma selleana Urb.		S
Solanaceae		
Cestrum brevifolium Urb.	H	
Cestrum coelophlebium O.E. Schulz.	H	
Cestrum inclusum Urb.	H	
Cestrum mononeurum Urb. & Ekm.	H	
Cestrum violaceum Urb.		S
Staphyleaceae		
Turpinia picardae Urb.	SH	
Theaceae		
Laplaceae alpestris (Krug & Urb.) Dyer	H	

Species	Status
Thymeliaceae	
Daphnopsis crassifolia (Poir) Meissn.	H
Urticaceae	
Pilea domengensis Urb.	H
Pilea lanceolata (Lam.) Wedd.	H
Pilea propinqua Wedd.	H
Pilea hepatica Urb.& Ekm.	SH
Pilea cephalantha Wedd	S
Pilea franquervilleana Wedd	S
Pilea lapidincola Urb & Ekm.	S
Pilea psilogyne Urb & Ekm.	S
Verbebaceae	
Verbena domingensis Urb.	H

* Rare species very restricted in distribution within the park. Especes rare de distribution restreinte dans le parc.

H = Endemic to Hispaniola; S = Endemic to Massif de la Selle; SH = Endemic to Massif de la Selle et de la Hotte

APPENDIX II
FAUNA

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

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

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

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

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
- ** *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

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

** *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

Annotated List of Amphibians and Reptiles known from the Massif de la Selle and Adjacent Mountain Areas.

Sixty-five taxa are listed as potentially occurring in, or are known from, the Massif de la Selle and adjacent mountain areas (Schwartz and Thomas, 1975; Henderson and Schwartz, 1984). * = indicates those taxa listed in Henderson and Schwartz (1984) form these mountain areas, but were not reported from the park; ** = includes those taxa either reported in the literature as occurring in the park or represented in our collections. Those taxa without notation are reported to occur more generally in the area and may eventually be found in or near the study area.

Order ANURA

Family Leptodactylidae (18 taxa)

- ** *Eleutherodactylus abbotti* Cochran
- ** *Eleutheordactylus armstrongi* Noble and Hassler
- ** *Eleutherodactylus audanti audanti* Cochran
- ** *Eleutherodactylus darlingtoni* Cochran
- * *Eleutherodactylus fowleri* Schwartz
- ** *Eleutherodactylus furcyensis* Shreve and Williams
- ** *Eleutherodactylus glanduliferoides* Shreve
- * *Eleutherodactylus heminota* Shreve and Williams
- * *Eleutherodactylus hypostenor* Schwartz
- *Eleutherodactylus inoptatus* (Barbour)
- ** *Eleutherodactylus jugans* (Cochran)
- ** *Eleutherodactylus leoncei* Shreven and Williams
- * *Eleutherodactylus norton* Schwartz
- ** *Eleutherodactylus oxyrhynchus* (Dumeril and Bibron)
- * *Eleutherodactylus pictissimus pictissimus* Cochran
- ? *Eleutherodactylus ruthae aporostegus* Schwartz
- * *Eleutherodactylus semipalmatus* Shreve
- * *Eleutherodactylus wetmorei ceraemerus* Schwawrtz

Family Hylidae (4 taxa)

- * *Hyla heilprini* Noble
- *Hyla pulchrilineata* Cope
- * *Hyla vasta* Cope
- *Osteopilius dominicensis* (Tschudi)

Suborder SAURIA

Family Gekkonidae (6 taxa)

- *Gonatodes albogularis notatus* Reinhardt and Lutken
- *Hemidactylus brooki haetianus* Meerwarth
- * *Sphaerodactylus altavelensis brevirostratus* Shreve
- * *Sphaerodactylus armstrongi* Noble and Hassler
- * *Sphaerodactylus cinereus*
- * *Sphaerodactylus streptophorus* Thomas and Schwartz

Family Anguidae (3 taxa)

- * *Celestus stenurus weinlandi* Cope
- * *Celestus costatus oreistes* Schwartz
- ** *Wetmorena haetiana haetiana* Cochran

Family Iguanidae (13 taxa)

- * *Anolis alinger* Mertens
- ** *Anolis armouri* (Cochran)
- *Anolis bahorucoensis southerlandi* Schwartz

Reptiles and Amphibians--Massif de la Selle (cont.)

Anolis coelestinus coelestinus Cope
Anolis cybotes cybotes Cope
Anolis distichus dominicensis Reinhardt and Lutken
* *Anolis hendersoni ravidormitana* Schwartz
Anolis ricordi subsolanus Schwartz
Anolis semilineatus Cope
* *Anolis singularis* Williams
* *Chamaelinorops barbouri* Schmidt
Leiocephalus melanochlorus hypsistus Schwartz
Leiocephalus personatus personatus Cope

Family Teiidae (1 taxon)
Ameiva taeniura varica Schwartz

Suborder SERPENTES

Family Typhlidae (4 taxa)
* *Typhlops capitulata capitulata* Richmond
Typhlops hectus Thomas
* *Typhlops pusilla* Barbour
Typhlops sulcata Cope

Family Leptotyphlopidae (1 taxon)
* *Leptotyphops leptepileptus* Thomas, McDiarmid, and Thompson

Family Boidae (3 taxa)
* *Epicrates fordi fordi* Gunther
Epicrates gracilis hapalus Sheplan and Schwartz
Epicrates striatus striatus Fischer

Family Tropidophiidae (1 taxon)
Trophidophis haetianus haetianus Cope

Family Colubridae (9 taxa)
Alsophis anomalus (Peters)
Antillophis parvifrons protenus (Jan)
* *Darlingtonia haetiana perfector* Schwartz and Thomas
* *Darlingtonia haetiana vaticinata* Schwartz
Hypsirhynchus ferox ferox Gunther
Ialtris dorsalis (Gunther)
Uromacer catesbyi catesbyi (Schlegel)
Uromacer frenatus frenatus (Gunther)
Uromacer oxyrhynchus Dumeril and Bibron

Suborder Amphisbaenia

Family Amphisbaenidae (2 taxa)
Amphisbaena innocens Weinland
* *Amphisbaena manni* Barbour

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							
White-winged Warbler	E	10	10	9	8	5	**92.4**
Chat Tanager	E	9	9	10	8	5	**90.2**
White-winged Crossbill	E	10	9	9	8	1	**81.4**
Black-capped Petrel	E	10	10	6	10	1	**81.4**
Antillean Piculet	T	6	7	8	8	5	**74.8**
Hispaniolan Trogon	T	7	7	8	8	4	**74.8**
Antillean Euphonia	T	7	8	8	8	1	**70.4**
Hispaniolan Parrot	T	9	7	8	6	1	**68.2**
Pine Warbler	T	4	8	8.5	8	1	**64.9**
Antillean Siskin	V	4	8	8	7	1	**61.6**
Hispaniolan Emerald	V	5	5	8	8	2	**61.6**
Grey-crowned Palm Tanager	V	3	4	10	6	4	**59.4**
Scaly-naped Pigeon	T	7	7	4	8	1	**59.4**
Narrow-Billed Tody	V	4	5	8	6	3	**57.2**
Rufous-throated Solitaire	V	4	5	7	8	2	**57.2**
Collared Swift	V	5	8	3	8	1	**55.0**
Found in La Visite but not Macaya							
Green-tailed Ground Warbler	T	7	6	10	8	5	**79.2**
La Selle Thrush	T	7	8	10	7	1	**72.6**

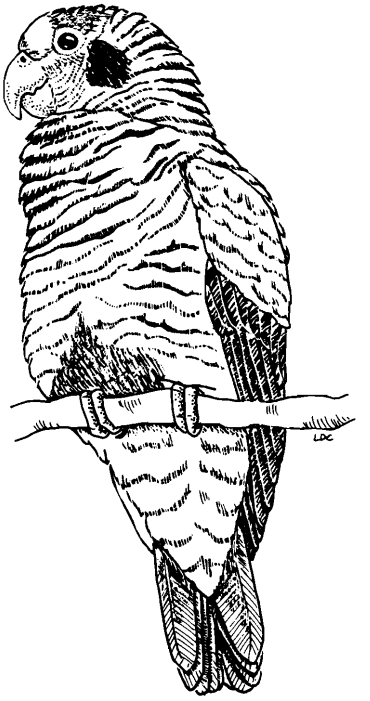
SPECIES	STATUS
LAND BIRDS	
Cuculidae	
Hispaniolan Lizard Cuckoo	
Saurothera longirostris	E
Bay-breasted Cuckoo	
Hyetornis rufigularis	E
Caprimulgidae	
Least Pauraque	
Siphonorhis brewsteri	E
Trochilidae	
Hispaniolan Emerald	
Chlorostilbon swansonii	E
Psittacidae	
Hispaniolan Parrot	
Amazona ventralis	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**

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**).

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 Dec	2000 m May	1000 m 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.



Hispaniolan Parrot

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*

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

MAMMAL DIVERSITY IN WEST INDIAN ISLANDS

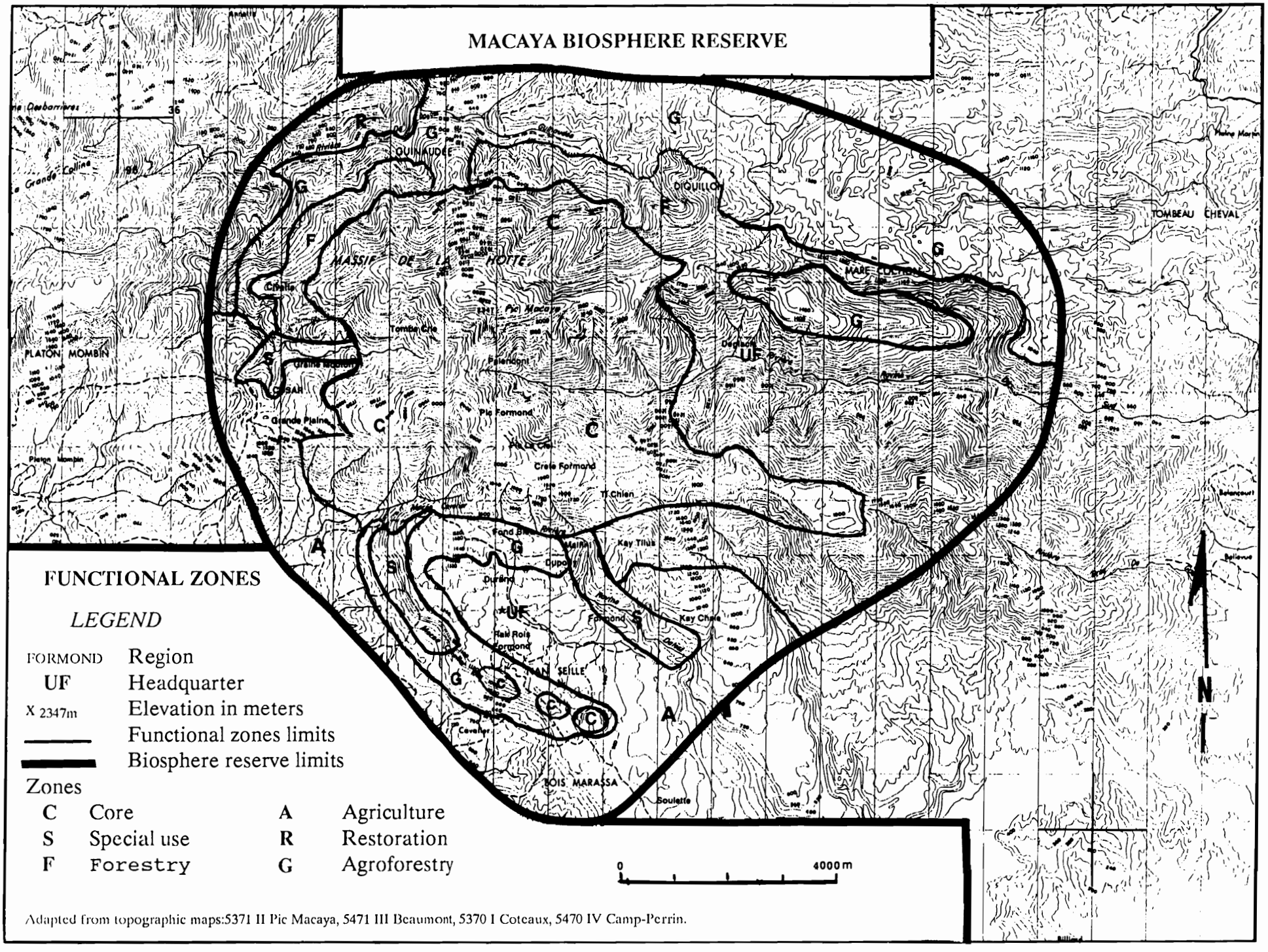
ISLAND	SIZE (sq. kms)	ELEVATION (meters)	MAMMALS (# species) Non-volant	Bats	Total	Div. Index
Cuba	111463	1973	43	33	76	7
Hispaniola	76193	3175	28	19	47	13
Jamaica	11424	2256	5	23	28	10
Puerto Rico	8865	1338	6	16	22	11
Andros	5957	22	1	4	5	6
I. Pines (Juventud)	3000	310	8	18	26	8
Guadeloupe	1510	1467	1	11	12	9
Great Abaco	1681	44	1	3	4	4
Great Inagua	1544	33	0	5	5	5
Grand Bahama	1373	21	0	1	1	1
Martinique	1102	1397	1	10	11	9
Dominica	751	1447	0	10	10	7
La Gonave	680	776	8	8	16	11
St. Lucia	616	950	1	8	9	7
Eleuthera	518	51	1	4	5	5
Long	448	54	1	6	7	7
Barbados	431	340	1	7	8	7
Cat	389	62	1	5	6	6
Acklins	389	43	0	5	5	5
St. Vincent	344	1234	1	9	10	6
Mayaguana	285	40	0	3	3	3
Antigua	280	402	1	9	10	11
Crooked	238	47	1	5	6	6
St. Croix	207	353	1	4	5	5
New Providence	207	37	1	13	14	7
Caicos	190	28	1	6	7	6
Exuma	187	38	1	7	8	7
Grand Cayman	185	42	3	8	11	8
La Tortue	180	464	3	7	10	8
St. Kitts	180	1155	1	6	7	5
Watlings (San Salvador)	163	37	1	4	5	5
Barbuda	160	39	2	11	13	8
Marie Galante	153	204	1	1	2	2
Nevis	130	985	0	6	6	3
Montserrat	102	915	2	9	11	6
St. Martin	88	485	1	7	8	6
St. Thomas	70	209	1	5	6	5
Mona	50	low	1	3	4	4
St. John	49	389	1	6	7	5
Beata	40	low	3	2	5	3
Anegada	34	8	0	1	1	1
Cayman Brac	31	138	3	6	9	7
St. Eustatius	31	600	1	6	7	5
Little Cayman	24	23	0	2	2	2
Saba	13	870	0	3	3	3
E. Plana	5	20	1	1	2	2
Swan	2	low	1	0	1	1

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

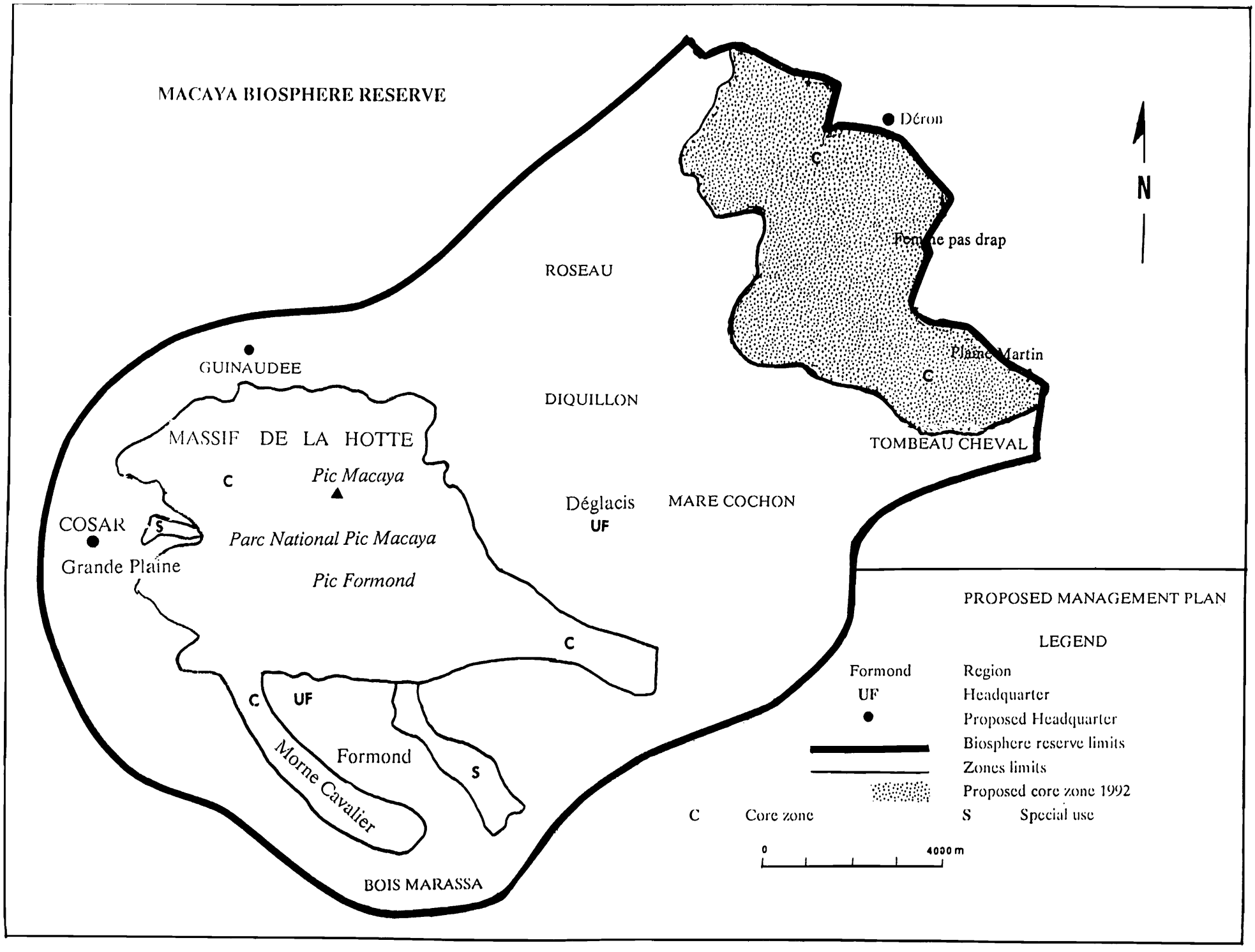
List of fossil and Recent land mammals in order of abundance collected from Trouing Jeremie #5, the type locality of Rhizoplagiodontia lemkei, located the base of Pic Formon in the upper Plain of Formon. (C = common, U = uncommon; R = rare; EX = extinct). The analysis is of the top 4 cm of sediment.

Species	Status		% of
	Recent	Fossil	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

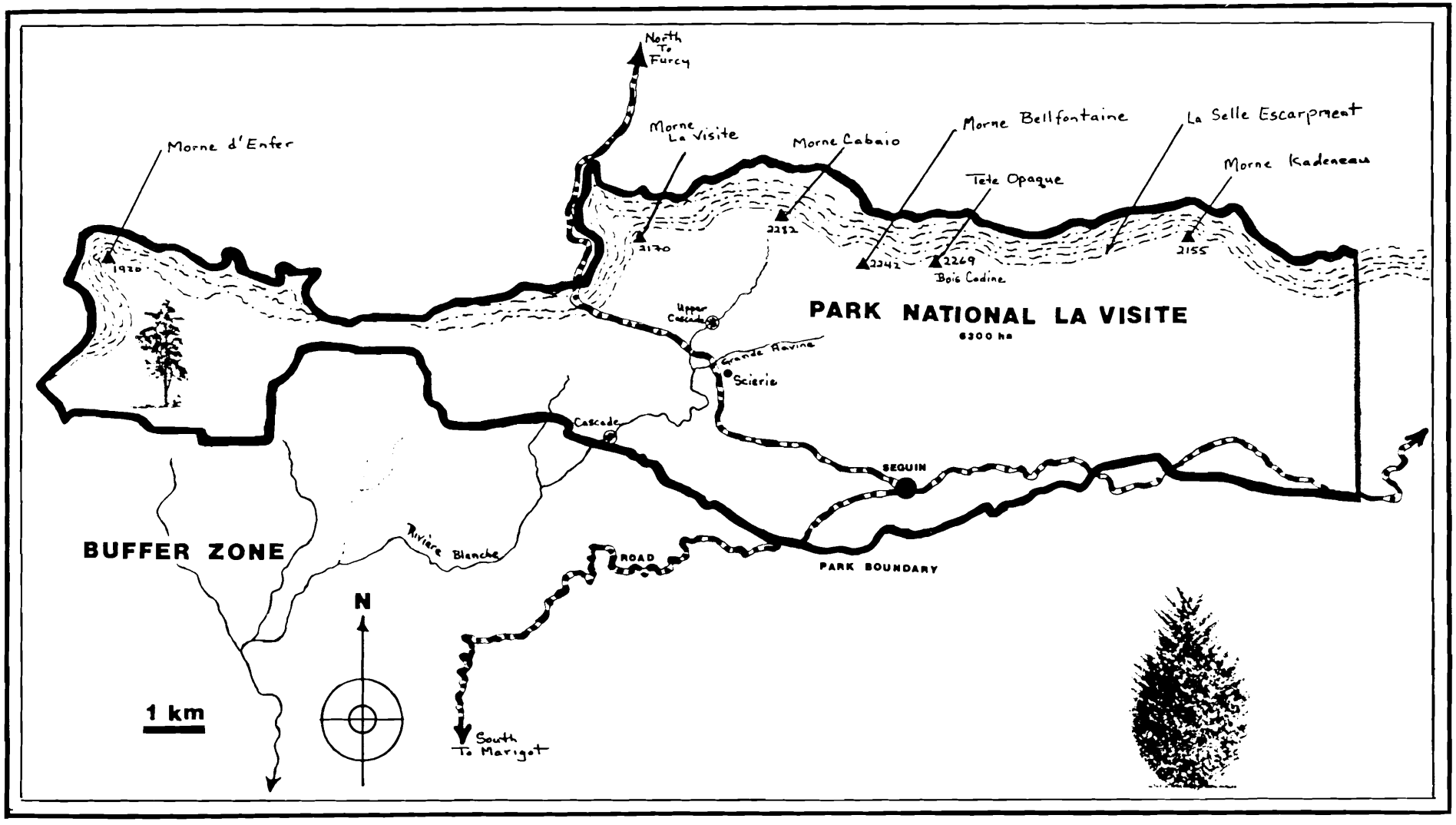


Adapted from topographic maps:5371 II Pic Macaya, 5471 III Beaumont, 5370 I Coteaux, 5470 IV Camp-Perrin.

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