USAID
FROM THE AMERICAN PEOPLE

Ministerio de Medio Ambiente y Recursos Naturales
GOBIERNO DE EL SALVADOR
UNIR, CRECER, INCLUIR

COMPREHENSIVE INVENTORIES OF SELECTED BIOLOGICAL RESOURCES WITHIN TARGETED WATERSHEDS AND ECOLOGICAL CORRIDORS OF SOUTHWESTERN EL SALVADOR

IMPROVED MANAGEMENT AND CONSERVATION OF CRITICAL WATERSHEDS PROJECT

SEPTEMBER 2009
THIS PUBLICATION HAS BEEN PRODUCED FOR REVIEW BY THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT. IT WAS PREPARED BY DEVELOPMENT ALTERNATIVES INC. (DAI) AND SALVANATURA.

COMPREHENSIVE INVENTORIES OF SELECTED BIOLOGICAL RESOURCES WITHIN TARGETED WATERSHEDS AND ECOLOGICAL CORRIDORS OF SOUTHWESTERN EL SALVADOR

IMPROVED MANAGEMENT AND CONSERVATION OF CRITICAL WATERSHEDS (IMCW) PROJECT

Contract No. EPP-I-00-04-00023-00
Strategic Objective No. 519-022
Contractor Name: DAI
Date: September 2009

Oliver Komar, editor.
Research Supervisor, Improved Management and Conservation of Critical Watersheds Project, and Director, Conservation Science Department, SalvaNATURA, San Salvador, El Salvador

Chapter authors are Oliver Komar, José L. Linares, Francisco Chicas Batres, José Alberto González Leiva, Vladlen Henríquez, Xiomara Henríquez, Luis E. Girón, Melissa Rodríguez, and James G. Owen.

Recommended citation:

Komar, O. (Editor). 2009. Comprehensive Inventories of Selected Biological Resources within Targeted Watersheds and Ecological Corridors of Southwestern El Salvador. USAID El Salvador, Improved Management and Conservation of Critical Watersheds Project.

Or for individual chapters, following this example:

Linares, J. L. 2009. Flora inventory in Southwestern El Salvador. in Komar, O. (editor). Comprehensive Inventories of Selected Biological Resources within Targeted Watersheds and Ecological Corridors of Southwestern El Salvador. USAID El Salvador, Improved Management and Conservation of Critical Watersheds Project.

Cover: *Cuscatlania vulcanicola*, a species rediscovered in the Coatepeque watershed. Photo by Frank Sullyvan Cardoza.

TABLE OF CONTENTS

TABLES AND FIGURES

TABLES

FIGURES

ACKNOWLEDGMENTS

This study was funded by a contract from USAID to DAI, Inc. and a subcontract to SalvaNATURA. This study was made possible by the support of the land managers who gave their permissions to carry out field work, including managers of the Protected Natural Areas System at the Ministry of Environment and Natural Resources, in particular Zulma Ricord de Mendoza, Walter Rojas, Alfonso Sermeño, and Patricia Quintana.

In the natural areas visited, we thank the following for their collaboration: Carlos Batres of Finca Monte Carlo Estate at Laguna de Las Ninfas; Nidia Lara of AGAPE at Plan de Amayo; the Instituto Salvadoreño de Turismo for work at Cerro Verde; Martha Huezo de Sandoval for lodging at Playa Los Cóbanos; FUNDARRECIFE, especially Luis Pineda, at Los Cóbanos; Walter Martínez of Asociación de Desarrollo Comunal Nueva Esperanza (ADESCONE) at Bosque Santa Rita; COEX and Finca El Pireo at Laguna de Las Ranas; Cooperativa San Rafael Los Naranjos at Cerro El Aguila; María Isabel Morales of Asociación Salvadoreña para la Conservación del Medio Ambiente (ASACMA) at Complejo San Marcelino; staff of the Natural Areas Department of *Salva*NATURA (Francisco Soto and Enrique Fuentes in particular) at Los Volcanes National Park and at El Imposible National Park. Also personnel of CATIE and Cooperativa María Auxiliadora for assistance at Los Volcanes National Park. Personnel of the Santo Domingo de Guzmán mayor's office assisted with visits to the municipality. The National Civil Police provided lodging at Barra Salada.

Botanical field trips and reports were assisted by Frank Sullyvan Cardoza, Vladlen Henríquez, Xiomara Henríquez, and Manuel Méndez. Herpetology field trips were accompanied by student volunteers Diana Quijano, Eder Caceros, Esmeralda Martínez, Jorge Herrera, and Vanessa Amaya. Karla Lara collected herpetofaunal data at Los Cóbanos. Mammalogy field trips were assisted by Arnulfo Morán, Elias Delgado, Alexandro Molina, and volunteer students Karla Lara, Stefany Henríquez, Verónica Guzmán, Jonathan Hernández, Enrique Fajardo, and Jorge García. Ornithology field trips technicians included Jesse Fagan, Carlos Funes, Jorge Jiménez, Sofia Trujillo, Iselda Vega, and Carlos Zaldaña and several volunteers.

All of the field trips were greatly assisted by numerous park wardens, for whom we are grateful, and apologize for not listing all of their names. Similarly, numerous officers of the National Civil Police, Environment division, provided security and assistance at several field sites.

The data in the SalvaNATURA flora and fauna database comes from many sources, both published and unpublished. Of particular note are extensive unpublished observations of birds contributed by Néstor Herrera, Ricardo Ibarra, Tom Jenner, Oliver Komar, Alvaro Moises, and Walter Thurber. The data base contains thousands of banding and observation records from the SalvaNATURA bird monitoring program, collected mostly by Lety Andino, Vicky Galán, Roselvy Juárez, Jennifer Smith, and their assistants.

Gerrit Davidse of the Missouri Botanical Garden graciously provided all the records from that institution that were requested. Frank Sullyvan Cardoza assisted with the flora database of the Escuela Agrícola Panamericana.

Héctor Manuel Quezada, Karen Xiomara García, and German Bladimir Sánchez provided valuable collaboration in the compilation of información in the fish database. Authorities and technical staff of the Natural History Museum of El Salvador and Miriam Cortez de Galán, coordinator of the zoology collections at the School of Biology of the University of El Salvador, facilitated the review of preserved fish collections.

Maps were prepared by Vladlen Henríquez, Juan Felipe Gutiérrez, and Luis Girón. For the many contributors, we extend sincere thanks and apologize for not listing everyone's name.

All chapters were reviewed by Oliver Komar. Selected chapters were reviewed by Néstor Herrera, Ricardo Ibarra Portillo, and Enrique Barraza. Marta Lilian Quezada and Melissa Rodríguez assisted with formatting. The director of the Improved Management and Conservation of Critical Watersheds Project during the implementation of this study was Steve Romanoff.

EXECUTIVE SUMMARY

Comprehensive biological inventories were carried out during the second half of 2007 as part of the Improved Management and Conservation of Critical Watersheds (IMCW) Project, in southwestern El Salvador. This field work focused on trees, herpetofauna (amphibians and reptiles), mammals, and birds in the principal natural areas, such as at Los Volcanes and El Imposible National Parks, and in targeted watersheds and ecological corridors. Specific field trips were designed to fill gaps in the biological inventory. Also, bibliographical and museum data on fishes were collected and reviewed.

The objective of this work was to develop more complete information on the status of biological resources, and effectively complete baseline information on distribution of key indicator species. Widely-distributed species that are habitat generalists were used as indicators of inventory progress, permitting the estimation of relative levels of inventory completeness for the entire project area and also at the finer scales of watersheds and municipalities, and in some cases, protected natural areas. Globally and nationally threatened (red-listed) species were used as indicators for conservation importance of sites.

Field surveys were carried out in six or more priority watersheds for each of the taxonomic groups studied, but not all taxonomic groups were studied in every watershed visited. In all, field studies of flora and/or fauna were carried out in 10 of the Project area's 11 watersheds during the study period. The studies increased the completeness of the biological inventory in 10 different ecosystems, and in 11 municipalities.

The study area contains the country's two largest national parks, El Imposible and Los Volcanes, and other important natural areas such as the Los Cóbanos coral reef, with many species of conservation importance. The Barra de Santiago mangrove estuary is also well known for important natural resources, including some unique aquatic species found nowhere else in the country. Field work was carried out at Los Volcanes National Park (plants, herpetofauna, mammals, birds), El Imposible National Park (plants, herpetofauna, mammals), and numerous corridor sites, such as within the Barra de Santiago—Garita Palmera estuaries (reptiles, mammals, birds), the El Imposible—Los Volcanes corridor (all taxonomic groups), and Barra de Santiago—El Imposible (birds). Fish resources were evaluated, via a desk study, in all of these areas.

The biodiversity inventory in the study area is probably the most complete of any area in El Salvador. We have identified 2719 species, including 584 trees and 1287 other plants, 220 fishes, 96 amphibians and reptiles, 101 mammals, and 431 birds, based on a cumulative database of nearly 40,000 modern and historical locality records. More than 1% of the species (37) are globally threatened (red-listed), and 15% (401) are nationally threatened. Some of the country's rarest species exist only in the project area. Of special note are at least 22 vertebrate species (without considering fishes) that are restricted in El Salvador to the area's natural habitats. One fish, described for science in 2007, is considered restricted (in the world) to Lake Coatepeque (Schmitter-Soto 2007). Even more impressive, at least 14 plant species

(10 trees and four herbs) are unique to the study area, including 6 new plant species discovered for science during the field work; these are natural resources found nowhere else in the world.

FLORA

The field work was carried out during 65 days, between the months of June 2007 and January 2008, recording a total of 1164 herbarium samples coming from approximately 707 vascular plant species. The results found include up to 11 probable new species for science, plus two new records for Central America, 10 new records for El Salvador, and two rediscoveries. Of the 584 tree species recorded, 23 of these are on the IUCN list of globally threatened (red-listed) species and one more should be included due to its rarity. Fourteen plant species are restricted in the world to the area of the project, including 10 trees and 4 herbs. Six of these endemic plants have yet to be described for science.

At the watershed level, the Cara Sucia watershed presents the most advanced tree inventory, with 82% of the expected tree species recorded. Before the execution of this study, only 64% had been recorded. At the municipal level, San Francisco Menéndez presents an 86% level of inventory completion, an increase from 68%. At the ecosystems level, Humid Forest and Savannas present 100% inventory completion, based on the presence of expected tree species, and the Cloud Forest 95%. Dry Forest presents an 86% level of completion. The Dry Forest's ecosystem presents a greater amount of species that are recognized as important for conservation, 12 species; followed by Humid Forest with 9 and Cloud Forest with 4 species.

FISH

A comprehensive bibliographic revision was made on the fish studies in the study area up until 2007, and the collections at the School of Biology of the University of El Salvador and at the Museum of Natural History of El Salvador were also verified. Only 753 records of fish species were found, documenting 220 fish species, of which 19 are Freshwater, 16 Freshwater-Brackish, 57 Estuarine, 21 Marine, 18 Reef-Marine and 89 Reef. Consequently, the level of inventory completion per ecosystem was: Freshwater 63% of expected species recorded, Estuarine had 56%, Reef had 55% and Marine barely reached 18%. The estimated percentage progress of the inventory for the whole study area was 41%.

The fish inventories within individual watersheds are very incomplete. The greatest inventory completion estimates at the watershed level were presented in Coatepeque with 32%, Los Cóbanos with 29%, Barra de Santiago with 24%, and Cara Sucia with 12%. The analysis by municipality shows records in just seven municipal districts, of which Acajutla has reached 27% inventory completion, Jujutla 24%, Tacuba and San Francisco Menéndez 19% and 12% respectively, while Sonsonate and Chalchuapa each register 8%.

Fifty-one fish species have been recognized as important for conservation, including freshwater species and others that are strictly reef-associated. According to the IUCN Red List, three reef species and one marine species in the study area are globally threatened. The

most important areas for conservation are the Los Cóbanos Reef System and Barra de Santiago estuary, as these are deemed highly productive areas and operate as integrated habitats for many coastal fish populations. Lake Coatepeque and the fluvial systems of the area are also included herein as conservation priorities, as these maintain the freshwater native species.

AMPHIBIANS AND REPTILES

Field work was carried out for a 130-day period, during the months of June and December 2007, registering a total of 96 species (22 amphibian species and 74 reptile species) with a total of 1279 records. The results obtained included 20 new records, three new reports for the project area and 17 new records at the departmental level. Of the 96 species that were registered, 50 are on the national or global threatened species list and of these eight are globally threatened.

At the watershed levels, the Izalco watershed presents a more advanced level of inventory completion with 74% of the expected species (indicators of inventory completion). Before the execution of this Project, the level of completion for this watershed was 47%. At the municipal level, San Francisco Menéndez presents a high level of inventory completion at 92% (an 18% increase). At the ecosystems level, the Dry Forest presents a relatively complete inventory (100% of the indicator species were detected) and another four ecosystems have completed inventories in a similar or greater percentage to 80%. At the level of the six Protected Natural Areas, where this study was carried out, the El Imposible National Park presents an inventory completeness of 85%. The five remaining natural areas present a level of inventory completenesse between 65 and 80%.

The Humid Forest ecosystem presents a greater amount of conservation importance species (28 species) followed by freshwater ecosystems (12 species) and the Dry Forest (10 species).

BIRDS

The ornithology team worked for 116 days in the field, at 8 sites, comprising 7 watersheds, 8 municipalities, and 6 ecosystems. The sites included 7 protected natural areas, and some non-protected areas. The team logged 10,724 mistnetting hours, and 296 hours of observations, generating 4,068 new locality records, supplementing the 21,724 locality records previously available from southwestern El Salvador. The bird list for the study area was increased from 412 to 424 bird species by the field work. Seven additional species (mostly marine species) have been discovered independently, thus the project area's bird list is now 431 species (79% of the country's avifauna). Ten of 11 watersheds now have reasonably complete inventories (on average, 86% of the expected inventory-indicator species have been recorded), compared to five watersheds with well-advanced inventories prior to this study. Only eight municipalities have sufficiently complete (>75%, mean 92%) inventories for analysis, compared with five prior to the study. Six of eight ecosystems now have complete inventories (>80%, mean of 90%). These 10 watersheds, 8 municipalities, and 6 ecosystems can be compared for their importance for conservation of threatened bird species.

The 188 nationally threatened bird species used as indicators for prioritizing sites of national conservation importance include 31 that are critically endangered, 69 endangered, and 88 vulnerable. The Cara Sucia and the Barra de Santiago watersheds (both include parts of El Imposible National Park and parts of Barra de Santiago estuary) have the highest conservation importance, with more than 70% of the area's nationally-threatened bird species present. They are distantly followed by the Coatepeque and Izalco watersheds (which both include parts of the Apaneca-Ilamatepec Biosphere Reserve). At the municipal level, the most important cities are San Francisco Menéndez (El Imposible National Park and Santa Rita Forest) and Jujutla (Barra de Santiago Protected Natural Area), with 68% and 57% of the area's threatened bird species, respectively. Estuaries have 39% of the threatened bird species (including many shorebirds and water birds). Although Humid Forest and Dry Forest have fewer threatened birds (33% and 26%, respectively), these are mostly forest specialists, which are at risk from fragmentation and climate change.

MAMMALS

Field work was carried out during 105 days, registering 1296 individuals of 72 mammal species, of which 49 were captured, 17 photographed with camera traps, 21 were recorded by observations and five were recorded only outside of the standardized sampling. Four species were recorded for the first time in the whole study area (including one that was new for the country, Van Gelder's Bat *Bauerus dubiaquercus*), increasing the mammal list for the study area to 101 species. We estimated that an index of inventory completion for the study area went from 92% to 100% after this study, suggesting that the mammal inventory is virtually complete. Nonetheless, specific natural areas still have incomplete lists. The protected natural areas with the most advanced mammal inventories are: El Imposible (81%), Santa Rita (63%), and Los Volcanes (52%).

Twenty-two mammal species recorded in the study area are nationally threatened, or are indicators of conservation-importance sites. Such species include the Margay Cat (*Leopardus wiedii*), the Ocelot (*Leopardus pardalis*), the River Otter (*Lontra longicaudis*), and Baird's Tapir (*Tapirus bairdi*) (these last three species have been recorded in previous years, but not during this study). At the national level, 11 threatened species and seven endangered species are reported (MARN 2004), as well as one species considered globally endangered (IUCN 2008).

Based on the presence of nationally and globally threatened and endangered terrestrial mammal species, the Dry Forest ecosystem is more important than the Humid Forest. However, the rest of the ecosystems, the majority of the watersheds, the municipalities, and the protected natural areas cannot be compared for conservation importance, because their mammal inventories are not yet reasonably complete.

RECOMMENDED STRATEGIES FOR CONSERVATION AND SUSTAINABLE ECONOMIC DEVELOPMENT

Conservation strategy recommendations for estuaries focus mostly on education and awareness-building, while for upland habitats, forests need to be expanded and organized to connect fragments via altitudinal corridors, ideally along rivers. More flora and faunal inventory work is needed (especially flora), as well as long-term population monitoring, in order to track progress with climate change adaptability projects that should be implemented in the region.

Ten recommendations for sustainable economic development identify the need to increase or promote activities such as payments for environmental services, sustainable forestry, urban and rural planning, agricultural certification, wildlife farms for diverse markets and export opportunities, development of sustainable businesses (such as ecotourism services), and government involvement in facilitating access by ecotourists to natural areas. Scientific tourism presents great potential, as a sustainable use of natural resources, and could also generate greater demand among international tourists for visiting natural areas in the project area, such as the national parks, biosphere reserves, and coral reef. A reintroduction program for the locally-extinct Scarlet Macaw can help rally multilateral support for sustainable development in the Barra de Santiago–El Imposible biological corridor. Certain development ~~-o~~pportunites" may cause more harm than good, however, and much care should be taken before promoting practices such as expansion of biofuels or other high-input agricultural crops, or factories that require high inputs of water or fuels.

CHAPTER 1:

SYNTHESIS AND SUMMARY OF THE BIODIVERSITY FIELD INVENTORIES

Oliver Komar
Conservation Science Department, SalvaNATURA
San Salvador, El Salvador
okomar@salvanatura.org

1. INTRODUCTION

A key element to the sustainable economic development of southwestern El Salvador is conservation of biodiversity. This region of El Salvador contains several of the country's most important wildlife reserves, including the two largest national parks and one of the country's two biosphere reserves. It has substantial tourism and ecotourism potential, with resources such as "la Ruta de las Flores", El Salvador's largest volcano (Ilamatepec) and its youngest (Izalco), the country's only coral reef, and extensive beaches. Despite a long history of biodiversity investigation in the area, the flora and fauna inventory was both taxonomically and geographically incomplete (Komar 2007). As a signatory to the Convention on Biological Diversity, for some time it has been a national priority in El Salvador to complete the inventories of all flora and fauna groups (MARN 2000a). Knowledge of the wildlife species present and their patterns of distribution and habitat use are essential for truly sustainable development to take place.

A principal objective of the Improved Management and Conservation of Critical Watersheds (IMCW) Project, which was planned to run from the end of 2006 through the end of 2009, is the conservation of biodiversity in several watersheds of Ahuachapán and Sonsonate, southwestern El Salvador. One of the scheduled outputs of this project is the realization of a comprehensive, multi-taxon biodiversity field inventory in selected watersheds, which this report summarizes. The IMCW Project also commissioned a preliminary study of the baseline biodiversity information available, which was completed prior to the initiation of the present study (Komar 2007). That report summarized the state of knowledge about plants, butterflies, amphibians, reptiles, mammals, and birds. It determined that 2,457 species of flora, butterflies, amphibians, reptiles, mammals, and birds had been recorded through 2006. More than half (1716 species) were plants. They included 325 nationally threatened species and 24 globally threatened species of flora and fauna. This latter group includes mostly trees and just seven vertebrates (four sea turtles, two frogs, and tapir which is presumed to be extirpated). However, there are extensive areas where practically no inventory efforts have been

undertaken, and the inventory is still far from complete for most taxonomic groups. Also reported in the baseline preliminary inventory was the presence of 48 plant species and 22 vertebrates (excluding fish) in the Project area that have not been recorded in other localities of El Salvador (Komar 2007). Reported separately was a unique fish in Lake Coatepeque, which thus became the only endemic vertebrate known to be unique to El Salvador (Schmitter-Soto 2007).

The IMCW project was interested in determining if specific watersheds or sites within southwestern El Salvador were more important than others for conserving biodiversity. In order to conserve overall diversity, maintaining a large number of species in a region, a strategy must focus on assuring that habitat specialists (and their habitats) are preserved, even if some specialized habitats have relatively few (but unique) species. It is not necessary for every habitat conserved to be of high species richness or diversity. Thus in seeking conservation priorities across sites, one must look for unique and rare species at the sites, and not simply count species. Comparison of sites requires the existence of complete inventories at the site level, rather than standardized counts of species. The purpose of the present study was to advance the state of the flora and fauna inventories for a series of sites and ecosystems in southwestern El Salvador, such that relative value for biodiversity conservation could be assessed.

The following chapters include the evaluation of the current state of inventories (at the beginning of 2008) for flora, fishes, herpetofauna (amphibians and reptiles), mammals, and birds in the entire IMCW project area. The present chapter includes a summary and comparison of the state of the inventories among these taxonomic groups. The main purpose is to establish conservation priorities and recommendations for future economic development.

2. STUDY AREA AND METHODS

The study area includes 11 watersheds that drain into the Pacific Ocean (Fig. 1), defined following the preliminary analysis that served as a baseline to this study (Komar 2007), as follows. The relatively large Río Banderas watershed was divided into three watersheds for the purpose of biological analysis: the lower Río Banderas (coastal plain), the Izalco watershed which drains most of Los Volcanes National Park, and the San Julian watershed which drains the northwestern sector of the Sierra del Bálsamo. The Los Cóbanos area was treated as a single watershed, although technically it consists of seven minor watersheds, each draining a small segment of the Los Cóbanos plain (an ancient landslide originating from the Santa Ana volcano); the divides of these tiny watersheds are almost indistinguishable in the field. The large Barra de Santiago watershed was divided into two: "Cara Sucia," which drains the western two-thirds of El Imposible National Park, and "Barra de Santiago" which drains the eastern third of the national park and several valleys to the east. Most of the rivers in the Cara Sucia watershed are drained or go underground before they reach the ocean.

Data previously available (Komar 2007) was combined with new data generated from the field work for conservation analyses of 11 watersheds and 25 municipalities that form the IMCW Project area in southwestern El Salvador (Fig. 1). This area covers the southern region of the department of Ahuachapán, the entire department of Sonsonate, and marginal areas of the

departments of Santa Ana and La Libertad. Three additional municipalities within the Project area (Ahuachapán, Atiquizaya, and El Congo) were excluded from the analysis because only insignificant areas of their territories are within the Project area. In total, the Project area covers 1545 km^2, or 7.4% of El Salvador. The Project area includes four terrestrial ecoregions, nine natural ecosystem types and a variety of anthropogenic land uses (Fig. 2). It also includes dozens of fragments of natural habitat areas, including 10 natural areas in various states of formal protection that were visited during the field surveys.

Field inventories were conducted during 2007 (and January 2008) for selected taxonomic groups: trees (and opportunistically other types of flora), amphibians, reptiles, mammals, and birds. Other groups, such as insects and other invertebrates, were not included in the study plan because they are harder to identify, and relative importance for conservation has not been established at the species level (i.e, we don't know which species are threatened with extinction). Butterflies were originally included in the study plan but removed when negotiations with a potential field team were unsuccessful. Fish were originally excluded from the study plan because El Salvador lacked a list of threatened fish species and because of lack of taxonomists in the country. Part of the savings from the canceled buttefly inventory were reinvested in a preliminary baseline evaluation of the state of knowledge of the fish inventory, which is included as a chapter in this report.

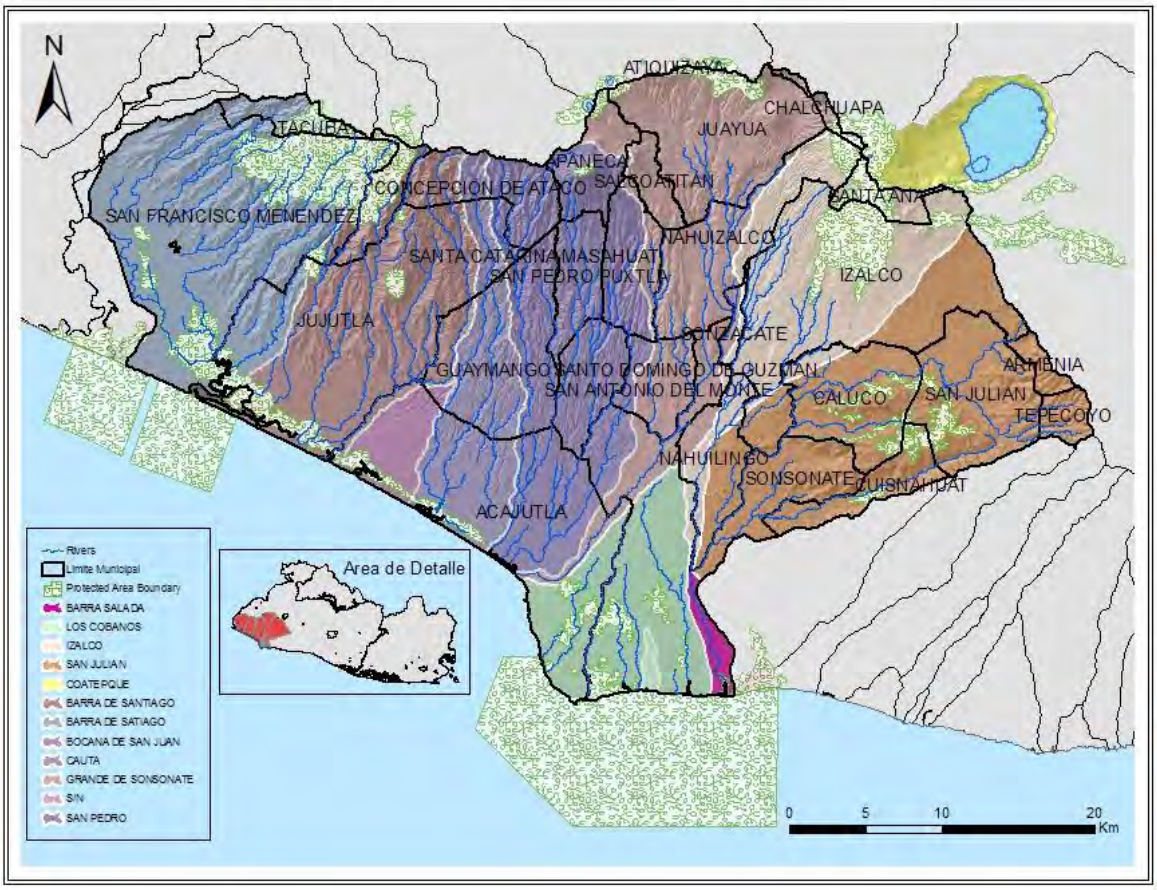

FIGURE 1. THE IMCW PROJECT AREA CONTAINS 11 WATERSHEDS AND 25 MUNICIPALITIES, AS WELL AS SEVERAL ADJOINING PROTECTED NATURAL AREAS.

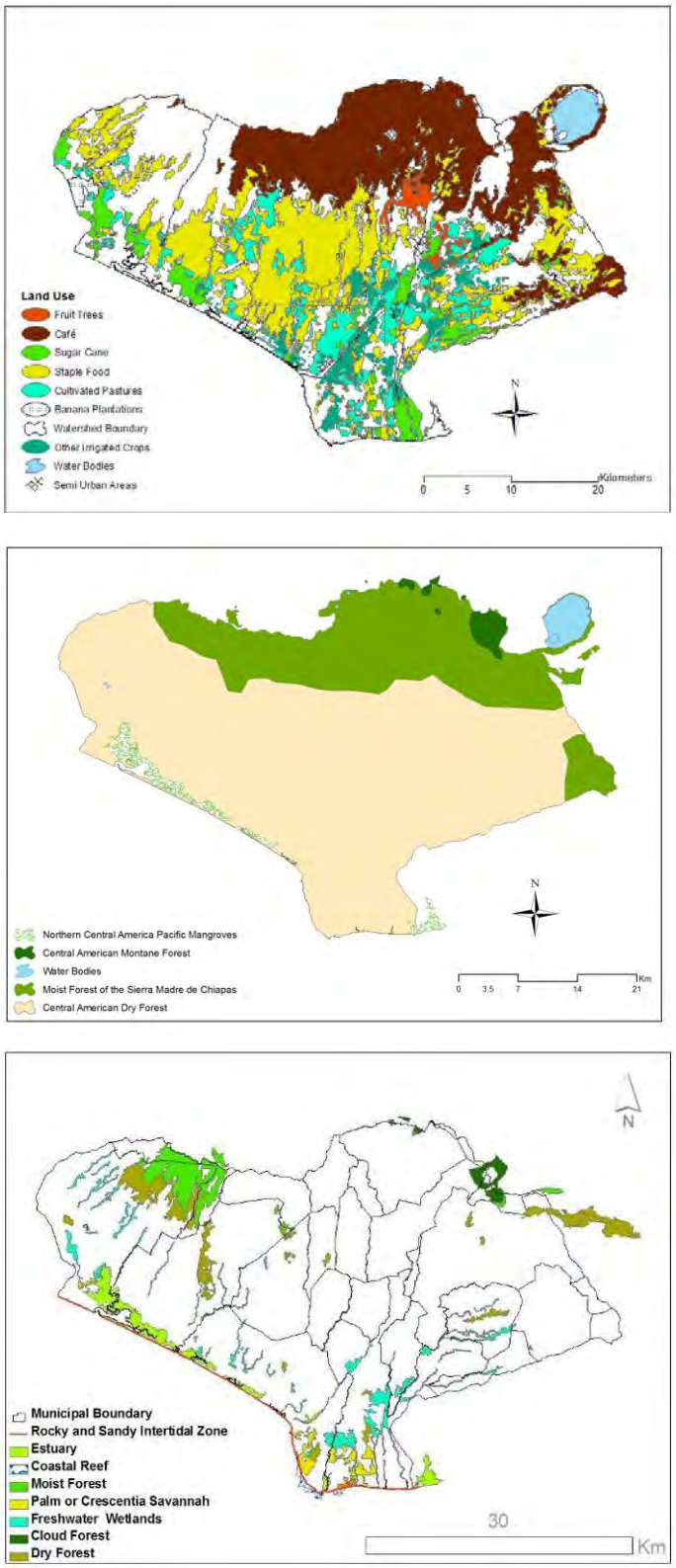

FIGURE 2. ECOREGIONS, NATURAL ECOSYSTEMS, AND ANTHROPOGENIC LAND USES (TOP TO BOTTOM) IN THE STUDY AREA.
Maps prepared by J. F. Gutiérrez.

TABLE 1. GEOGRAPHIC DISTRIBUTION OF FIELD DAYS FOR THE BIODIVERSITY SURVEYS CARRIED OUT DURING 2007 IN THE IMCW PROJECT AREA.

Location	Water-shed(s)	Munici-palities	Flora	Amphibians & Reptiles	Mammals	Birds
El Imposible National Park	Cara Sucia, Barra de Santiago	San Franciso Menéndez, Tacuba	25	20	40	0
Los Volcanes National Park	Izalco	Izalco, Santa Ana	15	20	20	20
Plan de Amayo PNA	San Julian	Caluco	15	20	10	12
Complejo San Marcelino PNA	Izalco, Coatepeque	Izalco	5	20	5	0
Cerro El Águila PNA	Río Grande de Sonsonate	Juayúa	5	0	0	0
Santa Rita y Zanjón El Chino PNA	Cara Sucia	San Franciso Menéndez	0	20	5	20
Laguna de Las Ninfas PNA	Río Grande de Sonsonate	Apaneca	0	20	5	11
Los Cóbanos PNA	Los Cóbanos	Sonsonate, Acajutla	0	10	10	20
Laguna de las Ranas PNA	Río Grande de Sonsonate	Juayúa, Chalchuapa	0	0	10	10
Santo Domingo de Guzmán	San Pedro	Santo Domingo de Guzmán	0	0	0	4
Barra Salada Sector (Los Cóbanos PNA)	Lower Río Banderas	Sonsonate	0	0	0	19
Total days of field work			65	130	105	116

PNA = Protected Natural Area

TABLE 2. HISTORICAL AND NEW RECORDS OF FLORA AND FAUNA IN THE IMCW PROJECT AREA, THROUGH 2007 (SOURCE: SALVANATURA'S FLORA AND FAUNA DATABASE*).

Taxon	Specimens	Other records (observations, photos, etc.)	Totals
Plants	5,313	2,686	7,999
Fish	615	138	753
Amphibians & reptiles	1,500	500	2,000
Mammals	1,200	1,616	2,816
Birds	2,076	23,716	25,792
All combined	10,704	28,656	39,360

*Primary sources include museums, natural history collections (national and foreign), data published in scientific literature and gray literature (project technical reports, etc.), and unpublished data contributed by independent researchers. More details are included in the thematic chapters of this report and in a previous report (Komar 2007).

Field collections or observations for the taxonomic groups were carried out in at least six watersheds, as required in the study's terms of reference, but not necessarily in the same watersheds for each group. The locations for each field inventory during 2007 and early 2008 are given in Table 1.

The various field methods used are detailed in the following chapters for each taxonomic group. In general, a team of botanists and zoologists sought to document the presence and relative abundance of as many species as possible, but with a focus on finding species that were not previously documented in the area. Thus field sites were selected with the aim of filling gaps in the inventory, rather than with the aim for standardized sampling (Komar 2007). This was justified by the objective of evaluating conservation importance, rather than comparing species diversity among sites. In order to ducument the presence of species, the biologists focused on collecting voucher specimens when possible, with one specimen collected for the El Salvador national museum of natural history, and a duplicate collected for a natural history museum or herbarium located outside of El Salvador. Additional specimens captured by various trapping methods were released unharmed. When possible, digital cameras were used to document the presence of species that could not be captured. The field teams used standard capture methods, which do not harm the individuals, such as mist nets for birds and harp traps for bats, under license from the Ministry of Environment and Natural Resources. Camera traps (movement-triggered digital and analog cameras) were used to document the presence of larger mammals.

The new data collected from the field surveys was logged in flora and fauna databases managed in SalvaNATURA's conservation science department. These data were added to the more than 29,000 locality records from the Study Area that had been assembled prior to the field surveys (Komar 2007; Table 2). After completing the field surveys, the updated data set was used to determine the relative level of inventory completeness, both for the whole

project area as well as for individual watersheds, municipalities, and ecosystems. For some groups, completeness levels were evaluated for individual Protected Natural Areas. Completeness was evaluated using the same method used for the baseline evaluation (Komar 2007, following Gómez de Silva and Medellín 2001), which identifies the list of generalist and relatively common species that would be present in any site that has been subjected to a proper inventory effort. Because these are generalist species, they may exist in a variety of habitats, a variety of altitudes, and sites with or without disturbance. These species are used as a ~~t~~est" or indicator for the effectiveness of the efforts to collect data on all the species in an area, and the proportion of test species recorded represents an index of inventory completeness. When 100% of the test species have been recorded, the inventory is considered relatively complete, although some rare species may not yet have been recorded. The species that do not qualify as tests (indicators), such as species restricted to certain natural habitats (~~h~~abitat specialists"), naturally rare species (predators at the top of the food chain), or species of cryptic behavior, may be present but not yet recorded. The method is nonetheless useful for identifying large gaps in the inventory, and to prioritize where to focus future inventory efforts.

Threatened species (i.e., species that are considered endangered and require conservation efforts to prevent local or global extinction) were used as indicators of conservation importance. Threatened status was based on IUCN (2007), MARN (2004), Greenbaum and Komar (2005), and Komar et al. (2009). Conservation priorities among sites were determined by comparing the numbers of nationally and globally threatened species recorded from the field sites, with highest priority assigned to sites with the most threatened species. Since many threatened species are rare, sites with incomplete inventories may not be comparable simply because their threatened species have not yet been documented (Remsen 1994, Komar 2003, Greenbaum and Komar 2005, Komar 2007). Only sites with reasonably complete inventories were used to evaluate site conservation priorities. In the case of the bird inventory, statistics were used to demonstrate the level of completeness required to include a site in the analysis of conservation importance. The richness of threatened species was regressed against the inventory completeness index score to determine if inventory effort was a significant predictor of conservation importance. If the slope of the regression line was significantly different from zero ($P<0.05$), then sites with low completeness scores were removed from the analysis until the regression slope was not significantly different from zero ($P>0.05$), indicating that inventory completeness was not a good predictor for conservation importance. This occurred when all sites included in the analysis had reasonably complete inventories (see Chapter 6).

3. RESULTS

More than 10,600 individual plants and animals were logged and mapped in the study area, permitting the documentation of numerous new species previously unknown from this area. As described in detail in the chapter on flora by José Linares, the 154 new tree species and many other new plant species documented included no fewer than 11 thought to be new species for science, as well as two first records for Central America, 10 additional first records for El Salvador, and two rediscoveries of species last reported by botanists in 1922, and known only from El Salvador. The project area appears to include all or part of a focal area for

evolutionary diversification of plants, because at least 14 plant species are known only from the project area and nowhere else in the world.

The herpetofaunal field survey documented five species not previously recorded in the study area, including one frog (amphibian) and four reptiles (Henríquez and Henríquez, this report). The mammal surveys found four new species for the study area (Girón et al., this report). The bird surveys reported 12 new species for southwestern El Salvador. In total, the taxa studied for this report number 2719 species (Table 3). Apparently 14 plant species and one vertebrate (a fish) found in the study area have never been detected elsewhere in the world.

TABLE 3. SPECIES RECORDED IN THE IMCW PROJECT AREA, THROUGH 2007.[1]

Taxon	All species	Nationally threatened species	Globally threatened species
Trees	584	17	23
Other plants (including orchids)	1287	78	1
Fish	220	51	4
Amphibians & Reptiles	96	49	8
Mammals	101	18	1
Birds	431	188	0
All combined	2719	401	37

[1]The species' names are given in the following chapters.

3.1. IMPROVED FLORA AND FAUNA INVENTORIES

The tree inventory improved dramatically in the study area, from 76% of the test species registered in the data base prior to field work, to 93% registered after completing the field phase. The fish inventory became available for the first time, with an estimate of 41% inventory completeness for the study area. The mammal inventory improved from 92% to 100%. The amphibians, reptiles, and birds inventories were already relatively complete (100% of test species recorded) before field work began, but those inventories improved greatly at the scale of watersheds (Table 4) and municipalities (Table 5), and several new species were recorded in the study area. Nonetheless, some watersheds and municipalities continue to be severely undersampled. The improvement in the overall coverage of inventory efforts and the relative completeness of the inventories is demonstrated graphically for the bird results (Fig. 3).

For the first time, the state of the flora and fauna inventories have been evaluated at the level of ecosystems (Table 6) and in some cases, protected natural areas. For protected natural areas, only mammal and herpetofaunal inventories have been assessed for completeness (see Chapters 4 and 5). Individual areas have mammal inventories that are still very incomplete (generally 30–60% complete). The best inventoried protected natural area in southwestern El Salvador is El Imposible National Park, with 81% of the expected ~~-t~~est" species documented.

TABLE 4. LEVEL OF INVENTORY COMPLETENESS RECORDED BY WATERSHED.

	"Test" species recorded (%)					
Watersheds	**Trees**	**Fishes**	**Amphibians & Reptiles**	**Mammals**	**Birds**	**COMBINED (proportion average)**
San Juan	0	0	0	15	4	4
Barra Salada	0	0	4	0	57	12
San Pedro	5	5	26	17	89	28
Los Cóbanos	0	29	30	40	73	33
San Julián	57	0	66	46	93	52
Río Cauta	0	5	2	0	74	16
Río Grande de Sonsonate	19	0	17	67	85	38
Izalco	58	0	74	31	96	52
Coatepeque	44	32	25	67	93	52
Cara Sucia	82	12	60	83	99	67
Barra de Santiago	38	24	58	79	100	60
Complete Project Area	**93**	**41**	**100**	**100**	**100**	86

TABLE 5. LEVEL OF INVENTORY COMPLETENESS IN THE MUNICIPALITIES.

	"Test" species recorded (%)					
Municipality	**Trees**	**Fishes**	**Amphibians & Reptiles**	**Mammals**	**Birds**	**COMBINED (proportion average)**
Acajutla	0	27	25	46	69	32
Apaneca	9	0	11	29	61	22
Armenia	0	0	0	19	0	4
Caluco	57	0	64	46	92	52
Chalchuapa	2	8	0	31	0	8
Concepción de Ataco	5	0	0	0	62	13
Cuisnahuat	0	0	0	0	0	0
Guaymango	0	0	0	0	0	0
Izalco	58	0	57	23	97	47
Juayúa	13	0	4	21	97	27
Jujutla	5	24	6	42	95	34
Nahuizalco	0	0	2	21	41	13
Nahulingo	0	0	0	0	27	5
Salcoatitán	0	0	0	0	0	0
San Antonio del Monte	0	0	0	0	0	0
San Francisco Menéndez	86	12	92	85	100	75
San Julián	1	0	30	0	8	8
San Pedro Puxtla	0	0	13	13	68	19
Santa Ana	45	0	13	60	77	39
Santa Catarina Masahuat	0	0	0	0	0	0
Santo Domingo de Guzmán	0	0	7	0	61	14
Sonsonate	3	8	43	10	82	29
Sonzacate	0	0	2	0	0	0
Tacuba	5	19	15	46	93	35
Tepecoyo	0	0	0	0	0	0

TABLE 6. LEVEL OF INVENTORY COMPLETENESS RECORDED BY ECOSYSTEM.

	"Test" species recorded (%)					
Ecosystem	**Trees**	**Fishes**	**Amphibians & Reptiles**	**Terrestrial Mammals**	**Birds**	**COMBINED (proportion average)**
Humid forest	100	--	95	79	98	93
Dry forest	86	--	100	90	97	93
Cloud forest	95	--	83	67	98	86
Savanna (palm and morro)	100	--	0	40	35	44
Freshwater	--	63	90	33	84	68
Intertidal zone (rocks and beaches)	--	--	80	0	81	54
Estuary	--	56	0	33	83	43
Coral reef	--	55	0	--	64	37
Marine	--	18	0	--	64	26

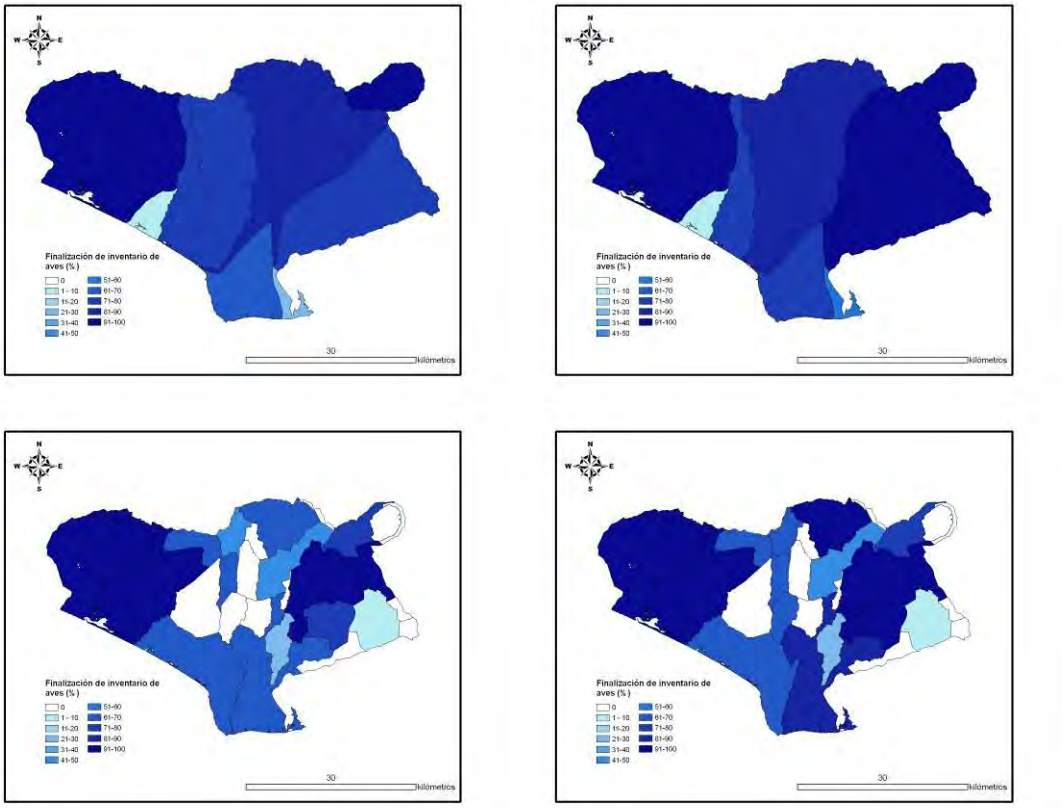

FIGURE 3. IMPROVEMENTS IN THE INVENTORY OF BIRDS DURING 2007, FOR WATERSHEDS (ABOVE) AND MUNICIPALITIES (BELOW). DARKER SHADING REPRESENTS MORE COMPLETE INVENTORIES. THE LEFTHAND COLUMN REPRESENTS THE STATE OF THE INVENTORY BEFORE FIELD WORK, AND THE RIGHTHAND COLUMN THE IMPROVED COVERAGE AFTER FIELD WORK.

3.2. PRIORITY AREAS FOR BIODIVERSITY CONSERVATION

Several natural areas within the IMCW Project area are clearly priorities for biodiversity conservation, on a national and even global scale. As have several prior studies, the present inventory has demonstrated the presence of globally threatened species at most of the remaining natural areas. These areas have now been identified as globally-important Key Biodiversity Areas (Henríquez 2009) and Important Bird Areas (Komar & Ibarra Portillo 2009). In particular, the areas identified in those documents include Barra de Santiago, Plan de Amayo, San Marcelino, and Santa Rita reserves, as well as El Imposible and Los Volcanes National Parks. The latter park, along with surrounding areas that form the Apaneca-Ilamatepec Biosphere Reserve, were jointly identified as a Key Biodiversity Area. Much of the unprotected part of the Los Cóbanos peninsula was also identified as an Important Bird Area, because of the presence of a suite of dry forest bird species representative of the Pacific dry forest biome that stretches from northwestern México to Costa Rica.

All of the aforementioned areas, including virtually all natural habitat remnants in the project area, are therefore of global importance for biodiversity conservation.

Nonetheless, we considered the question: which areas within the study area stand out as having greater priority for biodiversity conservation? Our aim was to use nationally and globally threatened species as indicators of conservation importance. A condition for such an analysis is that the areas being compared are sufficiently well studied such that the value is not biased by the level of inventory effort. Unfortunately, for some of the desired comparisons, that condition was not met and the analysis could not be completed.

For several taxonomic groups (trees, fish, amphibians, and reptiles), the biological inventories of watersheds were too variable or incomplete to permit comparisons. For mammals, only two watersheds could be analyzed, suggesting that the Cara Sucia watershed was more important than the Barra de Santiago watershed, probably due to the presence of the Santa Rita swamp forest in Cara Sucia. For birds, 10 watersheds were analyzed. Both Barra de Santiago and Cara Sucia had far greater importance than any other watershed, presumably because of El Imposible National Park (which straddles both watersheds). Barra de Santiago ranked slightly higher, probably because of the presence of more threatened waterbirds than in Cara Sucia. The next most important watersheds for birds were Coatepeque and Izalco, due to natural areas in Los Volcanes National Park and other areas of the Apaneca-Ilamatepec Biosphere Reserve.

Although most groups could not be analyzed at the municipality level, the bird inventories were sufficiently complete in eight municipalities. Thus, it appears that San Francisco Menéndez (El Imposible National Park and Santa Rita Forest Protected Natural Area) and Jujutla (Barra de Santiago estuary) have considerably more conservation importance than Sonsonate (Los Cóbanos and Barra Salada Protected Natural Areas), which in turn is more important for birds than Tacuba, Izalco and Santa Ana (the latter two municipalities include Los Volcanes National Park and San Marcelino Complex of Protected Natural Areas). These results only partially mimic the results generated by analyzing birds at the watershed level.

The inventories for the different taxonomic groups were more complete at the ecosystem level, permitting more useful analysis. Only fish data were excluded from this analysis (because of incomplete sampling), although current data strongly suggest a priority for coral reef habitat. The relative importance scores were not consistent among taxonomic groups, demonstrating the importance of including several taxonomic groups in the analysis. For example, the priorities for birds did not match the priorities for trees, mammals, amphibians, or reptiles (Table 7). The top-scoring ecosystems included humid forest (for trees, amphibians, and reptiles), dry forest (for mammals), and mangrove estuaries (for birds). When scores were combined, humid forest obtained the highest score. The humid forest ecosystem includes the permanently green forests growing at mid elevations, generally from 800 to 1800 meters above sea level; this is the area that has been most threatened by the expansion of coffee culture on montane hillsides. The cloud forest ecosystem scored consistently low across all groups.

Although not part of the formal terms of reference for this study, some authors analyzed the relative conservation importance of the specific Protected Natural Areas studied. Sampling was sufficiently complete for such analysis only for amphibians and reptiles (birds were not considered, but may also have complete sampling). For the herpetofauna, El Imposible National Park scored highest, followed in declining order by Los Volcanes National Park, and then corridor sites Santa Rita, San Marcelino, Plan de Amayo, and Laguna de las Ninfas (See Chapter 4 for details).

TABLE 7. IMPORTANCE RANKINGS BY ECOSYSTEM.*

Ecosystem	Trees	Amphibians & Reptiles	Mammals	Birds	Combined (average rank)
Humid forest	52	58	32	33	44
Dry forest	52	20	47	26	36
Cloud forest	16	12	--	17	15
Savanna (palm and morro)	0	0	--	5	2
Freshwater	--	26	--	20	23
Intertidal zone (beaches)	--	8	--	13	11
Estuary	--	--	--	39	39

*The rankings represent proportions of conservation-important indicator species (generally, threatened species) expected to be found in the study area.

4. RECOMMENDED CONSERVATION STRATEGIES

Conservation strategy recommendations for estuaries focus mostly on education and awareness-building, while for upland habitats, forests need to be expanded and organized to connect fragments via altitudinal corridors, ideally along rivers. More flora and faunal inventory work is needed (especially flora), as well as long-term population monitoring, in order to track progress with climate change adaptability projects that should be implemented in the region. The recommendations from the thematic chapters are summarized by taxonomic group in Table 8.

Some clear geographic conservation priorities are evident with respect to species of conservation importance, and in particular, globally threatened species. Threatened tree species, or plant species known only from southwestern El Salvador (unique world resources), are found mostly in the uplands of the Sierra de Bálsamo and Sierra de Apaneca. Remnant dry forests and limestone soil enclaves of the western end of the Sierra del Bálsamo at Plan de Amayo and nearby Protected Natural Areas stand out, as do the moist Sierra Madre de Chiapas forests of southfacing slopes at mid elevations in the Sierra de Apaneca, especially at El Imposible National Park. Also of importance, but less so, for plant conservation are the very humid montane forests (cloud forests) on the peaks of the Sierra de Apaneca, such as at Laguna de las Ranas, Cerro El Águila, Cerro Verde, and the Los Andes section of Los Volcanes National Park (collectively, the Apaneca-Ilamatepec Biosphere Reserve).

The most important fish area in southwestern El Salvador appears to be the coral reef at Los Cóbanos, followed by freshwater habitats, in particular Lake Coatepeque. Globally threatened sea turtles occupy most of the area's beaches for breeding, and also feed at Los Cóbanos reef. The globally vulnerable American Crocodile (*Crocodylus acutus*) is resident in the mangrove estuaries of the study area. Nationally threatened birds are concentrated in El Imposible National Park (Komar 2002).

Relatively little natural area remains in the study area. Virtually every remnant natural area, as well as ecologically sustainable production areas such as shaded coffee plantations in the ecological corridors that connect the natural areas, present some justifications to protect local biodiversity. Site conservation priorities for fish and reptiles are very different than priorities for trees, amphibians, and birds, which makes prioritization particularly challenging.

TABLE 8. SUMMARY OF RECOMMENDATIONS FOR CONSERVATION, ORGANIZED BY TAXONOMIC GROUP.

Actions	Flora	Fish	Amphibians & Reptiles	Mammals	Birds
Fill geographic gaps in the inventory	X (coastal zone)	X	X (coastal zone)	X	X (atlas mapping)
Fill taxonomic gaps in the inventory, using distinct detection methods	X (herbs, bushes, epiphytes)			X (Use Anabat for high-flying bats)	X (repeat during spring migration)
Evaluate use of coffee plantations as a biological corridor				X	
Monitor populations of threatened species at permanent plots			X (frogs, sea turtles, crocodiles)	X (esp. felines)	
Expand long-term monitoring of common species					X
Monitor habitat quality using indicator species	X (epiphytes)				
Provide training to park rangers about the conservation-important (threatened) species	X		X		
Provide environmental education near Protected Natural Areas			X (especially ref. vipers)		X (especially coastal areas)
Undertake ecological research to better understand how species are using the environment		X		X	
Strengthen habitat and species protection at important conservation sites, and expand natural habitat cover		X			X

Actions	Flora	Fish	Amphibians & Reptiles	Mammals	Birds
Improve ecological function of rivers and riparian (and altitudinal) corridors		X			X
Establish sustainable management programs at Lake Coatepeque and other lakes		X			

5. RECOMMENDATIONS FOR ECONOMIC DEVELOPMENT

The results of the taxonomic inventory provide abundant information about conservation priorities for biodiversity in the project area. Hopefully, the future economic development of the area can be sensitive to the needs of flora and fauna species, since this biodiversity is an integral part of the local natural heritage and a valuable natural resource that should be preserved and managed for the benefit of present and future generations. Biodiversity provides diverse benefits for all people (Martínez et al. 2009), and its conservation should be a priority not only in the Protected Natural Areas but also throughout the rural agricultural landscape (Harvey et al. 2008). Below are 10 suggestions for sustainable economic development suggested by the taxonomic inventory results.

1. Create financial incentives for the protection of natural habitats through the development of payments for environmental services, such as water conservation generated by forests, erosion control through abandonment of farming on steep slopes, and carbon sequestration by reforestation or by farming shaded permanent crops (coffee, cacao).

2. Develop the forestry industry. If extensive farmlands in the project area can be converted to sustainable forestry, biodiversity conservation can be benefited by increasing the functionality of ecological corridors. Forestry projects could be designed to benefit biodiversity by employing diversified plantings, including fruit trees or trees that otherwise provide foraging opportunities for wildlife. Forestry can also contribute to climate change adaptation and mitigation.

3. Keep urban development in the cities. Planned urban and rural development can help reduce the threat to biodiversity from new suburban residential areas sprouting up in former farmland, far from urban centers, and also prevent any further agricultural expansion.

4. Reduce agriculture's impact on natural habitat, by adopting less intensive production techniques, such as organic production, and promoting certification programs that provide market incentives for adopting environmentally friendly practices. Such programs exist or are under development by SalvaNATURA for the major export crops in the project area, coffee and sugar cane.

5. Promote industries or businesses that provide jobs for the rural population, and otherwise reduce the threat of extractions of wildlife from their natural hábitats, such as wild animal farms (*zoocriaderos*). Wild species that could be farmed and exported for various uses and markets include: native palms, shrubs, ferns, orchids, and other flowers; freshwater fish such as tilapia and others; estuarine shell fish such as clams, mussels, conchas, crabs, and shrimp; crocodile and cayman, freshwater turtles, iguanas; deer, paca, armadillo, and rabbits.

6. Promote business practices that permit sustainable use of natural resources, such as ecotourism in the region's national parks and Protected Natural Areas, and in estuaries or on beaches.

7. The national government could increase interest in sustainable tourism within southwestern El Salvador, by placing more signage on the highways for tourist attractions (such as the national parks), by improving some rural access roads to the parks, and by developing publicity campaigns for the natural areas, such as the biosphere reserves.

8. Biodiversity research, and scientific tourism in general, can have a multiplicative positive impact on local economies near the natural ecosystems of Protected Natural Areas. Not only does it bring some direct economic investment (construction of biological field stations, use of lodging facilities and local services by visiting scientists), but also can result in international publicity generated by publication of scientific investigation, which can greatly increase visitation from international ecotourists.

9. SalvaNATURA is currently developing a program that could help develop the market for sustainable tourism, and increase local pride in the native biodiversity. This program aims to reintroduce the locally extinct Scarlet Macaw (*Ara macao*) in the Barra de Santiago-El Imposible corridor (Bjork 2009), where the species can become a flagship for sustainable development in the corridor. Other high-profile reintroduction programs could be developed for species extirpated from the project area, such as Spider Monkeys (*Ateles geoffroyi*). These programs will require broad support and participation, not only from local communities but also local and national governments, donors, and businesses.

10. Business or agricultural activities that could harm the environment should be avoided. Examples include high-input crops (non-shade varieties of coffee, for example), or crops that may require further deforestation (such as biofuel crops), crops that require burning (certain varieties of sugar cane), factories that are not equipped to handle their waste properly or that require excessive quantities of water or fuel. Also not recommended are breeding programs of parrots for the pet industry, although at first glance, such an activity would seem to reduce pressure on the wild population. Nonetheless, it could also promote the practice of keeping parrots, which could create more demand for wild birds.

CHAPTER 2:

FLORA INVENTORY OF SOUTHWESTERN EL SALVADOR

José Ledis Linares
Conservation Science Department, SalvaNATURA.
San Salvador, El Salvador
linaresj_98@yahoo.com

1. INTRODUCTION

The southwestern region of El Salvador, made up of the southern region of the Department of Ahuachapán, the southern edge of the Department of Santa Ana and the entire Department of Sonsonate, is an intricate network of many ecosystems and vegetation types immerse in a matrix of annual and permanent crops. It is almost impossible to know the distribution and extension of the types of original vegetation. However, there are still vestiges of what could have been the original vegetation. These small vegetation remnants and spots reveal that the region hosted and still hosts a substantial floral biodiversity.

The flora inventory of El Salvador is far from being acceptable and even less complete. In spite of this, the aforementioned region is probably the best studied in the country, and even so, we continue to find new relatively large and noticeable tree species such as *Dalbergia salvanaturae* (Linares & Sousa 2008) endemic to El Imposible National Park. No accurate flora inventory of the area has yet been published and until the present study, there were only partial inventories of certain groups which are included in more general works such as the Flora appendix called "Trees of the El Imposible Forest" by Reyna in Serrano et al. (1993), the list of trees prepared by Linares (2005) or the orchid inventory prepared by Hamer (1974, 1981). Most of the works conducted in the zone are undergraduate or graduate theses little known but valuable because of the information they provide such as the studies carried out at Cerro El Águila by Amaya et al. (2003) and Cerén et al. (2003). In other areas such as Las Lajas forest, we have the work of Komar & Herrera (1995) and the work of Villacorta (2000), and at El Imposible, the work of Ramírez (2001) also stands out in addition to the aforementioned work of Serrano (1993).

To date, 1000 tree species are on record in El Salvador (Linares 2005) of which samples of 378 species were collected in the southwest region of the country with replicates deposited in local or foreign herbariums, until 2006. Of these collected tree samples, 185 were generalist species which are used as indicators of the level of completeness of an inventory. Prior to field work of the present study, the tree inventory was deemed 55%

complete if we consider only those records supported by herbarium samples. The baseline study (Linares 2007) recognized that the inventory was incomplete since only 76% of the expected tree species in the area were recorded. This 76% also included studies or consultancies which did not have voucher specimens but were deemed reliable by the author. In total, the baseline study recognized 1716 flora species of which only 430 were trees and of these 255 were indicators of a complete inventory. Past studies on vegetation have been mainly focused on El Imposible National Park, which in view of its wealth of species, types of vegetation, easy access, and good state of conservation, has captured much attention since the 1980s.

The primary objectives of this study were to determine the species, mainly trees, of interest for conservation in six watersheds of the southwestern region of El Salvador, as well as to try to fill information gaps regarding the presence and status of the populations of some tree species considered threatened, or otherwise important for the conservation of the biological diversity that still remains in the country.

2. METHODOLOGY

2.1. STUDY AREA

The study was conducted in 6 of the 11 watersheds located in the southwestern region of El Salvador, which correspond to 7 of the 25 municipalities distributed among the Departments of Ahuachapán, Sonsonate, Santa Ana and La Libertad that make up the area of USAID's Improved Management and Conservation of Critical Watersheds (~~I~~IMCW") Project. Table 9 and Fig. 4 detail the locations where the flora studies were carried out.

2.2. SAMPLING DESIGN

Between June 2007 and January 2008, intensive searches were conducted based on 1000 m^2 transects at each sampling site. In sites which comprised several types of forests, a transect was carried out in each forest type. Additionally, intensive searches were undertaken to locate species, either trees or other plants, that were not found in those transects. Samples that would allow proper identification were collected as needed. The samples or vouchers were deposited with the Herbarium of the Natural History Museum of El Salvador. Table 9 shows a detail of the sampling efforts and the number of species recorded in each natural area.

TABLE 9. SAMPLING SITES FOR TREES AND TOTAL BOTANICAL SAMPLING EFFORT.

Site	Watershed	Location	Description	Dates	Days	Number of Transects (1000 m^2 each)
El Imposible National Park	Barra de Santiago	Cerro Campana sector, Municipality of San Francisco Menéndez, high part of El Imposible (13.86° N; 89.91°W), Dept. of Ahuachapán	Undisturbed montane humid forest.	June 29 to July 3, July 10 to 14, from November 11 to 15, from December 26 to 30, 2007 and from January 8 to 12, 2008	25	2
	Cara Sucia	San Fco. Menéndez sector, Municipality of San Francisco Menéndez, between cantones El Corozo and El Sacramento (13.84°N; 90.01°W), Dept. of Ahuachapán	Evergreen broadleaf forest with anthropogenic disturbance due to the presence of a community within the area.			
Los Volcanes National Park	Izalco	María Auxiliadora sector, Municipality of Izalco, between the cantones of Chorro Abajo, Chorro Arriba, Shonshón, Teshcal, Las Marías, La Quebrada Española and Cuyagualo (13.89°N; 89.63°W), Dept. of Sonsonate	Lava flows of varying successional stages and rermnants of tropical dry forest	From July 27 to August 5, 2007	10	2
	Izalco	Cerro Verde sector, Municipality of Santa Ana, Cantón Lomas de San Marcelino (13.82ºN; 89.62ºW), Dept. of Santa Ana	montane humid forest	December 19 to 21, 27 to 28, 2007	5	1

TABLE 9. SAMPLING SITES FOR TREES AND TOTAL BOTANICAL SAMPLING EFFORT.

Site	Watershed	Location	Description	Dates	Days	Number of Transects (1000 m^2 each)
Plan de Amayo Protected Natural Area	San Julián	Municipality of Caluco, between the cantones of Plan de Amayo and El Castaño (13.41°N; 89.39°O), Dept. de Sonsonate	Cliff vegetation, tropical dry forest (in the areas closest to the cliffs) and gallery forests (in the lower parts).	August 22 to 31, 2007 and January 22 to 26, 2008	15	2
San Marcelino Complex Protected Natural Area	Coatepeque and Izalco	Municipalities of Izalco y Armenia, the cantones of Las Lajas, El Guayabo, Los Mangos, El Rosario, San Isidro and Las Marías, Dept. of Sonsonate. Municipalities of Santa Ana and El Congo, between the cantones of Lomas de San Marcelino (13.49°N; 89.34°W), Montebello, El Rodeo and La Presa, Dept. of Santa Ana (13.69°N; 89.64°W)	Vegetation succession on volcanic lava of different ages, deciduous forest, and evergreen broadleaf forest.	December 12 to 16, 2007	5	1
Cerro El Águila Protected Natural Area	Río Grande de Sonsonate	Municipality of Juayúa (13.88°N; 89.68°W), Dept. of Sonsonate	Wooded summit consists of humid montane forest	November 18 to 22, 2007	5	1

2.3. LEVEL OF INVENTORY COMPLETENESS

In order to make an analysis of the inventory progress or completeness in the municipalities and watersheds, I first prepared a list of indicator species for inventory completeness (Gómez de Silva & Medellín 2001). This list consists of generalist species, which are those that live in a variety of habitats and can be found in both disturbed and non-disturbed habitats. The relationship between the species that were recorded during the study and the list of expected generalist species represents an index of inventory completeness expressed as percent progress. The number of expected species recorded is divided by the total number of expected generalist species, which is 335 (listed in Linares 2007), and multiplied by one hundred.

A single list of expected species was determined for watersheds and municipalities; however, separate lists of indicator species for inventory completeness were determined for each ecosystem or vegetation type (Table 10). The reason why each habitat has different indicator species for inventory completeness is that some generalist species of the low and medium altitude zones do not live in habitats of the higher altitude zones.

2.4. SELECTION OF SPECIES CONSIDERED IMPORTANT FOR CONSERVATION

The main criterion to select species important for conservation is whether the species is included on the Red List of globally endangered species (IUCN 2008). We considered the tree *Machaerium* sp. to be an additional indicator of conservation importance, because we believe it meets the IUCN criteria for threatened status but the species has not yet been evaluated formally. All but one of the indicators are trees; the exception is a globally-vulnerable cycad *Zamia herrerae*, which is also included as an indicator in this analysis.

2.5. DATA SOURCES

Most of the information on the species recorded in the project area comes from the databases of the Panamerican School of Agriculture (EAP, for its acronym in Spanish) and the Missouri Botanical Garden (MO) herbaria and from fieldwork of the present study. It was deemed that the majority of records in local herbaria are already included in the consulted databases because duplicates of the collected items were frequently sent to one of these foreign herbaria. Some of these data, specifically those from El Imposible and Cerro Verde, have been complemented with information that previously existed on these Protected Natural Areas (summarized in Linares 2007). The bibliographic information mainly comes from thesis works and consultancies carried out in the different Protected Natural Areas and cited in the Introduction.

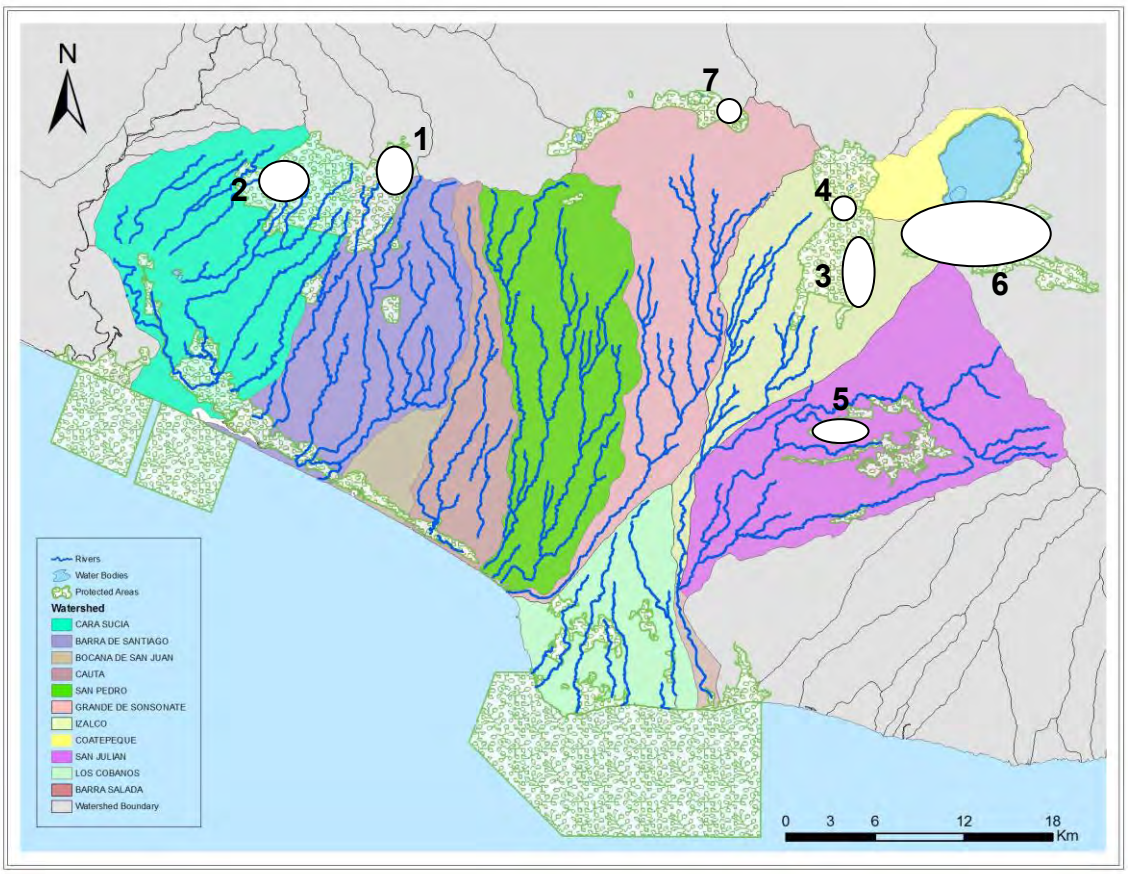

FIGURE 4. STUDY AREA, WATERSHEDS, AND SAMPLING SITES FOR FLORA: (1) CERRO CAMPANA (EL IMPOSIBLE), (2) SAN FRANCISCO MENÉNDEZ SECTOR (EL IMPOSIBLE), (3) MARÍA AUXILIADORA SECTOR (LOS VOLCANES) (4) CERRO VERDE (LOS VOLCANES NATIONAL PARK), (5) PLAN DE AMAYO, (6) COMPLEJO SAN MARCELINO, (7) CERRO EL ÁGUILA.

TABLE 10. INDICATOR SPECIES FOR INVENTORY COMPLETENESS OF TREES IN THE STUDY AREA.

Species	CF	DF	HF	S
Acacia angustissima (Mill.) Kuntze		X		
Acacia cornigera (L.) Willd.		X		
Acacia farnesiana (L.) Willd.		X		
Acacia hindsii Benth.		X		
Acacia polyphylla DC.		X		
Aegiphila panamensis Moldenke		X		
Albizia adinocephala (Donn. Sm.) Britton & Rose		X		X
Albizia carbonaria Britton				
Albizia niopoides (Spruce ex Benth.) Burkart		X	X	
Alibertia edulis (Rich.) A. Rich. ex DC.			X	
Allophylus occidentalis (Sw.) Radlk.				
*Alstonia pittier*i (Donn. Sm.) A.H. Gentry			X	
Alvaradoa amorphoides Liebm.		X		
Andira inermis (W. Wright) Kunth ex DC.		X	X	
Annona diversifolia Saff.		X		
Annona glabra L.			X	
Annona macroprophyllata Donn. Sm.		X		
Annona reticulata L.				
Apeiba tibourbou Aubl.		X	X	
Aralia humilis Cav.		X		
Ardisia compressa Kunth		X	X	
Ardisia paschalis Donn. Sm.		X	X	
Astronium graveolens Jacq.		X	X	
Banisteriopsis acapulcensis (Rose) Small				
Bauhinia cookii Rose			X	
Bauhinia divaricata L.			X	
Bauhinia pauletia Pers.		X	X	
Bauhinia ungulata L.		X		
Bixa orellana L.		X	X	
Bocconia arborea S. Watson	X			
Boehmeria caudata Sw.				
Boehmeria ulmifolia Wedd.	X			
Bourreria huanita (Lex.) Hemsl.			X	
Brachistus stramoniifolius (Kunth) Miers	X			
Brosimum alicastrum Sw.		X	X	
Bunchosia nitida (Jacq.) DC.			X	
Bursera simaruba (L.) Sarg.		X	X	
Byrsonima crassifolia (L.) Kunth		X		
Caesalpinia eriostachys Benth.		X		
Caesalpinia exostemma DC.		X		
Calatola laevigata Standl.	X		X	
Calophyllum brasiliense var. *rekoi* (Standl.) Standl.			X	
Calycophyllum candidissimun (Vahl) DC.		X		
Capparis discolor Donn. Sm.			X	

Species	CF	DF	HF	S
Capparis flexuosa (L.) L.		X		X
Capparis frondosa Jacq.			X	
Capparis indica (L.) Druce		X		
Capparis mollicella Standl.		X		
Capparis odoratissima Jacq.				
Capparis pringlei Briq.		X	X	
Capparis quiriguensis Standl.			X	
Carica cauliflora Jacq.		X	X	X
Carica papaya L.		X	X	X
Cascabela ovata (Cav.) Lippold		X		
Cascabela thevetia (L.) Lippold		X		
Casearia aculeata Jacq.		X		
Casearia commersoniana Cambess.			X	
Casearia corymbosa Kunth		X	X	X
Casearia sylvestris Sw.		X	X	X
Casimiroa sapota Oerst.	X		X	
Cassia grandis L. f.		X		
Cassine xylocarpa Vent		X	X	
Castilla elastica Sessé ex Cerv.			X	
Cecropia obtusifolia Bertol.		X	X	
Cecropia peltata L.		X	X	
Cedrela odorata L.			X	
Cedrela salvadorensis Standl.		X		
Ceiba aesculifolia (Kunth) Britten & Baker f.		X		
Ceiba pentandra (L.) Gaertn.		X	X	X
Celtis iguanaea (Jacq.) Sarg.		X		
Cestrum nocturnum L.		X		
Cestrum tomentosum L. f.				
Chiococca alba (L.) Hitchc.				
Chiococca pachyphylla Wernham				
Chrysobalanus icaco L.				X
Chrysophyllum mexicanum Brandegee ex Standl.		X	X	
Citharexylum donnell-smithii Greenm.			X	
Clethra mexicana DC.			X	
Clibadium arboreum Donn. Sm.	X			
Clusia guatemalensis Hemsl.			X	
Coccoloba barbadensis Jacq.				X
Coccoloba caracasana Meisn.				X
Cochlospermum vitifolium (Willd.) Spreng.		X		X
Colubrina arborescens (Mill.) Sarg.			X	
Colubrina heteroneura (Griseb.) Standl.		X		
Conocarpus erectus L.				X
Conostegia xalapensis (Bonpl.) D. Don ex DC.				
Cordia alliodora (Ruiz & Pav.) Oken		X		
Cordia dentata Poir.		X		X
Cordia panamensis L. Riley			X	
Cornutia pyramidata L.	X	X	X	X

Species	CF	DF	HF	S
Coutarea hexandra (Jacq.) K. Schum.		X	X	X
Crateva tapia L.		X		X
Critonia daleoides DC.				
Critonia hebebotrya DC.			X	X
Critonia morifolia (Mill.) R.M. King & H. Rob.	X		X	X
Cupania guatemalensis (Turcz.) Radlk.			X	X
Curatella americana L.		X		X
Dalbergia chontalensis Standl. & L.O. Williams		X		
Dendropanax arboreus (L.) Decne. & Planch.		X	X	X
Dichapetalum donnell-smithii Engl. var donnell-smithii			X	
Diospyros salicifolia Humb. & Bonpl. ex Willd.		X		
Diphysa americana (Mill.) M. Sousa	X	X		
Drypetes lateriflora (Sw.) Krug & Urb.			X	
Dussia cuscatlanica (Standl.) Standl. & Steyerm.	X		X	
Ehretia latifolia DC.			X	
Enterolobium cyclocarpum (Jacq.) Griseb.		X	X	
*Eremopsis trifloscul*osa (Kunth) Gleason subsp. trifloscul*osa*				X
Erythrina berteroana Urb.	X	X		
Eugenia jutiapensis Standl. & Steyerm.	X		X	
Eugenia lindeniana O. Berg	X		X	
Eugenia salamensis Donn. Sm.		X		
Eugenia sasoana Standl. & Steyerm.			X	
Exostema caribaeum (Jacq.) Roem. & Schult.		X		
Exostema mexicanum A. Gray		X		
Exothea paniculata (Juss.) Radlk.	X		X	
Ficus aurea Nutt.			X	
Ficus citrifolia Mill.			X	
Ficus costaricana (Liebm.) Miq.			X	
Ficus cotinifolia Kunth var. *cotinifolia*		X	X	
Ficus insipida Willd.			X	
Ficus maxima Mill.		X	X	X
Ficus obtusifolia Kunth			X	
Ficus ovalis (Liebm.) Miq.		X		
Ficus pertusa L. f.		X		
Ficus trigonata L.		X		
Forchhammeria trifoliata Radlk.			X	
Garcia nutans Vahl			X	
Gaultheria erecta Vent.	X			
Genipa americana L.		X		
Gliricidia sepium (Jacq.) Kunth ex Walp.		X		
Godmania aesculifolia (Kunth) Standl.		X		
Guarea glabra Vahl				
Guazuma ulmifolia Lam.		X		X
Guettarda deamii Standl.		X		
Guettarda macrosperma Donn. Sm.		X		
Guettarda subcapitata C.M. Taylor		X		

Species	CF	DF	HF	S
Gyrocarpus americanus Jacq.		X		
Hamelia patens Jacq.		X	X	
Hauya elegans subsp. *lucida* (Donn. Sm. & Rose) P.H. Raven & Breedlove [= *Hauya lucida* Donn. Sm. & Rose]		X		
Heliocarpus mexicanus (Turcz.) Sprague			X	
Hemiangium excelsum (Kunth) A.C. Sm.		X		
Heteropterys laurifolia (L.) A. Juss.		X		
Hibiscus pernambucensis Arruda				X
Hintonia latiflora (Sessé & Moc. ex DC.) Bullock		X		
Hintonia lumaeana (Baill.) Bullock			X	
Hymenaea courbaril L.		X	X	
Hyperbaena mexicana Miers		X		
Hyperbaena tonduzii Diels		X		
Inga flexuosa Schltdl.	X			
Inga pavoniana G. Don			X	
Inga punctata Willd.				X
Inga vera Willd.		X		X
Ipomoea wolcottiana Rose subsp. *wolcottiana*		X		
Jacaratia mexicana A. DC.		X		
Jacquinia longifolia Standl.		X		
Jacquinia nervosa C. Presl.		X		
Karwinskia calderonii Standl.		X		
Laguncularia racemosa (L.) C.F. Gaertn.				X
Lasianthaea fruticosa (L.) K.M. Becker	X			
Ledenbergia macrantha Standl.				
Licania arborea Seem.		X		
Licania platypus (Hemsl.) Fritsch				
Licania retifolia S.F. Blake			X	
Lippia umbellata Cav.				
Lippia cardiostegia Benth.				
Lippia myriocephala Schltdl. & Cham.	X			
Lonchocarpus guatemalensis Benth.			X	
Lonchocarpus minimiflorus Donn. Sm.		X	X	
Lonchocarpus rugosus subsp. *apricus* (Lundell) M.Sousa				
Lonchocarpus salvadorensis Pittier		X		
Lonchocarpus santarosanus Donn. Sm.			X	
Luehea candida (Moc. & Sessé ex DC.) Mart.		X		
Lycianthes arrazolensis (J.M. Coult. & Donn. Sm.) Bitter	X			
Lycianthes heteroclita (Sendtn.) Bitter			X	
Lysiloma acapulcense (Kunth) Benth.		X		
Lysiloma auritum (Schltdl.) Benth.		X		
Lysiloma divaricatum (Jacq.) J.F. Macbr.		X		
Machaerium biovulatum Micheli		X		
Machaerium salvadorense (Donn. Sm.) Rudd		X	X	
Maclura tinctoria (L.) D. Don ex Steud.		X		
Malpighia glabra L.		X		
Malvaviscus arboreus Cav. var. *arboreus*		X	X	

Species	CF	DF	HF	S
Margaritaria nobilis L. f.				
Miconia argentea (Sw.) DC.			X	
Miconia laevigata (L.) D. Don	X			
Montanoa grandiflora Alaman es DC.			X	
Montanoa guatemalensis B.L. Rob. & Greenm.			X	
Montanoa hibiscifolia Benth.		X		
Montanoa tomentosa subsp.. *xanthiifolia* (Sch. Bip. ex C. Koch) V.A. Funk		X		
Muntingia calabura L.		X		
Myriocarpa longipes Liebm.	X			
Myrospermum frutescens Jacq.		X		
Myroxylon balsamum var. *pereirae* (Royle) Harms			X	
Nectandra martinicensis Mez			X	
Neea psychotrioides Donn. Sm.		X		
Ochroma pyramidale (Cav. ex Lam.) Urb.			X	
Ocotea veraguensis (Meisn.) Mez		X		
Omphalea oleifera Hemsl.		X		
Pachira aquatica Aubl.				X
Pachythamnus crassirameus (B.L. Rob.) R.M. King & H. Rob.		X		
Parathesis vulgata Lundell	X			
Peltostigma pteleoides (Hook.) Walp.	X		X	
Perymenium grande Hemsl. var. *grande*	X			
Perymenium grande var. *nelsonii* (B.L. Rob. & Greenm.) J.J. Fay	X			
Phenax hirtus (Sw.) Wedd.			X	
Phenax mexicanus Wedd.			X	
Pilocarpus racemosus subsp. *viridulus* Kaastra				
Piper amalago L.				
Piper marginatum Jacq.			X	
Piper sanctum (Miq.) Schltdl. ex C. DC.				
Piper tuberculatum Jacq.				X
Piptadenia obliqua (Pers.) J.F. Macbr.		X		
Pithecellobium dulce (Roxb.) Benth.		X		
Plumeria rubra forma *acutifolia* (Poir.) Woodson		X		
Poeppigia procera C. Presl		X		
Pogonopus speciosus (Jacq.) K. Schum.		X	X	
Posoqueria latifolia (Rudge) Roem. & Schult.		X		
Prockia crucis P. Browne ex L.		X		
Pseudobombax ellipticum (Kunth) Dugand [=*Bombax ellipticum* H.B.K.]		X	X	
Pseudobombax septenatum (Jacq.) Dugand		X	X	
Psidium guajava L.		X		
Psidium guianense Pers.		X		
Psychotria limonensis K. Krause			X	
Psychotria microdon (DC.) Urb.		X	X	
Psychotria pubescens Sw.			X	

Species	CF	DF	HF	S
Quercus elliptica Née	X			
Quercus lancifolia Schltdl. & Cham.	X			
Quercus salicifolia Née	X			
Quercus sapotifolia Liebm.	X			
Quercus skinneri Benth.	X			
Randia armata (Sw.) DC.		X	X	
Randia grandifolia (Donn. Sm.) Standl.			X	
Robinsonella densiflora Fryxell				
Roldana petasioides (Greenm.) H. Rob.	X			
Rondeletia deamii (Donn. Sm.) Standl.		X	X	
Rondeletia laniflora Benth.	X			
Rondeletia thiemei Donn. Sm.		X		
Roupala glaberrima Pittier	X		X	
Ruprechtia costata Meisn.		X		
Samanea saman (Jacq.) Merr.		X		
Sapindus saponaria L.		X	X	
Sapium macrocarpum Müll. Arg.		X		
Sapranthus violaceus (Dunal) Saff.			X	
Schoepfia schreberi J.F. Gmel.		X		
Sciadodendron excelsum Griseb.		X		
Senna nicaraguensis (Benth.) H.S. Irwin & Barneby		X	X	
Senna pallida (Vahl) H.S. Irwin & Barneby		X	X	
Senna reticulata (Willd.) H.S. Irwin & Barneby	X	X	X	
Sideroxylon capiri subsp. *tempisque* (Pittier) T.D. Penn.		X		
Simarouba glauca DC.		X		
Sinclairia deamii (B.L. Rob. & Bartlett) Rydb.	X		X	
Sinclairia discolor Hook. & Arn.	X		X	
Sinclairia glabra (Hemsl) Rydb.	X		X	
Sinclairia sublobatum (B. L. Rob.) Rydb.	X		X	
Sloanea terniflora (Sessé & Moc. ex DC.) Standl.				
Solanum erianthum D. Don				
Solanum hazenii Britton			X	
Solanum lanceolatum Cav.		X		
Solanum umbellatum Mill.	X		X	X
Spondias mombin L.		X	X	
Spondias purpurea L.		X	X	
Spondias radlkoferi Donn. Sm.		X		
Stemmadenia donnell-smithii (Rose) Woodson		X		
Stemmadenia eubracteata Woodson			X	
Stemmadenia obovata K. Schum.		X		
Stenocereus aragonii (F.A.C. Weber) Buxb.		X		
Styrax argenteus C. Presl	X		X	
Swartzia simplex (Sw.) Spreng.	X			
Swietenia humilis Zucc.		X		
Swietenia macrophylla King			X	
Synardisia venosa (Mast.) Lundell	X			
Tabebuia chrysantha (Jacq.) G. Nicholson			X	

Species	CF	DF	HF	S
Tabebuia donnell-smithii Rose		X		
Tabebuia impetiginosa (Mart. ex A. DC.) Standl.		X		
Tabebuia rosea (Bertol.) A. DC.		X	X	
Tabernaemontana amygdalifolia Jacq.			X	
Tecoma stans (L.) Juss. ex Kunth	X	X	X	X
Telanthophora arborescens (Steetz) H. Rob. & Brettell	X			
Terminalia oblonga (Ruiz & Pav.) Steud.		X	X	
Thouinia velutina Radlk.		X		
Thouinia villosa DC.		X		
Thouinidium decandrum (Bonpl.) Radlk.		X		
Trema micrantha (L.) Blume var. *micrantha*		X	X	
Trema micrantha var *strigillosa* (Lundell) Standl. & Steyerm.	X		X	
Trichilia americana (Sesse & Moc.) T.D. Penn.		X		
Trichilia havanensis Jacq.	X	X	X	X
Trichilia hirta L.		X		
Trichilia martiana C. DC.		X	X	
Trichospermum galeottii (Turcz.) Kosterm.			X	
Triplaris melaenodendron (Bertol.) Standl. & Steyerm.		X	X	
Trophis racemosa (L.) Urb.		X	X	
Turpinia occidentalis (Sw.) G. Don	X			
Ulmus mexicana (Liebm.) Planch.	X			
Urera baccifera (L.) Gaudich. ex Wedd.	X	X	X	X
Urera corallina (Liebm.) Wedd.	X			
Urera eggersii Hieron.	X		X	X
Verbesina guatemalensis B.L. Rob. & Greenm.		X		X
Verbesina turbacensis Kunth	X		X	
Vernonia deppeana Less.			X	
Vernonia patens Kunth		X	X	
Viburnum hartwegii Benth.	X		X	
Ximenia americana L.		X		
Xylosma chlorantha Donn. Sm.	X		X	X
Xylosma flexuosum (Kunth) Hemsl.	X			
Zanthoxylum culantrillo Kunth		X	X	
Zanthoxylum microcarpum Griseb.			X	
Zapoteca formosa (Kunth) H.M. Hern. subsp. formosa		X	X	
Zinowiewia cuneifolia Lundell	X			

*** CF:** Cloud Forest; **DF:** Dry Forest; **HF:** Humid forest; **S:** Savanna.

3. RESULTS AND DISCUSSION

3.1. SPECIES RECORDED

During the study, we collected a total of 1164 herbarium samples coming from approximately 707 vascular plant species. With this new data, the floral inventory for the study area now presents 584 tree species (Table 11). This figure includes about 430 species that were already cited in previous reports or were collected previously in different locations of the project area. The remaining 154 were not recorded in the existing literature and/or were not included in the databases available at the beginning of the present study. During field work, botanical voucher specimens were collected for at least 415 tree species, giving priority to rare species or to those for which few specimens had been collected previously. The 584 tree species found in the project area represent approximately 58% of all trees known in the country. Many of the tree species found are completely restricted to the study area or their largest populations are known from the study area.

At El Imposible National Park, the list of trees reached a total of 269 species, including the species reported in previous studies. A total of 190 species were recorded in Plan de Amayo, and 172 species in San Marcelino Complex Protected Natural Area. The list of trees from Cerro Verde reached a total of 94 species. A total of 84 species were recorded in the María Auxiliadora sector at Los Volcanes National Park, and 45 species on Cerro El Águila.

3.2. IMPORTANT SPECIES FOR CONSERVATION

The study area presents 25 indicators of conservation importance (Table 12). The natural areas with the most threatened species are Plan de Amayo, El Imposible National Park, and Los Volcanes National Park with 12 species each, followed by San Marcelino with eight, and finally, El Águila with only two species. However, Plan de Amayo presents five species that are not shared with any of the other conservation areas, which also represent very rare species in El Salvador, such as *Lonchocarpus molinae* (Leguminosae). This is a species recorded in the country for the first time and also endemic to lowland karst (limestone) soil, which makes it very unlikely to find in another area of El Salvador. El Imposible National Park hosts 12 species of the IUCN red list and only has one of the 25 indicators, the Mahogany tree (*Swietenia macrophylla*), not shared with any other area of southwestern El Salvador.

TABLE 11. TREE SPECIES RECORDED IN THE STUDY AREA.

Family	Species	Indicator (I)
Leguminosae	*Acacia angustissima* (Mill.) Kuntze	I
Leguminosae	*Acacia cornigera* (L.) Willd.	I
Leguminosae	*Acacia farnesiana* (L.) Willd. var. *farnesiana*	
Leguminosae	*Acacia hindsii* Benth.	I
Leguminosae	*Acacia polyphylla* DC.	I
Leguminosae	*Acacia riparia* Kunth	
Leguminosae	*Acacia* sp.	
Euphorbiaceae	*Acalypha* sp.	
Euphorbiaceae	*Acalypha diversifolia* Jacq.	
Euphorbiaceae	*Acalypha villosa* Jacq.	
Cactaceae	*Acanthocereus tetragonus* (L.) Hummelinck	
Achatocarpaceae	*Achatocarpus nigricans* Triana	
Leguminosae	*Acosmium panamense* (Benth.) Yakovlev	
Arecaceae	*Acrocomia aculeata* (Jacq.) Lodd. ex Mart.	
Euphorbiaceae	*Adelia barbinervis* Schltdl. & Cham.	
Verbenaceae	*Aegiphila panamensis* Moldenke	I
Opiliaceae	*Agonandra loranthoides* L.O. Williams	
Opiliaceae	*Agonandra racemosa* (DC.) Standl.	
Leguminosae	*Albizia adinocephala* (Donn. Sm.) Britton & Rose	I
Leguminosae	*Albizia carbonaria* Britton	I
Leguminosae	*Albizia niopoides* (Spruce ex Benth.) Burkart	I
Euphorbiaceae	*Alchornea latifolia* Sw.	
Rubiaceae	*Alibertia edulis* (Rich.) A. Rich. ex DC.	I
Sapindaceae	*Allophylus occidentalis* (Sw.) Radlk.	I
Betulaceae	*Alnus acuminata* subsp. *arguta* (Schltdl.) Furlow	
Apocynaceae	*Alstonia longifolia* (A. DC.) Pichon	I
Simaroubaceae	*Alvaradoa amorphoides* Liebm.	I
Ulmaceae	*Ampelocera hottlei* (Standl.) Standl.	
Rutaceae	*Amyris balsamifera* L.	
Rutaceae	*Amyris guatemalensis* Lundell	
Anacardiaceae	*Anacardium occidentale* L.	
Leguminosae	*Andira inermis* (W. Wright) DC.	I
Annonaceae	*Annona cherimola* Mill.	
Annonaceae	*Annona diversifolia* Saff.	I
Annonaceae	*Annona glabra* L.	I
Annonaceae	*Annona macroprophyllata* Donn. Sm.	I
Annonaceae	*Annona reticulata* L.	I
Annonaceae	*Annona* sp.	
Annonaceae	*Annona squamosa* L.	
Annonaceae	Annonaceae indet.	
Tiliaceae	*Apeiba tibourbou* Aubl.	I
Ulmaceae	*Aphananthe monoica* (Hemsl.) J.-F. Leroy	
Acanthaceae	*Aphelandra schiedeana* Schltdl. & Cham.	
Apocynaceae	Apocynaceae indet.	

Family	Species	Indicator (I)
Araliaceae	*Aralia humilis* Cav.	I
Myrsinaceae	*Ardisia* sp.	
Myrsinaceae	*Ardisia compressa* Kunth	I
Myrsinaceae	*Ardisia paschalis* Donn. Sm.	I
Bignoniaceae	*Arrabidaea costaricensis* (Kraenzl.) A.H. Gentry	
Apocynaceae	*Aspidosperma megalocarpon* Müll. Arg.	
Asteraceae	Asteraceae indet.	
Anacardiaceae	*Astronium graveolens* Jacq.	I
Verbenaceae	*Avicennia bicolor* Standl.	
Verbenaceae	*Avicennia germinans* (L.) Stearn	
Asteraceae	*Baccharis* sp.	
Rubiaceae	*Balmea stormae* Martínez	
Malpighiaceae	*Banisteriopsis acapulcensis* (Rose) Small	I
Leguminosae	*Bauhinia cookii* Rose	I
Leguminosae	*Bauhinia divaricata* L.	I
Leguminosae	*Bauhinia pauletia* Pers.	I
Leguminosae	*Bauhinia seleriana Harms* (= *Bauhinia paradisii* Standl. & L.O. Williams)	
Leguminosae	*Bauhinia ungulata* L.	I
Begoniaceae	*Begonia calderonii* Standl.	
Bignoniaceae	*Cydista* sp.	
Berberidaceae	*Berberis johnstonii* Standl. & Steyerm.	
Euphorbiaceae	*Bernardia* sp.	
Bixaceae	*Bixa orellana* L.	I
Bixaceae	*Bixa urucurana* Willd.	
Papaveraceae	*Bocconia arborea* S. Watson	I
Urticaceae	*Boehmeria caudata* Sw.	I
Urticaceae	*Boehmeria ulmifolia* Wedd.	I
Boraginaceae	*Bourreria huanita* (Lex.) Hemsl.	I
Solanaceae	*Brachistus stramoniifolius* (Kunth) Miers	I
Acanthaceae	*Bravaisia integerrima* (Spreng.) Standl.	
Moraceae	*Brosimum alicastrum* Sw.	I
Loganiaceae	*Buddleja americana* L.	
Malpighiaceae	*Bunchosia nitida* (Jacq.) DC.	I
Burseraceae	*Bursera graveolens* (Kunth) Triana & Planch.	
Burseraceae	*Bursera longicuspis* Lundell	
Burseraceae	*Bursera simaruba* (L.) Sarg.	I
Malpighiaceae	*Byrsonima crassifolia* (L.) Kunth	I
Leguminosae	*Caesalpinia eriostachys* Benth.	I
Leguminosae	*Caesalpinia exostemma* DC.	I
Icacinaceae	*Calatola laevigata* Standl.	I
Leguminosae	*Calliandra* sp. nov.	
Cupressaceae	*Callitropsis lusitanica* (Mill.) D.P. Little	
Clusiaceae	*Calophyllum brasiliense* var. *rekoi* (Standl.) Standl.	I
Rubiaceae	*Calycophyllum candidissimun* (Vahl) DC.	I
Capparaceae	*Capparis discolor* Donn. Sm.	I

Family	Species	Indicator (I)
Capparaceae	*Capparis flexuosa* (L.) L.	I
Capparaceae	*Capparis frondosa* Jacq.	I
Capparaceae	*Capparis indica* (L.) Druce	I
Capparaceae	*Capparis mollicella* Standl.	I
Capparaceae	*Capparis odoratissima* Jacq.	I
Capparaceae	*Capparis pringlei* Briq.	I
Capparaceae	*Capparis quiriguensis* Standl.	I
Capparaceae	*Capparis* sp.	
Solanaceae	*Capsicum ciliatum* (Kunth) Kuntze	
Caricaceae	*Carica cauliflora* Jacq.	I
Caricaceae	*Carica papaya* L.	I
Apocynaceae	*Cascabela ovata* (Cav.) Lippold	I
Flacourtiaceae	*Casearia aculeata* Jacq.	I
Flacourtiaceae	*Casearia arguta* Kunth	
Flacourtiaceae	*Casearia coronata* Standl. & L.O. Williams	
Flacourtiaceae	*Casearia tremula* (Griseb.) Griseb. ex C. Wright	
Flacourtiaceae	*Casearia commersoniana* Cambess	I
Flacourtiaceae	*Casearia* sp.	
Flacourtiaceae	*Casearia corymbosa* Kunth	I
Flacourtiaceae	*Casearia sylvestris* Sw. var. *sylvestris*	I
Rutaceae	*Casimiroa sapota* Oerst.	I
Leguminosae	*Cassia grandis* L. f.	I
Celastraceae	*Cassine xylocarpa* Vent	I
Moraceae	*Castilla elastica* Sessé ex Cerv.	I
Moraceae	*Cecropia obtusifolia* Bertol.	I
Cecropiaceae	*Cecropia peltata* L.	I
Meliaceae	*Cedrela fissilis* Vell.	
Meliaceae	*Cedrela odorata* L.	I
Meliaceae	*Cedrela salvadorensis* Standl.	I
Meliaceae	*Cedrela tonduzii* C. DC.	
Bombacaceae	*Ceiba aesculifolia* (Kunth) Britten & Baker f.	I
Bombacaceae	*Ceiba pentandra* (L.) Gaertn.	I
Ulmaceae	*Celtis caudata* Planch.	
Ulmaceae	*Celtis iguanaea* (Jacq.) Sarg.	I
Solanaceae	*Cestrum dumetorum* Schltdl.	I
Solanaceae	*Cestrum nocturnum* L.	I
Solanaceae	*Cestrum pacayense* Francey	
Solanaceae	*Cestrum racemosum* Ruiz & Pav.	
Solanaceae	*Cestrum tomentosum* L. f.	I
Arecaceae	*Chamaedorea tepejilote* Liebm. ex Mart.	
Rubiaceae	*Chiococca alba* (L.) Hitchc.	I
Rubiaceae	*Chiococca pachyphylla* Wernham	I
Chrysobalanaceae	*Chrysobalanus icaco* L.	I
Sapotaceae	*Chrysophyllum mexicanum* Brandegee ex Standl.	I
Verbenaceae	*Citharexylum costaricense* Moldenke	
Verbenaceae	*Citharexylum donnell-smithii* Greenm.	I

Family	Species	Indicator (I)
Verbenaceae	*Clerodendrum pittieri* Moldenke	
Clethraceae	*Clethra mexicana* DC.	I
Clethraceae	*Clethra* sp.	
Clethraceae	*Clethra suaveolens* Turcz.	
Asteraceae	*Clibadium arboreum* Donn. Sm.	I
Clusiaceae	*Clusia guatemalensis* Hemsl.	I
Euphorbiaceae	*Cnidoscolus aconitifolius* (Mill.) I.M. Johnst. subsp.	
Euphorbiaceae	*Cnidoscolus* sp.	
Polygonaceae	*Coccoloba acapulcensis* Standl.	
Polygonaceae	*Coccoloba barbadensis* Jacq.	
Polygonaceae	*Coccoloba caracasana* Meisn.	I
Polygonaceae	*Coccoloba montana* Standl.	
Polygonaceae	*Coccoloba* sp. nov.	
Polygonaceae	*Coccoloba venosa* L.	
Cochlospermaceae	*Cochlospermum vitifolium* (Willd.) Spreng.	I
Leguminosae	*Cojoba arborea* (L.) Britton & Rose	
Leguminosae	*Cojoba graciliflora* (S.F. Blake) Britton & Rose	
Rhamnaceae	*Colubrina arborescens* (Mill.) Sarg.	I
Rhamnaceae	*Colubrina heteroneura* (Griseb.) Standl.	I
Combretaceae	*Combretum fruticosum* (Loefl.) Stuntz	
Combretaceae	*Conocarpus erectus* L.	I
Melastomataceae	*Conostegia xalapensis* (Bonpl.) D. Don ex DC.	I
Boraginaceae	*Cordia alliodora* (Ruiz et Pav.) Oken	I
Boraginaceae	*Cordia collococca* L.	
Boraginaceae	*Cordia dentata* Poir.	I
Boraginaceae	*Cordia panamensis* L. Riley	I
Boraginaceae	*Cordia salvadorensis* Standl.	
Verbenaceae	*Cornutia pyramidata* L.	I
Chrysobalanaceae	*Couepia polyandra* (Kunth) Rose	
Rubiaceae	*Coutarea hexandra* (Jacq.) K. Schum.	I
Capparaceae	*Crateva tapia* L.	I
Bignoniaceae	*Crescentia cujete* L.	
Asteraceae	*Critonia* sp.	I
Asteraceae	*Critonia daleoides* DC.	I
Asteraceae	*Critonia hebebotrya* DC.	I
Asteraceae	*Critonia morifolia* (Mill.) King et Rob	I
Celastraceae	*Crossopetalum* sp. nov.	
Euphorbiaceae	*Croton guatemalensis* Lotsy	
Euphorbiaceae	*Croton reflexifolius* Kunth	
Euphorbiaceae	*Croton* sp. nov.	
Sapindaceae	*Cupania guatemalensis* (Turcz.) Radlk.	I
Sapindaceae	*Cupania mollis* Standl.	
Dilleniaceae	*Curatella americana* L.	I
Annonaceae	*Cymbopetalum penduliflorum* (Dunal) Baill.	
Leguminosae	*Dalbergia calycina* Benth.	
Leguminosae	*Dalbergia chontalensis* Standl. & L.O. Williams	I

Family	Species	Indicator (I)
Leguminosae	*Dalbergia congestiflora* Pittier	
Leguminosae	*Dalbergia melanocardium* Pittier	
Leguminosae	*Dalbergia salvanaturae* J. Linares et M. Sousa	
Thymelaeaceae	*Daphnopsis witsbergeri* Nevling, Matek. & Barringer	
Leguminosae	*Delonix regia* (Bojer ex Hook.) Raf.	
Araliaceae	*Dendropanax arboreus* (L.) DCne. et Planch.	I
Dichapetalaceae	*Dichapetalum donnell-smithii* Engl.	I
Ebenaceae	*Diospyros morenoi* A. Pool	
Ebenaceae	*Diospyros nicaraguensis* (Standl.) Standl.	
Ebenaceae	*Diospyros salicifolia* Humb. & Bonpl. ex Willd.	I
Leguminosae	*Diphysa americana* (Miller) M. Sousa	I
Leguminosae	*Diphysa humilis* Oerst.	
Euphorbiaceae	*Drypetes lateriflora* (Sw.) Krug & Urb.	I
Leguminosae	*Dussia cuscatlanica* (Standl.) Standl. & Steyerm.	I
Leguminosae	*Dyphisa americana* (Mill.) M. Sousa	I
Boraginaceae	*Ehretia latifolia* DC.	I
Leguminosae	*Enterolobium cyclocarpum* (Jacq.) Griseb.	I
Asteraceae	*Eremopsis triflosculosa* (Kunth) Gleason subsp. *triflosculosa*	I
Leguminosae	*Erythrina berteroana* Urb.	I
Erythroxylaceae	*Erythroxylum areolatum* L.	
Erythroxylaceae	*Erythroxylum havanense* Jacq.	
Erythroxylaceae	*Erythroxylum rotundifolium* Lunan	
Myrtaceae	*Eugenia alfaroana* Standl.	
Myrtaceae	*Eugenia* sp.1	
Myrtaceae	*Eugenia* sp. 2	
Myrtaceae	*Eugenia jutiapensis* Standl. & Steyerm.	I
Myrtaceae	*Eugenia lindeniana* O. Berg	I
Myrtaceae	*Eugenia oerstediana* O. Berg	
Myrtaceae	*Eugenia quercetorum* Standl. & L.O. Williams ex Barrie	
Myrtaceae	*Eugenia salamensis* Donn. Sm. var. *salamensis*	
Myrtaceae	*Eugenia salamensis* var. *rensoniana* (Standl.) McVaugh	I
Myrtaceae	*Eugenia sasoana* Standl. & Steyerm.	I
Euphorbiaceae	*Euphorbia leucocephala* Lotsy	
Euphorbiaceae	*Euphorbia schlechtendalii* Boiss.	
Euphorbiaceae	*Euphorbia* sp.	
Euphorbiaceae	Euphorbiaceae indet. (sp. nov.?)	
Rubiaceae	*Exostema caribaeum* (Jacq.) Roem. & Schult.	I
Rubiaceae	*Exostema mexicanum* A. Gray	I
Sapindaceae	*Exothea paniculata* (Juss.) Radlk.	I
Leguminosae	*Eysenhardtia adenostylis* Baill.	
Rubiaceae	*Faramea occidentalis* (L.) A. Rich.	
Moraceae	*Ficus aurea* Nutt.	I
Moraceae	*Ficus citrifolia* Mill.	I

Family	Species	Indicator (I)
Moraceae	*Ficus costaricana* (Liebm.) Miq.	I
Moraceae	*Ficus cotinifolia* Kunth var. *cotinifolia*	I
Moraceae	*Ficus goldmanii* Standl.	
Moraceae	*Ficus insipida* Willd.	I
Moraceae	*Ficus jimenezii* Standl.	
Moraceae	*Ficus maxima* Mill.	I
Moraceae	*Ficus obtusifolia* Kunth	
Moraceae	*Ficus ovalis* (Liebm.) Miq.	I
Moraceae	*Ficus trigonata* L.	I
Apocynaceae	*Forchhammeria trifoliata* Radlk.	I
Onagraceae	*Fuchsia paniculata* Lindl.	
Euphorbiaceae	*Garcia nutans* Vahl	I
Clusiaceae	*Garcinia intermedia* (Pittier) Hammel	
Ericaceae	*Gaultheria erecta* Vent.	I
Rubiaceae	*Genipa americana* L.	I
Leguminosae	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	I
Bignoniaceae	*Godmania aesculifolia* (Kunth) Standl.	I
Nyctaginaceae	*Grajalesia fasciculata* (Standl.) Miranda	
Nyctaginaceae	*Guapira witsbergeri* Lundell	
Meliaceae	*Guarea glabra* Vahl	I
Sterculiaceae	*Guazuma ulmifolia* Lam.	I
Rubiaceae	*Guettarda macrosperma* Donn. Sm.	I
Rubiaceae	*Guettarda subcapitata* C.M. Taylor	I
Euphorbiaceae	*Gymnanthes riparia* (Schltdl.) Klotzsch	
Hernandiaceae	*Gyrocarpus americanus* Jacq.	I
Hernandiaceae	*Gyrocarpus jatrophifolius* Domin	
Rubiaceae	*Hamelia patens* Jacq.	I
Malvaceae	*Hampea stipitata* S. Watson	
Onagraceae	*Hauya elegans* subsp. *lucida* (Donn. Sm. & Rose) P.H. Raven & Breedlove	I
Tiliaceae	*Heliocarpus mexicanus* (Turcz.) Sprague	I
Hippocrateaceae	*Hemiangium excelsum* (Kunth) A.C. Sm.	I
Malpighiaceae	*Heteropterys laurifolia* (L.) A. Juss.	I
Malvaceae	*Hibiscus pernambucensis* Arruda	I
Rubiaceae	*Hillia tetrandra* Sw.	
Rubiaceae	*Hintonia latiflora* (Sessé & Moc. ex DC.) Bullock	I
Rubiaceae	*Hintonia lumaeana* (Baill.) Bullock	I
Malpighiaceae	*Hiraea* sp.	
Malpighiaceae	*Hiraea velutina* Nied.	
Chrysobalanaceae	*Hirtella racemosa* var. *hexandra* (Willd. ex Roem. &	
Euphorbiaceae	*Hura polyandra* Baill.	
Leguminosae	*Hymenaea courbaril* L.	I
Menispermaceae	*Hyperbaena mexicana* Miers	I
Menispermaceae	*Hyperbaena tonduzii* Diels	I
Aquifoliaceae	*Ilex discolor* Hemsl. var *discolor*	I

Family	Species	Indicator (I)
Aquifoliaceae	*Ilex discolor* var. *tolucana* (Hemsl.) Edwin ex T.R. Dudley	
Rutaceae	Indeterminada	
Flacourtiaceae	Indeterminada	
Celastraceae	Indeterminada	
Meliaceae	Indeterminada	
Melastomataceae	Indeterminada	
Sapindaceae	Indeterminada	
Sapotaceae	Indeterminada	
Leguminosae	*Inga calderonii* Standl.	
Leguminosae	*Inga flexuosa* Schltdl.	I
Leguminosae	*Inga oerstediana* Benth. ex Seem.	
Leguminosae	*Inga pavoniana* G. Don	I
Leguminosae	*Inga punctacta* Willd.	I
Leguminosae	*Inga sapindoides* Willd.	
Leguminosae	*Inga vera* Willd.	I
Convolvulaceae	*Ipomoea wolcottiana* Rose subsp. *wolcottiana*	I
Amaranthaceae	*Iresine diffusa* Humb. & Bonpl. ex Willd.	
Amaranthaceae	*Iresine herrerae* Conz. & S.F. Blake	
Amaranthaceae	*Iresine nigra* Uline & W.L. Bray	
Rubiaceae	*Ixora floribunda* (A. Rich.) Griseb.	
Caricaceae	*Jacaratia mexicana* A. DC.	I
Theophrastaceae	*Jacquinia longifolia* Standl.	I
Juglandaceae	*Juglans olanchana* Standl. & L.O. Williams	
Rhamnaceae	*Karwinskia calderonii* Standl.	I
Rhamnaceae	*Krugiodendron ferreum* (Vahl) Urb.	I
Rhamnaceae	*Krugiodendron* sp. nov.	
Lythraceae	*Lafoensia punicifolia* DC.	
Combretaceae	*Laguncularia racemosa (L.) C.F. Gaertn.*	I
Asteraceae	*Lasianthaea fruticosa* (L.) K.M. Becker	I
Phytolaccaceae	*Ledenbergia macrantha* Standl.	I
Leguminosae	*Lennea viridiflora* Seem.	
Leguminosae	*Leucaena diversifolia* (Schltdl.) Benth.	
Leguminosae	*Leucaena shannonii* Donn. Sm.	
Chrysobalanaceae	*Licania arborea* Seem.	I
Chrysobalanaceae	*Licania platypus* (Hemsl.) Fritsch	I
Chrysobalanaceae	*Licania retifolia* S.F. Blake	I
Lauraceaeindet	*Licaria capitata* (Schltdl. & Cham.) Kosterm.	
Lauraceae	*Licaria* sp.	
Verbenaceae	*Lippia cardiostegia* Benth.	I
Verbenaceae	*Lippia myriocephala* Schltdl. & Cham.	I
Verbenaceae	*Lippia umbellata* Cav.	I
Leguminosae	*Lonchocarpus* sp.	
Leguminosae	*Lonchocarpus acuminatus* (Schltdl.) M. Sousa	
Leguminosae	*Lonchocarpus guatemalensis* Benth.	I
Leguminosae	*Lonchocarpus lanceolatus* Benth.	

Family	Species	Indicator (I)
Leguminosae	*Lonchocarpus michelianus* Pittier	
Leguminosae	*Lonchocarpus minimiflorus* Donn. Sm.	I
Leguminosae	*Lonchocarpus molinae* Standl. & L.O. Williams	
Leguminosae	*Lonchocarpus parviflorus* Benth.	
Leguminosae	*Lonchocarpus peninsularis* (Donn. Sm.) Pittier	
Leguminosae	*Lonchocarpus phaseolifolius* Benth.	
Leguminosae	*Lonchocarpus purpusii* Brandegee	
Leguminosae	*Lonchocarpus retiferus* Standl. & L.O. Williams	
Leguminosae	*Lonchocarpus rugosus* subsp. *apricus* (Lundell) M. Sousa	I
Leguminosae	*Lonchocarpus salvadorensis* Pittier	I
Leguminosae	*Lonchocarpus sanctuarii* Standl. & L.O. Williams	
Leguminosae	*Lonchocarpus santarosanus* Donn. Sm.	I
Leguminosae	*Lonchocarpus schiedeanus* (Schltdl.) Harms	
Leguminosae	*Lonchocarpus stenophyllus* M. Sousa	
Tiliaceae	*Luehea candida* (Moc. & Sessé ex DC.) Mart.	I
Cucurbitaceae	*Luffa operculata* (L.) Cogn.	
Solanaceae	*Lycianthes arrazolensis* (J.M. Coult. & Donn. Sm.) Bitter	I
Solanaceae	*Lycianthes heteroclita* (Sendtn.) Bitter	I
Solanaceae	*Lycianthes orogenes* Standl. & Steyerm.	
Leguminosae	*Lysiloma acapulcense* (Kunth) Benth.	I
Leguminosae	*Lysiloma auritum* (Schltdl.) Benth.	I
Leguminosae	*Lysiloma divaricatum* (Jacq.) J.F. Macbr.	I
Leguminosae	*Machaerium biovulatum* Micheli	I
Leguminosae	*Machaerium kegelii* Meisn.	
Leguminosae	*Machaerium salvadorense* (Donn. Sm.) Rudd	I
Leguminosae	*Machaerium* sp.	
Moraceae	*Maclura tinctoria* (L.) D. Don ex Steud.	I
Malpighiaceae	*Malpighia glabra* L.	I
Malpighiaceae	*Malpighia* sp.	
Malvaceae	*Malvaviscus arboreus* Cav. var. *arboreus*	I
Sapotaceae	*Manilkara chicle* (Pittier) Gilly	
Sapotaceae	*Manilkara zapota* (L.) P. Royen	
Euphorbiaceae	*Margaritaria nobilis* L. f.	I
Sapindaceae	*Matayba glaberrima* Radlk.	
Celastraceae	*Maytenus chiapensis* Lundell	
Celastraceae	*Maytenus* sp. nov.	
Melastomataceae	*Miconia* sp.	
Melastomataceae	*Miconia argentea* (Sw.) DC.	I
Melatomataceae	*Miconia laevigata* (L.) D. Don	I
Asteraceae	*Montanoa grandiflora* Alaman es DC.	I
Asteraceae	*Montanoa guatemalensis* B.L. Rob. & Greenm.	I
Asteraceae	*Montanoa hibiscifolia* Benth.	I
Asteraceae	*Montanoa tomentosa* subsp. *xanthiifolia* (Sch. Bip. ex C. Koch) V.A. Funk	I

Family	Species	Indicator (I)
Myricaceae	*Morella cerifera* (L.) Small	
Melastomataceae	*Mouriri myrtilloides* subsp. *parvifolia* (Benth.) Morley	
Elaeocarpaceae	*Muntingia calabura* L.	I
Myrtaceae	*Myrcianthes fragrans* (Sw.) McVaugh var. *fragrans*	
Myrtaceae	*Myrcianthes* sp.	
Urticaceae	*Myriocarpa longipes* Liebm.	I
Leguminosae	*Myrospermum frutescens* Jacq.	I
Leguminosae	*Myroxylon balsamum* var. *pereirae* (Royle) Harms	I
Lauraceae	*Nectandra martinicensis* Mez	I
Lauraceae	*Nectandra mirafloris*	
Lauraceae	*Nectandra salicifolia* (Kunth) Nees	
Nyctaginaceae	*Neea psychotrioides* Donn. Sm.	I
Asteraceae	*Neurolaena lobata* (L.) Cass.	
Bombacaceae	*Ochroma pyramidale* (Cav. ex Lam.) Urb.	I
Lauraceae	*Ocotea botrantha* Rohwer	
Lauraceae	*Ocotea salvadorensis* (Lundell) van der Werff	
Lauraceae	*Ocotea sinuata* (Mez) Rohwer	
Lauraceae	*Ocotea veraguensis* (Meisn.) Mez	I
Euphorbiaceae	*Omphalea oleifera* Hemsl.	I
Euphorbiaceae	*Ophellantha spinosa* Standl.	
Araliaceae	*Oreopanax xalapensis* (Kunth) Decne. & Planch.	
Ochnaceae	*Ouratea lucens* (Kunth) Engl.	I
Bombacaceae	*Pachira aquatica* Aubl.	I
Asteraceae	*Pachythamnus crassirameus* (B.L. Rob.) R.M. King & H. Rob.	I
Rubiaceae	*Palicourea padifolia* (Willd. ex Roem. & Schult.)	
Myrsinaceae	*Parathesis columnaris* Lundell	
Myrsinaceae	*Parathesis vulgata* Lundell	I
Rutaceae	*Peltostigma pteleoides* (Hook.) Walp.	I
Lauraceae	*Persea americana* Mill.	I
Asteraceae	*Perymenium grande* Hemsl. var. *grande*	I
Asteraceae	*Perymenium grande* var. *nelsonii* (B.L. Rob. & Greenm.) J.J. Fay	I
Urticaceae	*Phenax hirtus* (Sw.) Wedd.	I
Urticaceae	*Phenax mexicanus* Wedd.	I
Lauraceae	*Phoebe acuminatissima* Lundell	
Lauraceae	*Phoebe* sp.	
Euphorbiaceae	*Phyllanthus elsiae* Urb.	
Euphorbiaceae	*Phyllanthus mocinianus* Baill.	
Euphorbiaceae	*Phyllanthus* sp.	
Ulmaceae	*Phyllostylon rhamnoides* (J. Poiss.) Taub.	
Simaroubaceae	*Picramnia antidesma* subsp. *fessonia* (DC.) W.W. Thomas	
Rutaceae	*Pilocarpus racemosus* subsp *viridulus* Kaastra	I
Pinaceae	*Pinus oocarpa* Schiede ex Schltdl.	
Piperaceae	*Piper amalago* L.	I

Family	Species	Indicator (I)
Piperaceae	*Piper marginatum* Jacq.	I
Piperaceae	*Piper sanctum* (Miq.) Schltdl. ex C. DC.	I
Piperaceae	*Piper* sp.	
Piperaceae	*Piper tuberculatum* Jacq.	I
Piperaceae	*Piper yzabalanum* C. DC.	
Leguminosae	*Piptadenia obliqua* (Pers.) J.F. Macbr.	I
Leguminosae	*Piscidia carthagenensis* Jacq.	
Leguminosae	*Piscidia grandifolia* (Donn. Sm.) I.M. Johnst.	
Nyctaginaceae	*Pisonia aculeata* Jacq.	
Nyctaginaceae	*Pisonia donnellsmithii* Heimerl ex Standl.	
Nyctaginaceae	*Pisonia macranthocarpa* (Donn. Sm.) Donn. Sm.	
Nyctaginaceae	*Pisonia* sp. nov.	
Leguminosae	*Pithecellobium dulce* (Roxb.) Benth.	I
Leguminosae	*Pithecellobium microstachyum* Standl.	
Leguminosae	*Platymiscium parviflorum* Benth.	
Asteraceae	*Pluchea odorata* (L.) Cass.	
Apocynaceae	*Plumeria rubra* forma *acutifolia* (Poir.) Woodson	I
Asteraceae	*Podachaenium eminens* (Lag.) Sch. Bip.	
Polygonaceae	*Podopterus mexicanus* Bonpl.	
Leguminosae	*Poeppigia procera* C. Presl	I
Rubiaceae	*Pogonopus speciosus* (Jacq.) K. Schum.	I
Rubiaceae	*Posoqueria latifolia* (Rudge) Roem. & Schult.	I
Sapotaceae	*Pouteria compechiana* (Kunth) Baehni	
Sapotaceae	*Pouteria sapota* (Jacq.) H.E. Moore & Stearn	
Sapotaceae	*Pouteria viridis* (Pittier) Cronquist	
Flacourtiaceae	*Prockia crucis* P. Browne ex L.	I
Rosaceae	*Prunus* sp.	
Rosaceae	*Prunus axitlana* Standl.	
Rosaceae	*Prunus brachybotrya* Zucc.	
Rosaceae	*Prunus salasii* Standl.	
Rosaceae	*Prunus skutchii* I.M. Johnst.	
Bombacaceae	*Pseudobombax ellipticum* (Kunth) Dugand	I
Bombacaceae	*Pseudobombax septenatum* (Jacq.) Dugand	I
Myrsinaceae	*Psidium guajava* L.	I
Myrtaceae	*Psidium guineense* Sw.	I
Myrtaceae	*Psidium* sp,	
Rubiaceae	*Psychotria* sp.	
Rubiaceae	*Psychotria costivenia* Griseb.	
Rubiaceae	*Psychotria limonensis* K. Krause	I
Rubiaceae	*Psychotria microdon* (DC.) Urb.	I
Rubiaceae	*Psychotria pubescens* Sw.	
Fagaceae	*Quercus elliptica* Née	I
Fagaceae	*Quercus lancifolia* Schltdl. & Cham.	I
Fagaceae	*Quercus salicifolia* Née	I
Fagaceae	*Quercus sapotifolia* Liebm.	I
Fagaceae	*Quercus segoviensis* Liebm.	

Family	Species	Indicator (I)
Fagaceae	*Quercus skinneri* Benth.	I
Fagaceae	*Quercus* sp.	
Fagaceae	*Quercus tristis* Liebm.	
Rubiaceae	*Randia* sp. 1	
Rubiaceae	*Randia* sp. 2	
Rubiaceae	*Randia* sp. 3	
Rubiaceae	*Randia aculeata* L.	
Rubiaceae	*Randia armata* (Sw.) DC.	I
Rubiaceae	*Randia grandifolia* (Donn. Sm.) Standl.	I
Rubiaceae	*Randia monantha* Benth.	
Rubiaceae	*Randia obcordata* S. Watson	
Rubiaceae	*Randia pleiomeris* Standl.	
Rubiaceae	*Randia thurberi* S. Watson	
Myrsinaceae	*Rapanea* sp.	
Asteraceae	*Rensonia salvadorica* S.F. Blake	
Rhamnaceae	*Rhamnus sphaerosperma* var. *mesoamericana* M.C. Johnst. & L.A. Johnst.	I
Rhizophoraceae	*Rhizophora mangle* L.	
Malvaceae	*Robinsonella densiflora* Fryxell	I
Asteraceae	*Roldana petasioides* (Greenm.) H. Rob.	I
Annonaceae	*Rollinia membranacea* Triana & Planch.	
Rubiaceae	*Rondeletia cordata* Benth.	
Rubiaceae	*Rondeletia deamii* (Donn. Sm.) Standl.	I
Rubiaceae	*Rondeletia laniflora* Benth.	I
Rubiaceae	*Rondeletia thiemei* Donn. Sm.	I
Proteaceae	*Roupala glaberrima* Pittier	I
Polygonaceae	*Ruprechtia chiapensis* Lundell	
Polygonaceae	*Ruprechtia costata* Meisn.	I
Leguminosae	*Samanea saman* (Jacq.) Merr.	I
Sapindaceae	*Sapindus saponaria* L.	I
Euphorbiaceae	*Sapium macrocarpum* Müell. Arg.	I
Annonaceae	*Sapranthus microcarpus* (Donn. Sm.) R.E. Fr.	
Annonaceae	*Sapranthus palanga* R.E. Fr.	
Annonaceae	*Sapranthus violaceus* (Dunal) Saff.	I
Actinidiaceae	*Saurauia kegeliana* Schltdl.	
Leguminosae	*Schizolobium parahyba* (Vell.) S.F. Blake	
Olacaceae	*Schoepfia schreberi* J.F. Gmel.	I
Olacaceae	*Schoepfia vacciniiflora* Planch. ex Hemsl.	
Araliaceae	*Sciadodendron excelsum* Griseb.	I
Hippocrateaceae	*Semialarium mexicanum* (Miers) Mennega	
Leguminosae	*Senna nicaraguensis* (Benth.) H.S. Irwin & Barneby	I
Leguminosae	*Senna pallida* (Vahl) H.S. Irwin & Barneby	I
Leguminosae	*Senna reticulata* (Willd.) H.S. Irwin & Barneby	I
Sapotaceae	*Sideroxylon* sp.	
Sapotaceae	*Sideroxylon capiri* subsp. *tempisque* (Pittier) T.D. Penn.	I

Family	Species	Indicator (I)
Sapotaceae	*Sideroxylon persimile* (Hemsl.) T.D. Penn. ssp. *persimile*	
Sapotaceae	*Sideroxylon tepicense* (Standl.) T.D. Penn.	
Simaroubaceae	*Simarouba glauca* DC.	I
Rubiaceae	*Simira calderoniana* (Standl.) Steyerm.	
Rubiaceae	*Simira salvadorensis* (Standl.) Steyerm.	
Asteraceae	*Sinclairia deamii* (B.L. Rob. & Bartlett) Rydb.	I
Asteraceae	*Sinclairia discolor* Hook. & Arn.	I
Asteraceae	*Sinclairia glabra* (Hemsl) Rydb.	I
Asteraceae	*Sinclairia sublobatum* (B. L. Rob.) Rydb.	I
Elaeocarpaceae	*Sloanea terniflora* (Sessé & Moc. ex DC.) Standl.	I
Solanaceae	*Solanum diphyllum* L.	
Solanaceae	*Solanum erianthum* D. Don	I
Solanaceae	*Solanum hazenii* Britton	I
Solanaceae	*Solanum lanceolatum* Cav.	I
Solanaceae	*Solanum* sp.	
Solanaceae	*Solanum umbellatum* Mill.	I
Anacardiaceae	*Spondias mombin* L.	I
Anacardiaceae	*Spondias purpurea* L.	I
Anacardiaceae	*Spondias radlkoferii* Donn. Sm.	I
Apocynaceae	*Stemmadenia donnell-smithii* (Rose) Woodson	I
Apocynaceae	*Stemmadenia eubracteata* Woodson	I
Apocynaceae	*Stemmadenia obovata* K. Schum.	I
Apocynaceae	*Stemmadenia pubescens* Benth.	
Apocynaceae	*Stemmadenia robinsonii* Woodson	
Cactaceae	*Stenocereus aragonii* (F.A.C. Weber) Buxb.	I
Sterculiaceae	*Sterculia apetala* (Jacq.) H. Karst.	
Loganiaceae	*Strychnos brachistantha* Standl.	
Leguminosae	*Styphnolobium sporadicum* M. Sousa & Rudd	
Styrax	*Styrax argenteus* C. Presl.	I
Styracaceae	*Styrax warscewiczii* Perkins	
Leguminosae	*Swartzia simplex* var. *ochnacea* (DC.) R.S. Cowan	I
Meliaceae	*Swietenia humilis* Zucc.	I
Meliaceae	*Swietenia macrophylla* King.	I
Theaceae	*Symplocarpon* sp.	
Symplocaceae	*Symplococarpon purpusii* (Brandegee) Kobuski	
Symplocaceae	*Symplocos limoncillo* Bonpl.	
Myrsinaceae	*Synardisia venosa* (Mast.) Lundell	I
Bignoniaceae	*Tabebuia chrysantha* (Jacq.) G. Nicholson subsp. *chrysantha*	I
Bignoniaceae	*Tabebuia donnell-smithii* Rose	I
Bignoniaceae	*Tabebuia impetiginosa* (Mart. ex DC.) Standl.	I
Bignoniaceae	*Tabebuia rosea* (Bertol.) A. DC.	I
Apocynaceae	*Tabernaemontana amygdalifolia* Jacq.	I
Sapindaceae	*Talisia olivaeformis* (Kunth) Radlk.	I
Bombacaceae	*Tecoma stans* (L.) Juss. ex Kunth	I

Family	Species	Indicator (I)
Compositae	*Telanthophora arborescens* (Steetz) H. Rob. & Brettell	I
Combretaceae	*Terminalia oblonga* (Ruiz & Pav.) Steud.	I
Euphorbiaceae	*Tetrorchidium* sp. nov.	
Sapindaceae	*Thouinia brachybotrya* Donn. Sm.	
Sapindaceae	*Thouinia velutina* Radlk.	I
Sapindaceae	*Thouinia villosa* DC.	I
Sapindaceae	*Thouinidium decandrum* (Bonpl.) Radlk.	I
Sapindaceae	*Thouinidium* sp.	
Melastomaceae	*Tibouchina* sp.	
Boraginaceae	*Tournefortia acutiflora* M. Martens & Galeotti	I
Boraginaceae	*Tournefortia glabra* L.	
Anacardiaceae	*Toxicodendron striatum* (Ruiz & Pav.) Kuntze	
Ulmaceae	*Trema micrantha* (L.) Blume var. *micrantha*	I
Ulmaceae	*Trema micrantha* var. *strigillosa* (Lundell) Standl. & Steyerm.	I
Meliaceae	*Trichilia americana* (Sesse & Moc.) T.D. Penn.	I
Meliaceae	*Trichilia glabra* L.	
Meliaceae	*Trichilia havanensis* Jacq.	I
Meliaceae	*Trichilia hirta* L.	I
Meliaceae	*Trichilia martiana* C. DC.	I
Meliaceae	*Trichilia* sp.	
Tiliaceae	*Trichospermum galeotti* (Turcz.) Kosterm.	I
Polygonaceae	*Triplaris melaenodendron* (Bertol.) Standl. & Steyerm.	I
Moraceae	*Trophis mexicana* (Liebm.) Bureau	
Moraceae	*Trophis racemosa* (L.) Urb.	I
Staphyleaceae	*Turpinia occidentalis* (Sw.) G. Don	I
Ulmaceae	*Ulmus mexicana* (Liebm.) Planch.	I
Urticaceae	*Urera baccifera* (L.) Gaudich. ex Wedd.	I
Urticaceae	*Urera corallina* (Liebm.) Wedd.	I
Urticaceae	*Urera eggersii* Hieron.	I
Urticaceae	*Urera* sp. nov.	
Asteraceae	*Verbesina guatemalensis* B.L. Rob. & Greenm.	I
Asteraceae	*Verbesina turbacensis* Kunth	I
Asteraceae	*Vernonia deppeana* Less.	I
Asteraceae	*Vernonia patens* Kunth	I
Caprifoliaceae	*Viburnum hartwegii* Benth.	I
Hydrophyllaceae	*Wigandia urens* (Ruiz & Pav.) Kunth	
Celastraceae	*Wimmeria cyclocarpa* Radlk.	
Olacaceae	*Ximenia americana* L.	I
Verbenaceae	*Xolocotzia asperifolia* Miranda	
Flacourtiaceae	*Xylosma chlorantha* Donn. Sm.	I
Flacourtiaceae	*Xylosma flexuosa* (Kunth) Hemsl.	I
Flacourtiaceae	*Xylosma* sp.	
Rutaceae	*Zanthoxylum aguilarii* Standl. & Steyerm.	

Family	Species	Indicator (I)
Rutaceae	*Zanthoxylum culantrillo* Kunth	I
Rutaceae	*Zanthoxylum kellermanii* P. Wilson	
Rutaceae	*Zanthoxylum melanostictum* Schltdl. & Cham.	
Rutaceae	*Zanthoxylum microcarpum* Griseb.	I
Rutaceae	*Zanthoxylum nicaraguense* Standl. & L.O. Williams	
Rutaceae	*Zanthoxylum riedelianum* Engl.	
Leguminosae	*Zapoteca formosa* (Kunth) H.M. Hern. subsp. formosa	I
Celastraceae	*Zinowiewia cuneifolia* Lundell	I

*I=Indicator species for evaluating the completeness of an inventory.

Figure 5A. *Diospyros morenoi* (Zapote negro). Finca María Auxiliadora, Los Volcanes National Park, July 2007. Previously known only from Cinquera, Cabañas Department, El Salvador, and a locality in Nicaragua.

Figure 5B. *Pinus oocarpa* (Pino). Los Volcanes National Park, Izalco Vocano, December 2007.

Figure 5C. *Guapira witsbergerii* (Siete camisas rojo). Los Volcanes National Park, Cerro Verde, December 2007. First photographic record of this species endemic to the study area.

Figure 5D. *Triphora mexicana*, a very rare orchid. Finca María Auxiliadora, Los Volcanes National Park. July 2007.

Figure 5E. *Oxalis salvadorensis* (Trébol de peña, or cliff clover), Plan de Amayo Protected Natural Area, August 2007. Endemic to the Project area.

Figure 5F. *Zamia herrerae* (Palmita), Plan de Amayo Protected Natural Area, August 2007. Listed as Vulnerable in the IUCN Red List.

Figure 5G. *Peperomia linaresii*. Plan de Amayo Protected Natural Area, August 2007. Very rare, known only from two localities, both within the Project area.

Figure 5H. *Balmea stormae,* Cerro El Águila Protected Natural Area, November 2007. Listed in the IUCN Red List.

Figure 5I. *Phyllostylon rhamnoides*, Plan de Amayo Protected Natural Area, August 2007. First record for El Salvador.

Figure 5K. *Phytolacca riviniodes*. Cerro El Águila Protected Natural Area, November 2007. First record for El Salvador.

Figure 5J. *Tetrorchidium sp*. Cerro El Águila Protected Natural Area, November 2007.

Figure 5L. Flower of *Cuscatlania vulcanicola* (Cuscatlania), San Marcelino Complex Protected Natural Area, December 2007. Rediscovery, being the first record since 1922 of a species known only from El Salvador.

Figure 5M. ***Urera sp.*** **El Imposible National Park, December 2007. Species new to science.**

Figure 5N. ***Prunus axitlana*****. El Imposible National Park, December 2007.**

Figure 5O. ***Sedum salvadorense*****. El Imposible National Park, December 2007. Very rare plant, known in the world only from the Project area, and never before photographed.**

Figure 5P. ***Bursera longicuspis*** **(Jiote rojo). San Marcelino Complex Protected Natural Area, December 2007. First records for El Salvador.**

FIGURE 5. SELECTED PHOTOGRAPHS OF FLORA TAKEN DURING THE STUDY (by Frank Sullyvan Cardoza).

TABLE 12. FLORA OF CONSERVATION IMPORTANCE IN THE PROJECT AREA.

Species	Risk*	F**	SM	PA	PNEI	PNLV	AG
Aegiphila panamensis Moldenke	VU A1c	HF		X			
Agonandra loranthoides L.O. Williams	VU C1	DF	X				
Bauhinia paradisi Standl. & L.O. Williams	CR C2a	DF		X			
Cedrela odorata L.	VU A1cd+2cd	DF	X	X	X	X	
Cordia salvadorensis Standl.	raro	DF				X	
Dalbergia retusa Hemsl.	VU A1acd	DF	X				
Dichapetalum donnell-smithii Engl.	VU D2	HF			X	X	
Eugenia salamensis Donn. Sm.	EN C2a	DF	X	X	X	X	
Juglans olanchana Standl. & L.O. Williams	EN C2a	CF				X	
Lennea viridiflora Seem.	VU A2c	DF		X			
Lonchocarpus minimiflorus Donn. Sm.	EN C2b	DF	X	X	X	X	
Lonchocarpus molinae Standl. & L.O. Williams	EN C2b	HF		X			
Lonchocarpus phaseolifolius Benth.	EN C2b	DF		X	X		
Lonchocarpus retiferus Standl. & L.O. Williams	EN C2a	HF	X				
Lonchocarpus sanctuarii Standl. & L.O. Williams	CR C2b	DF			X	X	
Lonchocarpus santarosanus Donn. Sm.	VU B1+2c	HF	X		X	X	
Machaerium sp.***	raro	HF				X	
Parathesis vulgata Lundell	EN C2a	CF				X	X
Persea schiedeana Nees	VU A1c	CF				X	
Pisonia donnellsmithii Heimerl ex Standl.	VU B1+2c	HF	X	X	X		
Quercus skinneri Benth.	VU A1c	CF			X	X	X
Swietenia humilis Zucc.	VU A1cd	DF		X	X		
Swietenia macrophylla King	VU A1cd+2cd	HF			X		
Xolocotzia asperifolia Miranda	EN C2a	DF		X			
Zamia herrerae S. Calderón & Standl.	VU C1	HF		X	X		

* Risk codes come from IUCN (2007): CR=Critically Endangered, EN=Endangered, VU=Vulnerable, NT=Near-Threatened, DD=Data Deficient. The other codes presented are the criteria used to assign risk classifications and are explained in IUCN (2007).

F=Type of Forest; **CF=Cloud Forest, **DF**=Dry Forest, **HF**=Humid Forest; **SM**=San Marcelino Complex Protected Natural Area, **PA**=Plan de Amayo Protected Natural Area, **PNEI**=El Imposible National Park, **CV**=Cerro Verde, **AG**=Cerro El Águila Protected Natural Area, **PNLV**=Los Volcanes National Park.
***Still not on the IUCN Red List, but should be evaluated.

TABLE 13. INVENTORY COMPLETENESS FOR TREE SPECIES AND RELATIVE IMPORTANCE OF ECOSYSTEMS.

Ecosystem	Species Recorded	Expected Species Recorded	Number of Indicator Species for Inventory Completeness	Level of Inventory Completeness (%)	Number of Conservation Important Species
Humid Forest	249	135	135	100	13
Dry Forest	281	166	194	86	13
Cloud Forest	134	57	60	95	4
Savanna	51	35	35	100	0

At the ecosystem level, the habitats presenting the largest amount of threatened and endangered species are humid forest and dry forest with 13 species each. Cloud forest only has four threatened species. The savanna did not present any globally threatened tree species (Table 13).

Although our objective was to evaluate which watersheds and municipalities of the study area showed the highest indices of importance for tree conservation, it was impossible to make this analysis because the inventories for specific watersheds and municipalities are largely incomplete, with the exception of one watershed (Cara Sucia) and one municipality (San Francisco Menéndez). Comparisons based on incomplete inventories would produce misleading results. They reflect the level of research effort and not real values of conservation importance (Komar 2007).

3.3. SPECIES OF INTEREST

Fourteen plant species are restricted globally to the project area, including 10 trees or shrubs and 4 herbaceous species (Table 14). Prior to this study, several of these endemic species were known only from El Imposible National Park. One of the important findings of this study is that nearly all of these species exist in other locations of southwestern El Salvador. New locations have been documented for *Daphnopsis witsbergerii*, the famous *Guapira witsbergerii* (~~s~~iete camisas rojo", Fig. 5C), and the recently named *Dalbergia salvanaturae,* three trees originally described for science from El Imposible and known

only to exist in the study area. Furthermore, new localities were found for the herbaceous species *Ageratum salvanaturae* and *Peperomia linaresii*.

Some plants found in the study area stand out either because they represent new records for El Salvador, for Central America, or because they are probably new species to science (Table 15). We believe that 11 of the species collected are indeed new for science, although it may take several years for their descriptions to be reviewed by the scientific community and published. Six of these have never been documented outside of the study area (see Table 14), but five are recognized by the author from his own collecting work in other parts of Central America. Although they were collected prior to the present study, they have yet to be described formally in the scientific literature (J. Linares, unpublished data). Others represent a second or third collection for El Salvador, or even more special, a second collection for science. For example, worth mentioning is the discovery of several specimens of *Styphnolobium sporadicum* (~~a~~lmendro de montaña") previously known only from one collection in Colombia, one in Mexico and one in El Salvador. Today the species is known from two locations within the project area.

TABLE 14. PLANTS ENDEMIC TO THE IMCW PROJECT AREA, WITH COLLECTION LOCATIONS FROM THE PRESENT STUDY.

Species	Family	Habit	Locality	Collection No.
Ageratum salvanaturae B. Smalla et N. Kilian	Asteraceae	Herb	El Imposible, Plan de Amayo, & San Marcelino	12523
Besleria sp. nov.	Gesneriaceae	Herb	Cerro El Aguila	12797
Calliandra sp. nov.	Leguminosae	Shrub	El Imposible	13227
Dalbergia salvanaturae J. Linares et M. Sousa	Leguminosae	Tree	El Imposible	12664
Daphnopsis witsbergeri Nevling, Matek. & Barringer	Thymelaeaceae	Tree	El Imposible	12707
Eugenia alfaroana Standl.	Myrtaceae	Tree	El Imposible	12162
Guapira witsbergeri Lundell	Nyctaginaceae	Tree	Cerro Verde, El Imposible, Plan de Amayo	12171
Lonchocarpus stenophyllus M. Sousa	Leguminosae	Tree	Plan de Amayo	12617
Maytenus sp. nov.	Celastraceae	Tree	Los Volcanes	12259
Peperomia linaresii Véliz	Piperaceae	Herb	Plan de Amayo	12533
Pisonia sp. nov.	Nyctaginaceae	Shrub	San Marcelino	12944
Sedum salvadorense Standl.	Crassulaceae	Herb	El Imposible	13040
Tetrorchidium sp. nov.	Euphorbiaceae	Tree	Cerro El Aguila	12832
Urera sp. nov.	Urticaceae	Tree	El Imposible	13228

TABLE 15. BOTANICAL SPECIES OF INTEREST COLLECTED IN THE STUDY AREA.

Criterion	Species	Family	Locality
New species for science	*Besleria* sp.	Gesneriaceae	El Águila
New species for science	*Calliandra* sp.	Leguminosae	El Imposible
New species for science	*Coccoloba* sp.	Polygonaceae	Plan de Amayo
New species for science	*Crossopetalum* sp.	Celastraceae	Plan de Amayo
New species for science	*Croton* sp.	Euphorbiaceae	Plan de Amayo
New species for science	Indet.	Euphorbiaceae	El Imposible
New species for science	*Krugiodendron* sp?	Rhamnaceae	El Imposible y Plan de Amayo
New species for science	*Pisonia* sp.	Nyctaginaceae	San Marcelino
New species for science	*Tetrorchidium* sp.	Euphorbiaceae	El Águila
New species for science	*Urera* sp.	Urticaceae	El Imposible
New for Central America	*Iresine herrerae* Conz. & S.F. Blake	Amaranthaceae	El Imposible
New for Central America	*Manfreda pubescens*	Amaryllidaceae	El Imposible y Plan de Amayo
First record in El Salvador	*Agonandra loranthoides* L.O. Williams	Opiliaceae	San Marcelino
First record in El Salvador	*Alysicarpus vaginalis* (L.) DC.	Leguminosae	Plan de Amayo
First record in El Salvador	*Amyris guatemalensis* Lundell	Rutaceae	El Imposible
First record in El Salvador	*Arrabidaea costaricensis* (Kraenzl.) A.H. Gentry	Bignoniaceae	San Marcelino
First record in El Salvador	*Eugenia quercetorum* Standl. & L.O. Williams ex Barrie	Myrtaceae	Cerro Verde
First record in El Salvador	*Lonchocarpus molinae* Standl. & L.O. Williams	Leguminosae	Plan de Amayo
First record in El Salvador	*Nectandra mirafloris* van der Werff	Lauraceae	El Águila
First record in El Salvador	*Philactis liebmannii* (Klatt) S.F. Blake	Asteraceae	El Imposible
First record in El Salvador	*Phyllostylon rhamnoides* (J. Poiss.) Taub.	Ulmaceae	Plan de Amayo

Criterion	Species	Family	Locality
First record in El Salvador	*Phytolacca rivinoide* Kunth & C.D. Bouché	Phytolaccaceae	El Águila
Rediscovery	*Cuscatlania vulcanicola* Standl.	Nyctaginaceae	San Marcelino
Rediscovery	*Sedum salvadorense* Standl.	Crassulaceae	El Imposible

Here, these species are presented as: Probable new species to science, new records for Central America, first records for El Salvador, and rediscoveries, according to the details provided below.

PROBABLE NEW SPECIES TO SCIENCE

***Besleria* sp.** (Gesneriaceae, African violet family).
During the field trip to Cerro El Águila Protected Natural Area, we observed several *Besleria* sp., an epyphite growing on large trees. The plants were losing their leaves and only some of them had fruit, therefore only a few botanical samples were collected. In 1993, the author collected a specimen at the same location, which was determined in 1996 by Dr. L. Skog of the U.S. National Herbarium, an expert on the family, to be a probable new species (L. Skog, pers. com.) but it has not been collected again in this area. The new specimens complement the previous collections in the same area because those only had flowers.

***Calliandra* sp.** (Leguminosae, Bean family).
A shrub or small tree only observed in the path known as "El Gallinero", on rocky and exposed ridges of El Imposible National Park. It is not more than 4 m high and is very similar to *Calliandra mexicana* with which it can be mistaken, but its leaves are glabrous with very marked nerves. If this is not a new species it should be classified at least as a subspecies given its geographic isolation and incipient morphological differentiation. According to Stevents et al. (2001), this species would be part of a group of species and subspecies distributed from the north of Mexico to Panama, and is poorly known taxonomically. The flowers are red and showy and the plant is known locally as "barba" or "barba de rey" (beard or king's beard).

***Coccoloba* sp.** (Polygonaceae, "Papaturro" family)
Shrub or small tree known locally as "papaturrito". It is particulary noticeable for its small-sized leaves, probably the smallest of the genus, at least in Central America. The *Coccoloba nicaraguensis* has leaves as small as our specimen but this species is only known from one single collection deposited with the herbarium of the Panamerican School of Agriculture and looks different. According to data from the park rangers of Plan de Amayo Protected Natural Area, this plant was observed by them for the first time in Caluco, Sonsonate, in May 2007. This probable new species could also be identified as *Coccoloba acuminata*, a species from the rain forests of the Atlantic or the Caribbean

slope, from Mexico to Brazil. If this species is confirmed, our collection would be the first specimen on record for the Pacific slope area.

***Croton* sp.** (Euphorbiaceae, Poinsettia family)
This tree is very closely related to *Croton guatemalensis* (Copalchí). The main difference between them is that it has hairs and scales instead of just scales as in *C. guatemalensis.* It was found in Plan de Amayo Protected Natural Area.

***Crossopetalum* sp.** (Rhamnaceae, "Huilihuishte" family)
This tree collected in Plan de Amayo Protected Natural Area does not match with any of the species known in the region. It could be a non-described species or a new country record.

***Euphorbiaceae* indet.**
Samples of this tree species have not previously been collected in El Salvador. So far, we have not been able to establish the genus to which it belongs because female flowers or fruits are required. In any case, if it is not a new species for science, it would be a new species for Central America. It was found on the way down from Cerro La Cumbre, on a ridgetop, at El Imposible National Park.

***Krugiodendron* sp.** (Rhamnaceae, "Huilihuishte" family)
This tree was only known from a collection deposited with the herbarium of La Laguna Botanical Garden (LAGU) and was tagged as *Karwinskia* sp. To the author, it is obvious that it is not a *Karwinskia*; furthermore, it does not match with any of the *Krugiodendron* species from Mesoamerica described so far. During the present study, abundant material was collected from Plan de Amayo, Las Lajas forest, and El Imposible, but it is still necessary to collect material with flowers in good condition in order to be sure that this is a new species to science. It is a small tree found in rocky areas of the aforementioned locations.

Maytenus sp. (Celastraceae)
A small tree, collected in the higher part of Finca María Auxiliadora inside an active coffee plantation (buffer zone of Los Volcanes National Park). The flowers are greenish and inconspicuous. Only four trees of this apparently new species for science were observed, and botanical samples were collected. These trees were all at risk of being eliminated through normal coffee plantation maintenance, as they had grown up among the coffee shrubs.

***Pisonia* sp.** (Nyctaginaceae, Bougainvillea family).
The plant is a spread-out shrub as opposed to other *Pisonia* species existing in the country, which are erect trees. E. Martínez from the National Herbarium of Mexico, a Mesoamerican tree expert, was consulted and has concluded that this tree could belong to an undescribed species, new to science. Only four individuals were observed at the top of Cerro Chino, in San Marcelino Complex Protected Natural Area. We did not determine a local name for this species, but other species of the genus are commonly called "uña de gato" (cat´s claw) because of the curved thorns on the stem. This plant should be included

on the IUCN Red List because its worldwide distribution may be limited to this location. Fertile botanical specimens were collected.

***Tetrorchidium* sp.** (Euphorbiaceae, Poinsettia family)
This tree was found in Cerro El Águila Protected Natural Area, without any flower or fruit, but its vegetative features match with those of the *Tetrorchidium* genus, even though the size and shape of the leaves do not match with any of the five species of this genus currently on record for Central America. This genus was not recorded by Linares (2003 [2005]) on his list of trees. Only two sterile trees were observed and samples of each were collected (Fig. 5J).

***Urera* sp.** (Urticaceae, ~~O~~rtiga" or Nettle family).
It is a medium-sized tree from 6 to 10 m high that has only been found in the higher parts of the headwaters of the El Venado River at El Imposible National Park (Fig. 5M). Its inflorescence is 3–5 cm long and forms under the leaves, and for this reason it is difficult to observe in the field. As a result, there are no previous collections of this plant. It does not match any of the *Urera* tree species described for northern Central America. To classify this species it will be necessary to compare the material with collections housed in other countries.

NEW RECORDS FOR CENTRAL AMERICA

Two plants were found, one herbaceous and one arboreal, known until now from the Pacific coast of central and southern Mexico and reported here for the first time for Central America. These findings help us to confirm the links between the flora of southwestern El Salvador and that of the Pacific coast of central and southern Mexico.

Iresine herrerae (Amaranthaceae, ~~A~~maranto" family).
This species is a tree that grows more than 10 m high and has up to 20 cm diameter, which is significant for a genus mainly made up of shrubs and small trees. It was originally described as native to Puchutla on the Mexican Pacific slope, in the State of Oaxaca, the same as *Manfreda pubescens* (see previous paragraph). It was found at El Imposible National Park.

Manfreda pubescens (Amarillydaceae, ~~B~~úcaros" family).
In El Salvador, the genus only has one additional species, *Manfreda brachystachys* that grows in the northern mountain range in pine-oak forests. Our species has wider leaves with pubescent and purple spots which give it a very colorful appearance. It was found in Plan de Amayo Protected Natural Area and El Imposible National Park.

FIRST RECORDS FOR EL SALVADOR

Agonandra loranthoides (Opiliaceae, ~~O~~pilias" family).
This tree is noted in the field for its small and fleshy leaves, reddish and slightly ribbed stem with bark exfoliation occurring in long, thin, and irregular plates. Several specimens were observed in San Marcelino Complex Protected Natural Area and even though they

were sterile, their identification is accurate given the unmistakable characteristics described above. Samples had only been previously collected in Honduras, that is, it was considered endemic to that country. This is the first record outside of Honduras. The species was not known to the local guides and did not have a common name. This is the second location in the world for this species since it was only known to the Comayagua valley. This species is included on the IUCN Red List as Vulnerable. Botanical samples were collected.

Alysicarpus vaginalis (Leguminosae).
It is an invasive herbaceous plant native to the Old World and recently naturalized in Central America. It can be a very aggressive weed. It was found in Plan de Amayo Protected Natural Area.

Amyris guatemalensis (Rutaceae, citrus family).
This species is a tree that grows 5–10 m high. Until now, it was only known from semi-deciduous forests of Guatemala at altitudes below 400 m. It differs from *Amyris balsamifera* by having much larger folioles and opposing leaves. It was collected at El Imposible also at altitudes below 400 m.

Arrabidaea costaricensis (Bignoniaceae, ~~"M~~aquilishuat" family).
This plant was found as a small tree of a little more than 5 cm diameter. It was originally described as native to Costa Rica and then to Mexico, where it was described with the name of *Arrabidaea erecta*. It is easily recognized even in sterile state because it is the only tree or shrub species of a genus where all the rest are climbing vines. It was collected in Plan de Amayo (Municipality of Caluco, Department of Sonsonate) as well as in Las Lajas forest in San Marcelino Protected Natural Area.

Eugenia quercetorum (Myrtaceae, Guava family).
This species is a small tree collected previously only in Honduras. Only one specimen was observed at the foot of Cerro Verde, near the Izalco Volcano. Botanical samples were collected. This is the first record outside of Honduras.

Lonchocarpus molinae (Leguminosae).
This species, which is included on the IUCN red list, was described in Honduras but had not been collected in the region since 1950. It has been occasionally collected in Mexico. It is a conspicuous tree because its trunk has several thick ribs that resemble intertwined snakes, hence the common name ~~"c~~ulebro" (snake). It was found in Plan de Amayo Protected Natural Area.

Nectandra mirafloris (Lauraceae, Avocado family).
So far, this tree had only been collected in one specific location of Nicaragua. Several specimens were observed in this study in the cloud forest of Cerro El Águila Protected Natural Area. Samples were collected.

Philactis leibmannii (Asteraceae, Sunflower family).
This species is a small shrub known from Mexico and Guatemala. In the latter country it was reported in Santa Rosa, a department with which El Imposible forest shares many species. Therefore, it is not surprising that it was found there. It was collected at El Pedrerón lookout, on the way to La Fincona, in El Imposible National Park.

Phyllostylon rhamnoides (Ulmaceae, Elm family).
This tree is typical of dry or very dry forests and relatively common in other countries of Central America, but never reported in El Salvador. It was found in Plan de Amayo Protected Natural Area (Fig. 5I).

Phytolacca rivinoides (Phytolaccaceae).
This shrub with spread-out and fleshy stems is common to the Honduran and Guatemalan area of El Trifinio (Komar et al. 2006), but it had not been recorded before in El Salvador until it was collected on Cerro El Águila. It has distinct morphology because it is the only species of its genus which has the form of a shrub. Fertile botanical samples of this species were collected (Fig. 5K).

REDISCOVERIES:

Cuscatlania vulcanicola (Nyctaginaceae).
This small herbaceous plant was described in 1923 from material collected in San Vicente, El Salvador, in 1922. Only two herbarium sheets were known with very little material (two small branches with some leaves and very few flowers). It had not been reported since from anywhere in the world. We found a population at San Marcelino Protected Natural Area (Las Lajas forest), with probably more than 30 plants. It is a rediscovery, a major botanical finding that emphasizes the importance of the locality as a reservoir of rare plants unique in the world. Botanical samples were collected and the finding was amply documented with photographs taken by Frank Sullyvan Cardoza (Fig. 5L).

Sedum salvadorense (Crassulaceae).
This potentially ornamental herbaceous plant was collected and described by Standley at Finca Las Colinas (wrongly cited as Colima) in January 1922. In 1999, Eliberto Sandoval collected some specimens at El Imposible National Park that were identified as *Sedum* sp. We have now documented the existence of this species in the area with several herbarium specimens and many photographs (Fig. 5O). We do not know of any records of the species in another country, and therefore, we consider it a rediscovery of an endemic species not reported since its discovery in 1922.

3.4. COMPLETENESS OF THE TREE INVENTORY

The tree inventory for southwestern El Salvador made progress, from a completeness estimate of 76% prior to the study to a completeness estimate of 93% at the end of the present study. In other words, 312 of the 335 species that are widely distributed and considered to be indicators for inventory completeness have been recorded.

The completeness of the tree inventory at the level of watersheds progressed significantly in the six watersheds where the flora studies were carried out. Currently, the watersheds with the most advanced tree inventories are Cara Sucia (82%), Izalco (58%), and San Julián (57%). In spite of the little time invested, the Coatepeque and Río Grande de Sonsonate watersheds also reported some progress although none of them exceeded 50% (Table 16).

Through the present study, the tree inventory in the municipality of San Francisco Menéndez has almost been completed (Table 17). Another municipality that shows a high level of completeness is the municipality of Caluco, which prior to the research was at 0%. The municipality of Izalco shows a completeness level of 65%. The remaining municipalities show an inventory completeness level below 40%. Twelve municipalities do not have any records of trees in the data bases consulted (Table 17).

At the ecosystem level, complete inventories have been attained for Humid Forest and Savanna (Table 13). The inventory of the Dry Forest is nearly complete, that is, 86% of the expected species are on record. The Cloud Forest is 95% complete. However, it is still possible to detect new ~~"u~~nexpected" species in all of these ecosystems.

TABLE 16. INVENTORY COMPLETENESS FOR TREE SPECIES AND RELATIVE IMPORTANCE OF WATERSHEDS.

Watershed	Registered Species	Expected Registered Species (of 355)	Inicial Level of Inventory Completeness (%)	Final Level of Inventory Completeness (%)
Barra de Santiago	128	128	38	38
Barra Salada	0	0	0	0
Cara Sucia	334	274	64	82
Izalco	225	193	15	58
Lago de Coatepeque	175	148	13	44
Los Cóbanos	1	1	0	0
Río Cauta	0	0	0	0
Río Grande de Sonsonate	44	44	13	19
San Juan	0	0	0	0
San Julian	295	190	1	57
San Pedro	79	62	5	5

TABLE 17. INVENTORY COMPLETENESS FOR TREE SPECIES AND RELATIVE IMPORTANCE OF MUNICIPALITIES.

Municipality	Species Recorded	Expected Species Recorded (of 355)	Initial Level of Inventory Completeness (%)	Final Level of Inventory Completeness (%)
Acajutla	4	4	1	1
Apaneca	50	29	9	9
Armenia	0	0	0	0
Caluco	295	190	0	57
Chalchuapa	12	12	6	16
Concepción de Ataco	16	16	5	5
Cuisnahuat	0	0	0	0
El Congo	200	143	10	43
Guaymango	0	0	0	0
Izalco	225	193	15	58
Juayua	79	45	7	13
Jujutla	18	18	5	5
Nahuizalco	0	0	0	0
Nahulingo	0	0	0	0
Salcoatitan	0	0	0	0
San Antonio del Monte	0	0	0	0
San Francisco Menéndez	334	276	68	86
San Julián	2	2	1	1
San Pedro Puxtla	0	0	0	0
Santa Ana	195	151	6	45
Santa Catarina Masahuat	0	0	0	0
Santo Domingo de Guzmán	0	0	0	0
Sonsonate	10	10	3	3
Sonzacate	0	0	0	0
Tacuba	16	16	5	5
Tepecoyo	0	0	0	0

4. RECOMMENDATIONS

- Continue the flora inventory efforts in the southwest region of El Salvador with the goal of completing the inventories at the levels of ecosistema, watershed, municipality, and protected natural areas.

- Conduct new inventory efforts in the savannas of palm trees and ~~"m~~orros" (*Crescentia alata*) and other ecosystems, with an emphasis on other plant groups such as herbaceous and shrublike species because samples of these were not taken in this study.

- Prepare sampling protocols for epyphitic species because they indicate to a large extent the degree of maturity and/or conservation of the ecosystems as well as the levels of degradation and/or contamination.

- Carry out training workshops for the park rangers of the Protected Natural Areas, focused on the threatened and endangered species recorded for those areas.

CHAPTER 3:

PRELIMINARY INVENTORY OF FISH SPECIES IN ELEVEN WATERSHEDS OF SOUTHWESTERN EL SALVADOR

Francisco Chicas Batres
School of Biology
Faculty of Natural Sciences and Mathematics
University of El Salvador
francisco.chicas@ues.edu.sv

José Alberto González Leiva
Institute of Marine Sciences and Limnology of El Salvador
University of El Salvador
ICMARES/UES
albergleiva@yahoo.es

1. INTRODUCTION

Mesoamerica is considered one of the most important regions of the American continent for its great diversity of species (CEPF 2004, PNUMA 2004). From the moment it was formed, the region has functioned as the link between the two major continental masses, facilitating the migration processes of the terrestrial fauna (Jiménez 1994, Waid et al. 1999). Dynamic geological processes such as plate tectonics and volcanism have constantly modified the relief, allowing the formation of geographic barriers that along with the modification of niches have facilitated vicariant processes and dispersion events of many taxa, among them freshwater fish species (Concheiro Pérez et al. 2006, Hrbek 2007, Martin & Bermingham 1997, Morrone 2007, Perdices et al. 2002).

It is estimated that the number of freshwater fish species of the Mesoamerican region reaches at least 446 (Myers 1966) with very specific distribution patterns in certain zones. Accordingly, Bussing (1976) proposed four icthyogeographic provinces (Fig. 6). One of them is the Chiapas–Nicaraguan province which comprises the entire Salvadoran territory and which is considered poor in species and with little endemism (Bussing 1998), a condition attributed to the ~~r~~recent" closing of the Isthmus of Panama that started approximately 3 million years ago (Bermingham et al. 1997). This may have been too recent to allow a higher degree of speciation of the representative genera of the group, as

has occurred in North and South America. Perhaps for these reasons and because their size is smaller than the size of their congeners of other regions, the native populations of freshwater fish species of El Salvador have been more or less ignored. Their conservation has been similarly ignored, to the extent that the introduction of exotic species was recommended in order to diversify the diet and increase the income of the rural population (Hildebrand 1925, Lin 1957).

FIGURE 6: ICHTHYOGEOGRAPHIC PROVINCES OF CENTRAL AMERICA
Source: Bussing (1998).

On the other hand, the marine ichthyofauna of El Salvador is included in the biogeographic region known as the Tropical Eastern Pacific (TEP), which extends from the southern part of Magdalena Bay (~ 24°N) in Baja California, passing through the Gulf of California and south along the continental coastline to approximately Cabo Blanco (4°S) in Perú (Zapata & Robertson 2006). This region also comprises five oceanic islands and groups of islands: Revillagigedos, Clipperton Island, Coco Island, Malpelo Island, and the Galapagos Islands (Fig. 7). The TEP has a coastal fish fauna that comprises approximately 1,285 known species, where the highest number (740–760 species) is located in Costa Rica and Panama. The TEP has the highest endemism rate, with 911 endemic species from coastal habitats (79%), when compared to any other tropical region of similar size (Robertson & Allen 2008).

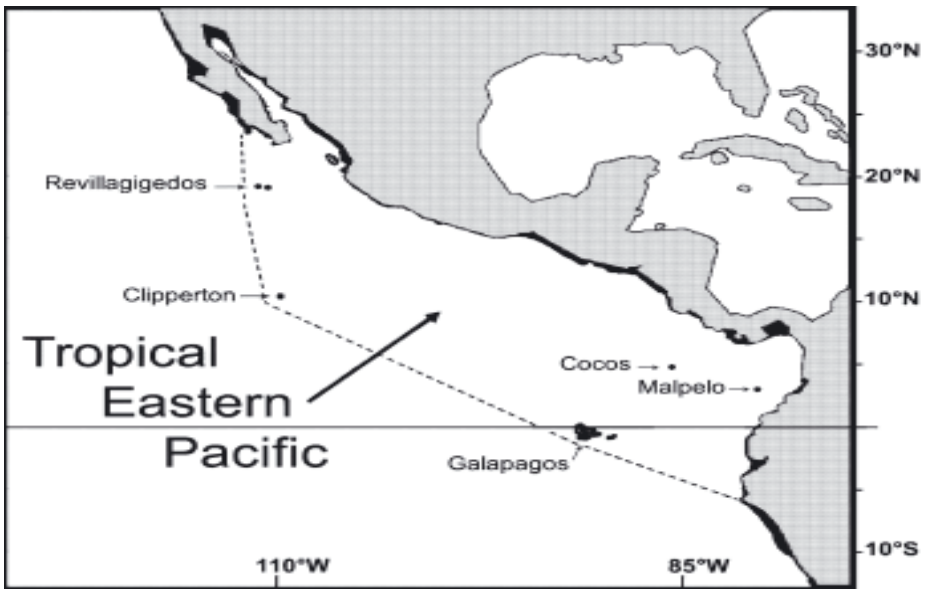

FIGURE 7. THE TROPICAL EASTERN PACIFIC BIOGEOGRAPHIC REGION
Source: Zapata & Robertson 2006.

In an analysis of the matter specifically made for El Salvador, we establish that several ichthyofauna studies which comprise two nationwide inventories have been carried out (Hildebrand 1925, Boeseman 1956), and more recently, Orellana (1992) published a work that compiles the research conducted in the country as of that year. With regard to lakes (lotic systems), the main studies are the research conducted by Monterrosa (1960), Johnson (1971a) and Ulloa & Castro (1985b) on Lake Güija; Lake Ilopango by Johnson & Argumedo (1971a), Godínez & Castro (1977), Ulloa & Melgar (1983), López (1995) and Huezo & Rosales (2001); Lake Coatepeque by Johnson & Argumedo (1971b); Laguna de Apastepeque by Johnson & Ramírez (1975); Laguna de Olomega by Johnson (1971b) and Castro & Godínez (1978); Laguna de Metapán by Ulloa & Castro (1985a); and the works of Castro (1983) and Ulloa *et al*. (1988) on the Cerrón Grande Reservoir. The studies of García (1974), García & Robinson (1974), Castro (1976) and Castro & Robinson (1976) on the Paz, Lempa and Grande de San Miguel rivers cover the lentic systems.

One of the most recent studies on freshwater fish species was conducted by González (1995) and addressed endangered native fish species associated with the main continental water bodies of the country. Another was conducted by PREPAC (2005), which characterized and updated the state of use and conservation of the fishing resources of lakes and lagoons and some estuaries of the country. After an analysis of the IUCN criteria and the conservation status of the water bodies of the country, the study recommended to treat the native freshwater species as Vulnerable.

With respect to marine fish, the most recent country-wide research was carried out by Fuentes and Hernández (2004), covering the entire Salvadoran coast and various bathimetric strata within the four fishing regions of the country. Other studies that include

sampling on the continental shelf have been carried out to evaluate the effectiveness of circular fish hooks for catching migratory fish (Pacheco & Cokkom 2007) and in-shore species (Barahona & Henríquez 2007). The remaining research has been directed towards certain geographic areas of the country such as the Jiquilisco Bay (Calderón & Hernández 1974, Phillips & Ulloa 1981, Mejía & Chicas 2007, Méndez 2006); Estero de Jaltepeque (Candray & Ríos 2005, González & Ramírez 2007, Ulloa et al. 2003); Barra de Santiago (Orellana 1992, Vázquez 1995); and Gulf of Fonseca (Chicas et al. In preparation).

The purpose of the present study was to evaluate the status of inventory completeness of the fish communities existing in the hydrographic watersheds of the southwestern region of El Salvador through a review of the studies carried out or published as of 2007 and a visual sampling report from the Los Cóbanos Reef System as of 2008, prepared by Enrique Barraza.

2. METHODOLOGY

2.1. STUDY AREA

The study area comprises eleven hydrographic watersheds of southwestern El Salvador, located across 25 municipalities of the Departments of Ahuachapán, Sonsonate and part of Santa Ana (Table 18). The study area is characterized by a complex hydrological system formed by rivers with different flow intensity, lakes, and ponds. The area also includes estuarine ecosystems connected to the sea such as Barra de Santiago, Bocana San Juan, Cauta, and Barra Salada (Fig. 8). Los Còbanos ~~-w~~atershed" is important because of it's rocky reef ecosystem with coral formations that maintain a diversity of species.

2.2. INFORMATION COLLECTION

The present report only consisted in a thorough bibliographic review of the fish studies carried out in the study area (Hildebrand 1925, Boeseman 1956, García & Robinson 1974, Orellana 1985, 1992, Jiménez 1986, Vásquez 1993, González 1995, MARN 2000b, 2005, Galdámez 2002, Reyes Bonilla & Barraza 2003, Fuentes & Hernández 2004, PREPAC 2005, ICMARES 2006, 2007, Segovia & Navarrete 2007, Schmitter-Soto 2007). The scope of these studies ranges from lists of species to deep-sea fishing research in the open sea where large fish species such as mahi-mahi or dolphinfish, shark and sword fish are caught. Additionally, the catalogued collections of the School of Biology of the University of El Salvador and the Natural History Museum of El Salvador as well as the references of other museums cited in scientific publications were verified. This information was used to prepare a species database, arranging them by ecosystem, watershed, and municipality. It is important to mention that georeferenced records are very few.

TABLE 18. WATERSHEDS, MUNICIPALITIES, AND ECOSYSTEMS LOCATED IN THE DEPARTMENTS OF AHUACHAPAN, SANTA ANA, AND SONSONATE, CONSIDERED IN THE EVALUATION OF THE FISH INVENTORY.

Departament	Watershed	Municipality	Ecosystem
Ahuachapán	Cara Sucia, Barra de Santiago, *Bocana de San Juan, *Cauta, *San Pedro, *Grande de Sonsonate	Concepción de Ataco, Guaymango, Jujutla, San Francisco Menéndez, San Pedro Puxtla, Tacuba	Freshwater rivers and lakes, estuarine and marine environments
Santa Ana	Coatepeque	El Congo	Freshwater lake
Sonsonate	*Bocana de San Juan, *Cauta, *San Pedro, Los Cóbanos, *Grande de Sonsonate, Izalco, Barra Salada y San Julián	Acajutla, Armenia, Apaneca, Caluco, Cuisnahuat, Santa Isabel Ishuatán, Izalco, Juayúa, Nahuizalco, Nahulingo, Chalchuapa, San Antonio del Monte, San Julián, Santa Catarina Masahuat, Santo Domingo de Guzmán, Sonsonate, Salcoatitán y Sonzacate	Freshwater rivers, estuarine and mangrove forests environments, marine environments, rocky beach with coral outcrops, coral reef

*Watersheds shared by the departments of Ahuachapán and Sonsonate.

The classification criterion of Froese & Pauly (2007) was used in the ecological organization of the species on record. This classification establishes four types of habitats: Marine, Brackish, Reef-Associated, and Freshwater. Since a species may live in more than one habitat, we created combinations of those that can be inhabited by the same species, resulting in six categories: Reef, Marine, Marine-Reef, Marine-Brackish, Freshwater-Brackish, and Freshwater. The list of species was organized in alphabetical order by family and according to genus and species.

2.3. INVENTORY COMPLETENESS LEVEL

The inventory completeness level was obtained from the relationship between the number of species recorded in the study area and the expected number of species to be found in the same area. The latter criterion was based on the records of generalist species found in other areas of the country as of 2007 and the reef fish studies of Los Cóbanos carried out by Segovia in 2007 (in preparation) and sampling undertaken by Barraza in the same area in 2008 (E. Barraza, unpublished data).

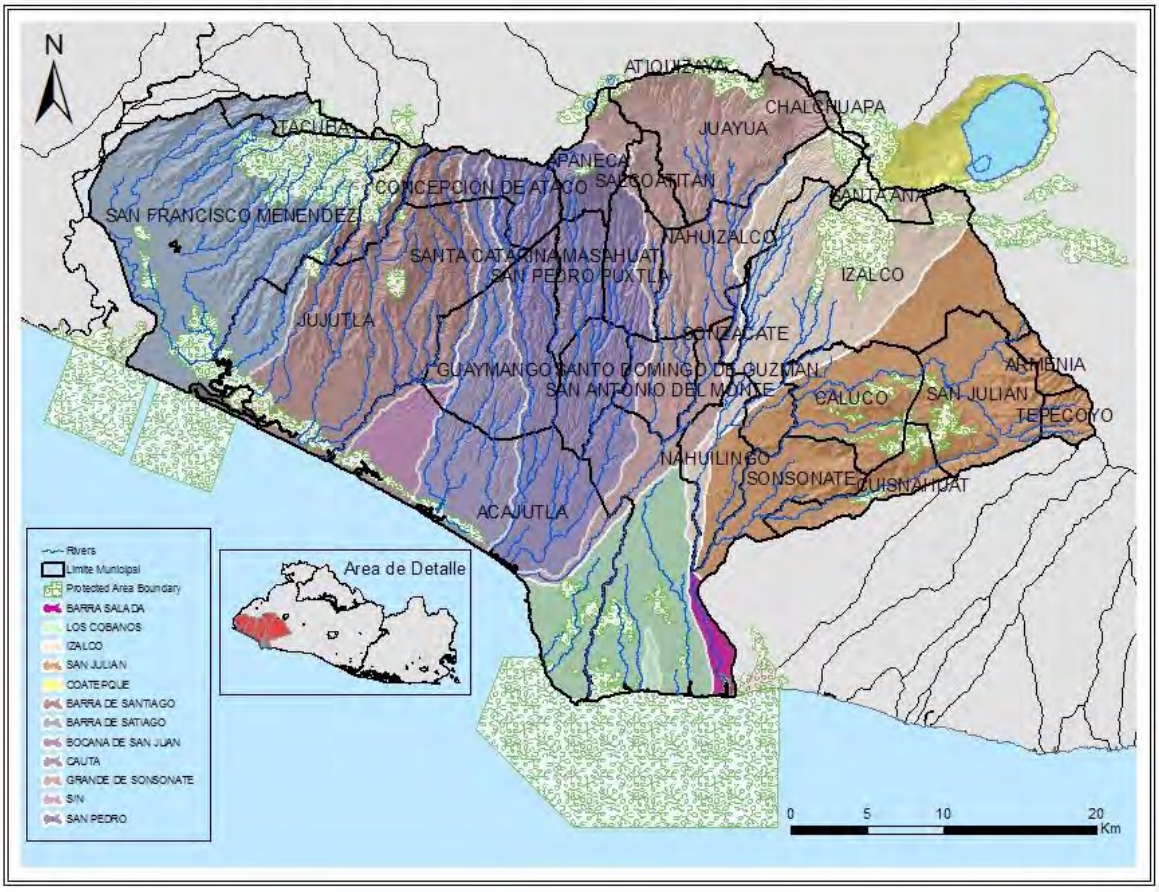

FIGURE 8. STUDY AREA IN SOUTHWESTERN EL SALVADOR, WITH WATERSHEDS AND MUNICIPALITIES LABELED.
Map by J. F. Gutiérrez.

The works on regional fish distribution that refer to the presence of species in El Salvador (Villa 1971, 1982, Bussing 1998, Bussing & López 1993, Perdices et al. 2002, Smith & Bermingham 2005, Hernández 2006, Soto-Galera 2006, Ornelas-García et al. 2008, Robertson & Allen 2008, Froese & Pauly 2009) were consulted as well, comparing them with MARN records. As a result, the number of expected species in the study area is at least 541 (Table 19).

2.4. SELECTION OF IMPORTANT SPECIES FOR CONSERVATION

Species considered important for conservation were selected according to their ecological and economic importance, vulnerability, and conservation status established in other studies and in the regional and worldwide databases (PREPAC 2005, IUCN 2007, 2009, Robertson & Allen 2008, Froese & Pauly 2009). For the present study, they were grouped in six categories: (A) included on the IUCN Red List, (B) freshwater species that are threatened or are indicative of environmental health, (C) endemic species, (D) living fossil, (E) scuba diving tourism, and (F) fishing importance.

TABLE 19. LIST OF FISH SPECIES CONSIDERED TO BE INDICATORS OF COMPLETE SITE INVENTORIES IN SOUTHWESTERN EL SALVADOR, BUT NOT YET RECORDED.

No.	Family	Scientific Name	Habitat
1	Achiridae	*Trinectes fimbriatus*	Marine
2	Achiridae	*Trinectes fonsecensis*	Marine-Brackish
3	Albulidae	*Albula vulpes*	Marine-Reef associated
4	Alopiidae	*Alopias pelagicus*	Reef associated
5	Ammodytidae	*Ammodytoides gilli*	Marine
6	Antennariidae	*Antennarius avalonis*	Reef associated
7	Antennariidae	*Antennarius sanguineus*	Reef associated
8	Antennariidae	*Antennarius strigatus*	Reef associated
9	Ariidae	*Bagre pinnimaculatus*	Freshwater-Brackish
10	Ariidae	*Cathorops fuerthii*	Marine-Brackish
11	Ariidae	*Cathorops multiradiatus*	Freshwater-Brackish
12	Ariidae	*Cathorops steindachneri*	Marine-Brackish
13	Ariidae	*Notarius biffi*	Marine-Brackish
14	Ariidae	*Notarius planiceps*	Marine-Brackish
15	Ariidae	*Genus A platypogon*	Marine-Brackish
16	Atherinopsidae	*Atherinella argentea*	Freshwater
17	Atherinopsidae	*Atherinella eriarcha*	Reef associated
18	Atherinopsidae	*Atherinella nepenthe*	Marine
19	Atherinopsidae	*Atherinella pachylepis*	Reef associated
20	Atherinopsidae	*Membras gilberti*	Marine
21	Balistidae	*Canthidermis maculata*	Reef associated
22	Balistidae	*Melichthys niger*	Reef associated
23	Belonidae	*Ablennes hians*	Marine-Reef associated
24	Belonidae	*Tylosurus crocodilus fodiator*	Reef associated
25	Belonidae	*Tylosurus pacificus*	Marine
26	Belonidae	*Strongylura scapularis*	Marine
27	Blenniidae	*Entomacrodus chiostictus*	Reef associated
28	Blenniidae	*Hypsoblennius brevipinnis*	Reef associated
29	Bothidae	*Bothus constellatus*	Marine
30	Bothidae	*Bothus leopardinus*	Marine
31	Bothidae	*Engyophrys sanctilaurentii*	Marine
32	Bothidae	*Monolene asaleus*	Marine
33	Bothidae	*Perissias taeniopterus*	Marine
34	Bramidae	*Brama dusumieri*	Marine
35	Bregmacerotidae	*Bregmaceros bathymaster*	Marine

36	Bythitidae	*Grammonus diagramus*	Reef associated
37	Bythitidae	*Ogilbia ventralis*	Reef associated
38	Carangidae	*Carangoides otrynter*	Marine
39	Carangidae	*Caranx lugubris*	Marine
40	Carangidae	*Caranx melanpigus*	Marine
41	Carangidae	*Chloroscombrus orqueta*	Marine-Brackish
42	Carangidae	*Decapterus maroadsi*	Marine
43	Carangidae	*Decapterus macrosoma*	Reef associated
44	Carangidae	*Hemicaranx leucurus*	Marine-Brackish
45	Carangidae	*Hemicaranx zelotes*	Marine-Brackish
46	Carangidae	*Naucrates ductor*	Reef associated
47	Carangidae	*Selar crumenophthalmus*	Reef associated
48	Carangidae	*Seriola lalandi*	Marine-Brackish
49	Carangidae	*Seriola peruana*	Marine
50	Carangidae	*Seriola rivoliana*	Reef associated
51	Carangidae	*Trachinotus kennedyi*	Marine-Brackish
52	Carangidae	*Trachinotus rhodopus*	Marine-Brackish
53	Carapidae	*Uraspis secunda*	Marine
54	Carapidae	*Carapus dubius*	Marine
55	Carcharhinidae	*Carcharhinus albimarginatus*	Reef associated
56	Carcharhinidae	*Carcharhinus galapagensis*	Reef associated
57	Carcharhinidae	*Negaprion brevirostris*	Marine-Reef associated
58	Carcharhinidae	*Prionace glauca*	Marine
59	Centropomidae	*Rhizoprionodon longurio*	Marine
60	Centropomidae	*Centropomus unionensis*	Marine-Brackish
61	Centropomidae	*Centropomus viridis*	Marine
62	Chaenopsidae	*Ekemblemaria myersi*	Marine
63	Chaenopsidae	*Emblemaria piratica*	Marine
64	Characidae	*Roeboides bouchellei*	Freshwater
65	Cichlidae	*Oreochromis mosambicus*	Freshwater
66	Cichlidae	*Oreochromis aureus*	Freshwater
67	Cichlidae	*Oreochromis urolepis hornorum*	Freshwater
68	Cichlidae	*Parachromis dovii*	Freshwater
69	Cichlidae	*Tilapia rendalli*	Freshwater
70	Cirrhitidae	*Oxycirrhites typus*	Reef associated
71	Clupeidae	*Etrumeus teres*	Marine
72	Clupeidae	*Harengula thrissina*	Marine-Brackish
73	Clupeidae	*Odontognathus panamensis*	Marine-Brackish
74	Clupeidae	*Opisthonema bulleri*	Marine
75	Clupeidae	*Opisthonema medirastre*	Marine

76	Clupeidae	*Opisthopterus dovii*	Marine-Brackish
77	Congridae	*Ariosoma gilberti*	Reef associated
78	Congridae	*Chiloconger dentatus*	Marine
79	Congridae	*Gnathophis cinctus*	Marine
80	Congridae	*Gorgasia punctata*	Marine
81	Congridae	*Paraconger californiensis*	Marine
82	Congridae	*Rhynchoconger nitens*	Marine
83	Coryphaenidae	*Coryphaena equiselis*	Marine
84	Cynoglossidae	*Symphurus atramentatus*	Reef associated
85	Cynoglossidae	*Symphurus callopterus*	Marine
86	Cynoglossidae	*Symphurus chabanaudi*	Marine-Brackish
87	Cynoglossidae	*Symphurus elongatus*	Marine-Brackish
88	Cynoglossidae	*Symphurus fasciolaris*	Marine-Brackish
89	Cynoglossidae	*Symphurus gorgonae*	Marine
90	Cynoglossidae	*Symphurus leei*	Marine
91	Cynoglossidae	*Symphurus melanurus*	Marine-Brackish
92	Cynoglossidae	*Symphurus melasmatotheca*	Marine
93	Cynoglossidae	*Symphurus prolatinaris*	Marine
94	Cynoglossidae	*Symphurus undecimplerus*	Marine
95	Cynoglossidae	*Symphurus williamsi*	Marine
96	Dactyloscopidae	*Dactyloscopus pectoralis*	Marine
97	Dactyloscopidae	*Gillellus arenicola*	Marine
98	Dactyloscopidae	*Gillellus searcheri*	Marine
99	Dactyloscopidae	*Gillellus semicinctus*	Marine
100	Dactyloscopidae	*Heteristius cinctus*	Marine
101	Dasyatidae	*Dasyatis brevis*	Marine
102	Dasyatidae	*Dasyatis dipterura*	Marine
103	Diodontidae	*Chilomycterus affinis*	Reef associated
104	Echeneidae	*Remora australis*	Marine
105	Echeneidae	*Remora osteochir*	Marine
106	Echeneidae	*Remorina albescens*	Marine
107	Engraulidae	*Anchoa mundeola*	Marine-Brackish
108	Engraulidae	*Anchoa walkeri*	Freshwater-Brackish
109	Engraulidae	*Anchoa argentivittata*	Marine
110	Engraulidae	*Anchoa curta*	Freshwater-Brackish
111	Engraulidae	*Anchoa exigua*	Marine
112	Engraulidae	*Anchoa ischana*	Marine
113	Engraulidae	*Anchoa nasus*	Marine-Brackish
114	Engraulidae	*Cetengraulis mysticetus*	Marine-Brackish

115	Engraulidae	*Lycengraulis poeyi*	Marine-Brackish
116	Exocoetidae	*Cypselurus callopterus*	Marine
117	Exocoetidae	*Exocoetus volitans*	Marine
118	Exocoetidae	*Fodiator rostratus*	Marine
119	Exocoetidae	*Hirundichthys marginatus*	Marine
120	Exocoetidae	*Hirundichthys speculiger*	Marine
121	Exocoetidae	*Oxyporrhamphus micropterus*	Marine
122	Exocoetidae	*Prognichthys tringa*	Marine
123	Gerreidae	*Eucinostomus entomelas*	Marine-Brackish
124	Gerreidae	*Eugerres axillaris*	Marine
125	Gerreidae	*Eugerres brevimanus*	Marine
126	Gerreidae	*Eugerres lineatus*	Marine
127	Ginglymostomatidae	*Ginglymostoma cirratum*	Marine-Reef associated
128	Gobiesocidae	*Gobiesox papillifer*	Marine
129	Gobiesocidae	*Tomicodon petersii*	Marine
130	Gobiidae	*Akko rossi*	Marine
131	Gobiidae	*Chriolepis cuneata*	Marine
132	Gobiidae	*Elacatinus digueti*	Marine-Reef associated
133	Gobiidae	*Elacatinus puncticulatus*	Marine-Reef associated
134	Gobiidae	*Gobioides peruanus*	Freshwater-Brackish
135	Gobiidae	*Gobiosoma etheostoma*	Marino
136	Gobiidae	*Gobiosoma nudum*	Reef associated
137	Gobiidae	*Gobiosoma paradoxum*	Marine-Reef associated
138	Gobiidae	*Gobulus hancocki*	Reef associated
139	Gobiidae	*Gymneleotris seminuda*	Reef associated
140	Gobiidae	*Microgobius brevispinis*	Marine
141	Gobiidae	*Microgobius cyclolepis*	Marine
142	Gobiidae	*Microgobius emblematicus*	Marine
143	Gobiidae	*Microgobius erectus*	Marine
144	Gobiidae	*Microgobius tabogensis*	Marine
145	Gobiidae	*Parrella maxillaris*	Marine
146	Gymnuridae	*Gymnura marmorata*	Marine
147	Haemulidae	*Anisotremus dovii*	Marine
148	Haemulidae	*Anisotremus pacifici*	Marine
149	Haemulidae	*Conodon serrifer*	Marine
150	Haemulidae	*Haemulon maculicauda*	Reef associated
151	Haemulidae	*Haemulopsis axillaris*	Marine
152	Haemulidae	*Haemulopsis elongatus*	Marine
153	Haemulidae	*Haemulopsis nitidus*	Marine

154	Haemulidae	*Orthoptristis cantharinus*	Marine
155	Haemulidae	*Orthoptristis chalceus*	Marine
156	Haemulidae	*Pomadasys bayanus*	Freshwater-Brackish
157	Haemulidae	*Pomadasys branickii*	Marine-Brackish
158	Haemulidae	*Xenistius californiensis*	Marine
159	Hemiramphidae	*Hemiramphus saltator*	Marine
160	Hemiramphidae	*Hyporhamphus gilli*	Marine
161	Hemiramphidae	*Hyporhamphus rosae*	Freshwater-Brackish
162	Kyphosidae	*Kyphosus analogus*	Marine
163	Labridae	*Decodon melasma*	Reef associated
164	Labridae	*Halichoeres chierchiae*	Reef associated
165	Labridae	*Halichoeres melanotis*	Reef associated
166	Labridae	*Iniistius pavo*	Reef associated
167	Labridae	*Novaculichthys taeniourus*	Reef associated
168	Labridae	*Polylepion cruentum*	Reef associated
169	Labrisomidae	*Dialommus macrocephalus*	Marine
170	Labrisomidae	*Labrisomus multiporosus*	Reef associated
171	Labrisomidae	*Malacoctenus ebisui*	Marine
172	Labrisomidae	*Paraclinus mexicanus*	Reef associated
173	Lophiidae	*Lophiodes caulinaris*	Marine
174	Lutjanidae	*Lutjanus jordani*	Reef associated
175	Lutjanidae	*Lutjanus viridis*	Reef associated
176	Malacanthidae	*Caulolatilus affinis*	Marine-Brackish
177	Malacanthidae	*Caulolatinus hubbsi*	Marine
178	Malacanthidae	*Caulolatinus princeps*	Reef associated
179	Microdesmidae	*Microdesmus dipus*	Marine
180	Monacanthidae	*Aluterus monocerus*	Reef associated
181	Moridae	*Physiculus nematopus*	Marine
182	Mugilidae	*Chaenomugil proboscideus*	Marine
183	Mugilidae	*Joturus pichardi*	Freshwater-Brackish
184	Mugilidae	*Mugil hospes*	Marine-Brackish
185	Mugilidae	*Xenomugil thuborni*	Marine
186	Mullidae	*Pseudupeneus grandiscuamis*	Marine
187	Muraenesocidae	*Cynoponticus coniceps*	Marine
188	Muraenidae	*Anarchias galapagensis*	Marine
189	Muraenidae	*Enchelycore octaviana*	Reef associated
190	Muraenidae	*Gymnomuraena zebra*	Reef associated
191	Muraenidae	*Gymnothorax panamensis*	Marine
192	Muraenidae	*Muraena argus*	Reef associated

193	Muraenidae	*Muraena lentiginosa*	Reef associated
194	Muraenidae	*Muraena clepsydra*	Reef associated
195	Muraenidae	*Uropterygius macrocephalus*	Reef associated
196	Myliobatidae	*Manta birostris*	Reef associated
197	Myliobatidae	*Mobula japanica*	Reef associated
198	Myliobatidae	*Mobula thursoni*	Marine
199	Myliobatidae	*Rhinoptera steindachneri*	Marine
200	Narcinidae	*Diplobatis ommata*	Reef associated
201	Narcinidae	*Narcine entemedor*	Marine
202	Nettastomatidae	*Hoplunnis sicarius*	Marine
203	Ogcocephalidae	*Zalieutes elater*	Marine
204	Ophichtidae	*Echiophis brunneus*	Marine
205	Ophichtidae	*Myrichthys tigrinus*	Reef associated
206	Ophichtidae	*Ophichthus frontalis*	Marine
207	Ophichtidae	*Ophichthus longipenis*	Marine
208	Ophichtidae	*Ophichthus mecopterus*	Marine
209	Ophichtidae	*Ophichthus triserialis*	Marine
210	Ophichtidae	*Ophichthus zophochir*	Marine
211	Ophidiidae	*Brotula clarkae*	Marine
212	Ophidiidae	*Lepophidium negropinna*	Marine
213	Ophidiidae	*Lepophidium prorates*	Marine
214	Ophidiidae	*Ophidion imitator*	Marine
215	Opistognathidae	*Opisthognatus punctatus*	Marine
216	Opistognathidae	*Opisthognatus scops*	Marine
217	Ostraciidae	*Lactoria diaphana*	Reef associated
218	Paralichthyidae	*Ancylopsetta dendritica*	Marine
219	Paralichthyidae	*Citharichthys xanthostigma*	Marine
220	Paralichthyidae	*Cyclopsetta panamensis*	Marine-Brackish
221	Paralichthyidae	*Cyclopsetta querna*	Marine-Brackish
222	Paralichthyidae	*Etropus crossotus*	Marine-Brackish
223	Paralichthyidae	*Etropus peruvianus*	Marine
224	Paralichthyidae	*Hippoglossina bollmani*	Marine
225	Paralichthyidae	*Hippoglossina tetrophthalma*	Marine
226	Paralichthyidae	*Paralichthys woolmani*	Marine-Brackish
227	Paralichthyidae	*Syacium latifrons*	Marine
228	Paralichthyidae	*Syacium ovale*	Marine
229	Poeciliidae	*Poecilia marcellinoi*	Freshwater
230	Poeciliidae	*Poeciliosis pleurospilus*	Freshwater
231	Poeciliidae	*Poecilia salvatoris*	Freshwater

232	Poeciliidae	*Poeciliopsis turrubarensis*	Freshwater-Brackish
233	Priacanthidae	*Cookeolus japonicus*	Reef associated
234	Pristidae	*Pristis pristis*	Freshwater-Brackish
235	Pristigasteridae	*Neoopisthopterus tropicus*	Marine-Brackish
236	Pristigasteridae	*Pliosteostoma lutipinnis*	Marine
237	Profundulidae	*Profundulus labialis*	Freshwater
238	Pseudocharchariidae	*Pseudocarcharias kamoharai*	Marine
239	Rhinobatidae	*Rhinobates leucorhynchus*	Marine
240	Rhinobatidae	*Rhinobatos glaucostigma*	Marine
241	Rhinobatidae	*Zapterix exasperata*	Reef associated
242	Scaridae	*Nicholsina denticulata*	Reef associated
243	Scaridae	*Scarus ghobban*	Marine-Brackish
244	Sciaenidae	*Bairdiella armata*	Marine-Brackish
245	Sciaenidae	*Corvula macrops*	Marine
246	Sciaenidae	*Cynoscion albus*	Marine-Brackish
247	Sciaenidae	*Cynoscion phoxocephalus*	Marine
248	Sciaenidae	*Elattarchus archidium*	Marine
249	Sciaenidae	*Isopisthus remifer*	Marine-Brackish
250	Sciaenidae	*Larimus effulgens*	Marine
251	Sciaenidae	*Larimus argenteus*	Marine
252	Sciaenidae	*Larimus pacificus*	Marine
253	Sciaenidae	*Menticirrhus panamensis*	Marine
254	Sciaenidae	*Menticirrhus elongatus*	Marine
255	Sciaenidae	*Menticirrhus nasus*	Marine
256	Sciaenidae	*Menticirrhus paitensis*	Marine
257	Sciaenidae	*Menticirrus undulatus*	Marine
258	Sciaenidae	*Ophioscion imiceps*	Marine
259	Sciaenidae	*Ophioscion scierus*	Marine
260	Sciaenidae	*Ophioscion strabo*	Marine-Brackish
261	Sciaenidae	*Paralonchurus goodei*	Marine-Brackish
262	Sciaenidae	*Paralonchurus petersii*	Marine
263	Sciaenidae	*Pareques viola*	Reef associated
264	Sciaenidae	*Stellifer ericymba*	Marine
265	Sciaenidae	*Stellifer fuerthii*	Marine
266	Sciaenidae	*Stellifer illecebrosus*	Marine
267	Sciaenidae	*Umbrina dorsalis*	Marine
268	Sciaenidae	*Umbrina analis*	Marine
269	Sciaenidae	*Umbrina bussingi*	Marine
270	Sciaenidae	*Umbrina xanti*	Marine

271	Scombridae	*Acanthocybium solandri*	Marine
272	Scombridae	*Auxis rochei rochei*	Marine-Brackish
273	Scombridae	*Auxis thazard thazard*	Marine
274	Scombridae	*Katsuwonus pelamis*	Marine
275	Scombridae	*Sarda orientalis*	Marine
276	Scombridae	*Scomber japonicus*	Marine
277	Scombridae	*Thunnus albacares*	Marine-Brackish
278	Scorpaenidae	*Pontinus sierra*	Marine
279	Scorpaenidae	*Scorpaena histrio*	Marine
280	Scorpaenidae	*Scorpaena russula*	Marine
281	Scorpaenidae	*Scorpaenodes xyris*	Reef associated
282	Serranidae	*Alphestes multiguttatus*	Marine
283	Serranidae	*Dermatolepis dermatolepis*	Reef associated
284	Serranidae	*Diplectrum eumelum*	Marine
285	Serranidae	*Diplectrum euryplectrum*	Marine
286	Serranidae	*Diplectrum labarum*	Marine
287	Serranidae	*Diplectrum macropoma*	Marine
288	Serranidae	*Diplectrum pacificum*	Marine
289	Serranidae	*Diplectrum rostrum*	Marine
290	Serranidae	*Epinephelus acanthistius*	Marine
291	Serranidae	*Epinephelus exsul*	Marine
292	Serranidae	*Epinephelus niphobles*	Marine
293	Serranidae	*Hemanthias peruanus*	Marine
294	Serranidae	*Hemanthias signifer*	Marine
295	Serranidae	*Mycteroperca xenarcha*	Marine-Brackish
296	Serranidae	*Pronotogrammus multifasciatus*	Marine
297	Serranidae	*Pseudogramma thaumasium*	Reef associated
298	Serranidae	*Serranus fasciatus*	Marine-Reef associated
299	Sparidae	*Calamus brachysomus*	Reef associated
300	Sphyrnidae	*Sphyrna corona*	Marine
301	Sphyrnidae	*Sphyrna media*	Marine
302	Sphyrnidae	*Sphyrna mokarran*	Marine-Reef associated
303	Stromateidae	*Peprilus medius*	Marine
304	Syngnathidae	*Syngnathus auliscus*	Marine-Brackish
305	Synodontidae	*Synodus lacertinus*	Reef associated
306	Synodontidae	*Synodus sechurae*	Marine
307	Tetraodontidae	*Sphoeroides sechurae*	Marine
308	Triakidae	*Mustelus dorsalis*	Marine
309	Trichiuridae	*Trichiurus lepturus*	Marine-Brackish

310	Triglidae	*Bellator loxias*	Marine
311	Triglidae	*Prionotus albirostris*	Reef associated
312	Triglidae	*Prionotus birostratus*	Marine
313	Triglidae	*Prionotus horrens*	Marine
314	Triglidae	*Prionotus ruscarius*	Marine
315	Triglidae	*Prionotus stephanophrys*	Marine-Brackish
316	Tripterygiidae	*Axoclinus lucillae*	Reef associated
317	Tripterygiidae	*Enneanectes carminalis*	Reef associated
318	Uranoscopidae	*Kathetostoma averruncus*	Marine
319	Urolophidae	*Urobatis halleri*	Marine
320	Urolophidae	*Urotrygon rogersi*	Marine
321	Zanclidae	*Zanclus cornutus*	Reef associated

3. RESULTS

3.1. FISH SPECIES RECORDED IN THE STUDY AREA

It was possible to establish that the study area presents 753 records of 220 fish species (Table 20) corresponding to 139 genera of 72 families. This value is equivalent to 40% of the nationwide list of fish species. Out of this total, 19 are primary freshwater species; 16 are from freshwater-brackish environments; 57 from marine-brackish or estuarine environments; 20 are strictly marine species; 13 are marine-reef species; and 89 are reef species.

Most of the recorded species have nutritional and economic importance for the local communities engaged in the extraction and commercialization of this resource. These include commonly consumed species such as: snappers of the genus *Lutjanus*, jurels of the genera *Caranx* and *Elagatis*, bass of the genus *Centropomus*, "mojarras" represented by the genera *Eucinostomus currani* and *Diapterus peruvianus*, "roncadores" of the genera *Pomadasys* and *Haemulopsis,* mahi-mahi or dolphinfish (*Coryphaena hippurus*), and mackerel (*Scomberomorus sierra*).

3.2. SPECIES RECORDED BY ECOSYSTEM

FRESHWATER ECOSYSTEM

Lake Coatepeque and Laguna de Las Ninfas are among the most notable lotic ecosystems, complementing a very broad fluvial system formed by the Apancoyo, Grande de Sonsonate, Banderas, Las Marías and other minor rivers (Fig. 3-3). To date, the number of freshwater and freshwater-brackish species recorded in the area is 35. Most of them are native occurring in almost all the watersheds of the country, such as *Astyanax fasciatus*, *Amphiolophus macracanthus*, *Rhamdia quelen*, *Poeciliopsis gracilis* y *P. sphenops*. Eight families comprise the freshwater species: Atherinopsidae, Characidae, Cichlidae, Gobiidae, Eleotridae, Heptapteridae, Lepisosteidae, and Poecilidae.

The freshwater-brackish species are frequently found in the upper parts of the estuaries or temporarily living there looking for food or the proper environmental conditions to spawn (Bussing 1998) when the salinity decreases as a result of the rains. They include Pacific four-eyed fish (*Anableps dowei*), freshwater mullet (*Agonostomus monticola*), Pacific sleeper (*Gobiomorus maculatus*), and marbled swamp eel (*Synbranchus marmoratus*).

TABLE 20. FISH RECORDED IN SOUTHWESTERN EL SALVADOR, BY ECOSYSTEM, THROUGH 2008.

Nº	Family	Scientific Name	Spanish Common Name
		Coral Reef	
1	Acanthuridae	*Acanthurus triostegus*	cirujano
2	Acanthuridae	*Acanthurus xanthopterus*	cirujano
3	Acanthuridae	*Prionurus laticlavius*	cirujano
4	Acanthuridae	*Prionurus punctatus*	cirujano
5	Apogonidae	*Apogon dovii*	cardenal
6	Apogonidae	*Apogon pacificus*	cardenal
7	Apogonidae	*Apogon retrosella*	cardenal
8	Balistidae	*Balistes polylepis*	tunco
9	Balistidae	*Pseudobalistes naufragium*	tunco
10	Balistidae	*Sufflamen verres*	tunco
11	Blenniidae	*Ophioblennius steindachneri*	señorita
12	Blenniidae	*Plagiotremus azaleus*	diente sable
13	Carangidae	*Alectis cilliaris*	jurel
14	Carangidae	*Caranx vinctus*	jurel
15	Carangidae	*Elagatis bipinnulata*	salmón
16	Carangidae	*Gnathonodon speciosus*	jurel
17	Carcharhinidae	*Carcharhinus falciformis*	tiburón
18	Carcharhinidae	*Carcharhinus longimanus*	tiburón
19	Chaetodontidae	*Chaetodon humeralis*	mariposa limón
20	Chaetodontidae	*Johnrandallia nigrirostris*	señorita
21	Cirrhitidae	*Cirrhitus rivulatus*	tigre
22	Cirrhitidae	*Cirrihitichtys oxycephalus*	tigre
23	Diodontidae	*Diodon holocanthus*	zorroespín
24	Diodontidae	*Diodon hystrix*	zorroespín
25	Ephippidae	*Chaetodipterus zonatus*	pañuelo
26	Fistulariidae	*Fistularia commersonii*	aguja
27	Gobiidae	*Bathygobius andrei*	mojarra
28	Gobiidae	*Bathygobius ramosus*	gobio
29	Gobiidae	*Coryphopterus urospilus*	gobio
30	Gobiidae	*Microgobius miraflorensis*	gobio
31	Haemulidae	*Anisotremus caesius*	ruco
32	Haemulidae	*Anisotremus interruptus*	melón
33	Haemulidae	*Anisotremus taeniatus*	melón
34	Haemulidae	*Haemulon flaviguttatum*	ruco
35	Haemulidae	*Haemulon scudderi*	ruco
36	Haemulidae	*Haemulon sexfasciatum*	ruco
37	Haemulidae	*Haemulon steindachneri*	naguilla
38	Haemulidae	*Pomadasys macracanthus*	ruco
39	Haemulidae	*Pomadasys panamensis*	ruco

Nº	Family	Scientific Name	Spanish Common Name
40	Holocentridae	*Myripristis leiognathus*	salmonete
41	Holocentridae	*Sargocentron suborbitalis*	salmonete
42	Kyphosidae	*Kyphosus elegans*	chopa
43	Labridae	*Bodianus diplotaenia*	perico
44	Labridae	*Halichoeres dispilus*	perico
45	Labridae	*Halichoeres nicholsi*	perico
46	Labridae	*Halichoeres notospilus*	perico
47	Labridae	*Thalassoma lucasanum*	cortez
48	Labrisomidae	*Malacoctenus margaritae*	sarado
49	Labrisomidae	*Malacoctenus tetranemus*	sarado
50	Lutjanidae	*Hoplopagrus guentherii*	sardo
51	Lutjanidae	*Lutjanus aratus*	pargo
52	Lutjanidae	*Lutjanus argentiventris*	pargueta
53	Lutjanidae	*Lutjanus colorado*	pargo rojo
54	Lutjanidae	*Lutjanus guttatus*	lunarejo
55	Lutjanidae	*Lutjanus novemfasciatus*	dentón
56	Lutjanidae	*Lutjanus peru*	guachinango
57	Lutjanidae	*Lutjanus inermis*	pargo
58	Monacanthidae	*Aluterus scriptus*	cuche
59	Mullidae	*Mulloidichthys dentatus*	salmonete
60	Muraenidae	*Echidna nebulosa*	culebra
61	Muraenidae	*Echidna nocturna*	culebra
62	Muraenidae	*Gymnothorax castaneus*	morena
63	Muraenidae	*Gymnothorax dovii*	morena
64	Pomacanthidae	*Chromis atrilobata*	castañuela
65	Pomacanthidae	*Holacanthus passer*	muñeca rey
66	Pomacanthidae	*Pomacanthus zonipectus*	ángel
67	Pomacentridae	*Abudefduf concolor*	burra
68	Pomacentridae	*Abudefduf troschelii*	burra verde
69	Pomacentridae	*Microspathodon bairdii*	burra
70	Pomacentridae	*Microspathodon dorsalis*	burra
71	Pomacentridae	*Stegastes acapulcoensis*	burrita
72	Pomacentridae	*Stegastes flavilatus*	burrita
73	Scaridae	*Scarus compressus*	lora
74	Scaridae	*Scarus perrico*	pez lora
75	Scaridae	*Scarus rubroviolaceus*	perico
76	Scorpaenidae	*Scorpaena mystes*	pez escorpión
77	Serranidae	*Alphestes immaculatus*	tigre
78	Serranidae	*Cephalopholis panamensis*	señorita
79	Serranidae	*Epinephelus analogus*	cabrilla
80	Serranidae	*Paralabrax loro*	cabrilla
81	Serranidae	*Paranthias colonus*	cabrilla
82	Serranidae	*Serranus psittacinus*	loro
83	Signatidae	*Hippocampus ingens*	caballo de mar
84	Tetraodontidae	*Arothron hispidus*	globo

Nº	Family	Scientific Name	Spanish Common Name
85	Tetraodontidae	*Arothron meleagris*	globo
86	Tetraodontidae	*Canthigaster punctatissima*	globo
87	Tetraodontidae	*Sphoeroides angusticeps*	tamboril
88	Tetraodontidae	*Sphoeroides annulatus*	tamboril
89	Tetraodontidae	*Sphoeroides lobatus*	tamboril
		Marine	
1	Carcharhinidae	*Nasolamia velox*	tiburón volador
2	Clupeidae	*Opisthonema libertate*	sardina boquita
3	Coryphaenidae	*Coryphaena hippurus*	dorado
4	Dasyatidae	*Dasyatis longa*	raya
5	Engraulidae	*Anchoa mundeoloides*	sardina
6	Exocoetidae	*Cheilopogon xenopterus*	volador
7	Fistulariidae	*Fistularia corneta*	aguja
8	Gerreidae	*Diapterus aureolus*	iscanala
9	Gobiesocidae	*Arcos rhodospilus*	calate
10	Haemulidae	*Microlepidotus brevipinnis*	ruco
11	Haemulidae	*Xenichthys xanti*	ruco
12	Muraenidae	*Gymnothorax equatorialis*	morena
13	Nematistiidae	*Nematistius pectoralis*	gallo
14	Ophichtidae	*Myrophis vafer*	anguila
15	Ophidiidae	*Lepophidium microlepis*	congrio
16	Rhincodontidae	*Rhincodon typus*	tiburon ballena
17	Sciaenidae	*Larimus acclivis*	pancha
18	Scombridae	*Euthynnus lineatus*	atún
19	Scombridae	*Scomberomorus sierra*	macarela
20	Sphyraenidae	*Sphyraena qenie*	picuda
21	Uranoscopidae	*Astroscopus zephyreus*	astrólogo
		Marine–Reef associated	
1	Carangidae	*Caranx sexfasciatus*	jurel
2	Carcharhinidae	*Carcharhinus leucas*	gambuso
3	Carcharhinidae	*Carcharhinus limbatus*	tiburón
4	Carcharhinidae	*Galeocerdo cuvier*	tiburón
5	Echeneidae	*Echeneis naucrates*	
6	Ephippidae	*Parapsettus panamensis*	luna
7	Gerreidae	*Eucinostomus argenteus*	mojarra
8	Gerreidae	*Gerres cinereus*	mojarra
9	Hemiramphidae	*Hyporhamphus unifasciatus*	gorrión
10	Kyphosidae	*Sectator ocyurus*	pichel
11	Labridae	*Thalassoma grammaticum*	cortez
12	Scaridae	*Scarus ghobban*	lora
13	Serranidae	*Rypticus nigripinnis*	loro
14	Muraenidae	*Muraena lentiginosa*	morena

Nº	Family	Scientific Name	Spanish Common Name
15	Serranidae	*Alphestes multiguttatus*	tigre
16	Serranidae	*Epinephelus itajara*	mero
17	Serranidae	*Epinephelus labriformis*	mero
18	Sphyraenidae	*Sphyraena ensis*	picuda
		Marine-Brackish (Estuarine)	
1	Achiridae	*Achirus mazatlanus*	lenguado
2	Achiridae	*Achirus scutum*	lenguado
3	Ariidae	*Sciades seemanni*	bagre negro
4	Batrachoididae	*Batrachoides waltersi*	sapamiche
5	Belonidae	*Porichthys margaritatus*	sapamiche
6	Belonidae	*Strongylura exilis*	volador
7	Carangidae	*Caranx caballus*	jurel
8	Carangidae	*Caranx caninus*	jurel
9	Carangidae	*Oligoplites altus*	perro
10	Carangidae	*Oligoplites saurus*	chucha
11	Carangidae	*Oligoplites refulgens*	chucha
12	Carangidae	*Selene brevoortii*	caballo
13	Carangidae	*Selene orstedii*	papelillo
14	Carangidae	*Trachinotus paitensis*	palometa
15	Carangidae	*Selene peruviana*	caballo frances
16	Carcharhinidae	*Carcharhinus porosus*	punta
17	Centropomidae	*Centropomus armatus*	robalo
18	Centropomidae	*Centropomus medius*	chichiguique
19	Centropomidae	*Centropomus robalito*	aleta
20	Clupeidae	*Lile stolifera*	sardina
21	Elopidae	*Elops affinis*	macabilo
22	Engraulidae	*Anchoa lucida*	sardina
23	Engraulidae	*Anchoa panamensis*	sardina
24	Engraulidae	*Anchoa starksi*	sardina
25	Engraulidae	*Anchovia macrolepidota*	sardina bocona
26	Gerreidae	*Diapterus peruvianus*	mojarra
27	Gerreidae	*Eucinostomus currani*	pampano
28	Gerreidae	*Eucinostomus gracilis*	mojarra
29	Gobiesocidae	*Gobiesox daedaleus*	calate
30	Gobiidae	*Ctenogobius sagittula*	guavina
31	Haemulidae	*Haemulopsis leuciscus*	ruco
32	Hemiramphidae	*Hyporhamphus snyderi*	fósforo
33	Labridae	*Halichoeres aestuaricola*	perico
34	Labrisomidae	*Malacoctenus zonifer*	trambollo
35	Mugilidae	*Mugil cephalus*	lebriancha
36	Mugilidae	*Mugil curema*	lisa
37	Myliobatidae	*Aetobatus narinari*	gavilan
38	Narcinidae	*Narcine vermiculatus*	raya eléctrica
39	Paralichthyidae	*Citharichthys gilberti*	pez caite
40	Polynemidae	*Polydactylus approximans*	barbona

Nº	Family	Scientific Name	Spanish Common Name
41	Polynemidae	*Polydactylus opercularis*	barbona
42	Pristigasteridae	*Ilisha fuerthii*	sardina
43	Sciaenidae	*Bairdiella ensifera*	pancha
44	Sciaenidae	*Cynoscion reticulatus*	pancha rayada
45	Sciaenidae	*Cynoscion squamipinnis*	curvina
46	Sciaenidae	*Cynoscion stolzmanni*	curvina
47	Sciaenidae	*Micropogonias altipinnis*	ratón
48	Sciaenidae	*Nebris occidentalis*	guavina
49	Sciaenidae	*Odontoscion xanthops*	ratón
50	Sciaenidae	*Paralonchurus dumerilii*	pacún
51	Sciaenidae	*Stellifer crysoleuca*	panchita
52	Sphyrnidae	*Sphyrna lewini*	tiburón martillo
53	Stromateidae	*Peprilus snyderi*	tilosa
54	Synodontidae	*Synodus evermanni*	garrobo
55	Synodontidae	*Synodus scituliceps*	garrobo
56	Urolophidae	*Urotrygon chilensis*	murciélago
57	Urolophidae	*Urotrygon munda*	murciélago
		Freshwater–Brackish	
1	Anablepidae	*Anableps dowei*	cuatro ojos
2	Ariidae	*Bagre panamensis*	bagre
3	Ariidae	*Sciades troschelii*	tacazonte
4	Ariidae	*Sciades guatemalensis*	bagre
5	Centropomidae	*Centropomus nigrescens*	robalo
6	Chanidae	*Chanos chanos*	sábalo
7	Eleotridae	*Dormitator latifrons*	sambo
8	Eleotridae	*Eleotris picta*	ilama
9	Engraulidae	*Anchoa spinifer*	sardina
10	Gobiidae	*Awaous banana*	talalais
11	Gobiidae	*Gobiomorus maculatus*	guavina
12	Gobiidae	*Gobionellus microdon*	luciernaga
13	Lepisosteidae	*Atractosteus tropicus*	machorra
14	Mugilidae	*Agonostomus monticola*	tepemechín
15	Poeciliidae	*Poecilia sphenops*	chimbolo
16	Synbranchidae	*Symbranchus marmoratus*	anguila
		Freshwater	
1	Atherinopsidae	*Atherinella guatemalensis*	ejote
2	Characidae	*Astyanax fasciatus*	plateada
3	Cichlidae	*Amatitlania coatepeque*	mojarra negra
4	Cichlidae	*Amatitlania nigrofasciata*	mojarra negra
5	Cichlidae	*Amphilophus citrinellum*	mojarra negra
6	Cichlidae	*Amphiolophus macracanthus*	burra
7	Cichlidae	*Cichlasoma trimaculatum*	guapote
8	Cichlidae	*Parachromis managuense*	guapote tigre
9	Cichlidae	*Parachromis motaguense*	guapote tigre
10	Cichlidae	*Oreochromis niloticus niloticus*	tilapia

Nº	Family	Scientific Name	Spanish Common Name
11	Cichlidae	*Vieja guttalata*	burra
12	Gobiidae	*Sicydium multipunctatum*	culebra
13	Heptapteridae	*Rhamdia laticauda*	juilín
14	Heptapteridae	*Rhamdia quelen*	juilín
15	Poeciliidae	*Poecilia gillii*	chimbolo
16	Poeciliidae	*Poeciliopsis gracilis*	bute
17	Profundulidae	*Profundulus guatemalensis*	chimbola
18	Profundulidae	*Profundulus punctatus*	chimbola
19	Sygnathidae	*Pseudophallus starksii*	anguila

One species of special interest is the Tropical gar (*Atractosteus tropicus*) considered a living fossil, apparently confined to Zanjón del Chino, Department of Ahuachapán but occasionally it expands its distribution to the estuarine environments of Barra de Santiago (Solís 2006). Another is the native ~~"c~~onvict cichlid" *Amatitlania coatepeque* endemic to the Coatepeque Lake, considered until 2006 as *Cichlasoma nigrofasciatum*, but recent studies showed that this is a new species (Schmitter-Soto 2007).

Other species have been introduced to diversify income and improve nutrition of the communities living near water bodies. We refer to the Nile tilapia (*Oreochromis niloticus niloticus*), guapote tigre (*Parachromis managuense*) and false yellowjacket cichlid (*P. motaguense*), recorded in the Cara Sucia and Coatepeque watersheds. Tilapia is from the African continent and the last two come from Nicaraguan lakes.

ESTUARINE ECOSYSTEM

The estuarine ecosystems, mainly those associated with mangrove ecosystems, are among the most productive in the world and are used by fish species for reproduction, feeding, and shelter (Day et al. 1989). Besides they function as biological corridors for movement and gene flow of freshwater and marine ichthyofauna (Yañez-Arancibia 1975). The present study reports 57 species recorded. Even though they are not strictly estuarine as a whole, the may occur frequently and they can even penetrate rivers with sufficient flow for short periods of time and during the highest tides. Schools of fish such as "~~j~~urel" (*Caranx caninus*), "~~m~~ojarras" (*Diapterus peruvianus* and *Eucinostomus currani*), "~~lis~~as" (*Mugil curema*), sardines and anchovies (*Lile stolifera* and *Anchoa spp.*), bass (*Centropomus armatus*, *C. medius* and *C. robalito*) can be frequently observed. Also representative of this ecosystem are the corvinas (*Cynoscion reticulatus*, *C. phoxocephalus, C. squamipinnis,* and *C. stolzmani*).

MARINE ECOSYSTEM

Given the continuity of the marine ecosystem habitats and the capacity of many species to move from one place to another, we recognize that the 39 species recorded only represents a small fraction of the species distributed in this habitat. These species are strictly marine, but can also be found in rocky environments and reefs. A wide variety of

pelagic species of commercial importance occur in this habitat such as mackerel (*Scomberomorus sierra*), tuna (*Euthynnus lineatus*), and highly migratory species such as mahi-mahi or dolphinfish (*Coryphaena hippurus*). Consequently, fisheries productivity is very important in this zone, as shown in a study conducted to evaluate the by-catch ichthyofauna in industrial shrimping (Fuentes & Hernández 2004). This study showed that this coastal strip reported the highest volume of fish catch. Whale shark (*Rhincodon typus*), a species included on the IUCN Red List as Vulnerable, is also present.

REEF ECOSYSTEM

Coral reefs are considered among the most diverse and productive ecosystems in the world because their structure provides different habitats and microenvironments that facilitate the establishment of a complex food network. This complexity allows them to function as breeding, feeding, shelter, and reproduction zones for many marine organisms (Ruiz et al. 2003). Approximately 45 reef-forming coral species and approximately 25 km^2 of structural reefs are found in the TEP region. They are located in Baja California, Revillagigedos archipelago, Tres Marías Islands, Nayarit and the South Pacific Coast of Mexico, Los Cóbanos in El Salvador, Culebra Bay, Ballena Marine Park and Cocos Island in Costa Rica, as well as Coiba Island, Rey Island and San José in Panamá, and Galapagos Islands in Ecuador (Cortés 1997, Robertson & Allen 2008).

The entire area is influenced by two zones where equatorial and temperate waters combine, bordering north with the California Current and south with the Peru Current (an extension of the Humboldt Current). The superficial current pattern of the zone varies bidirectionally, depending on the time of the year (Fisher et al. 1995). This condition turns the reef patches into strategic habitats that facilitate the dispersion of larvae of many coral, crustacean, echinoderm, mollusk, and fish species. It also intervenes in migratory processes, movement, and distribution of other fauna groups of regional and global importance, including marine turtles, whales, sharks, and tuna fish.

The studies carried out in the reef zone of Los Cóbanos show records of 89 reef fish species and reef-associated fish species, even though the total number probably amounts to more than 170 species. We were able to identify 13 families directly depending on reef environments. Although some of them can sporadically penetrate the neighboring estuaries, they spend most of their life cycle in the reef. These families are: Acanthuridae, Balistidae, Cirrhitidae, Labridae, Labrisomidae, Pomacantidae, Pomacentridae, and Serranidae. Fishing this group is a significant means of support for the area's coastal communities since th studies indicate that more than 800 artisanal fishermen benefit from the reef ecosystem (ICMARES 2006) and according to CENDEPESCA (2006), this group provided 23% of the total catch in the country for a total of U.S. $918,747.

3.3. LEVEL OF INVENTORY COMPLETENESS

The level of inventory completeness by watershed shows very low percentages with marked differences among them. Coatepeque reports the highest percentage, 32%; Los Cóbanos, 29%; Barra de Santiago, 24%; and Cara Sucia and Cauta report 12% and 5%, respectively, while the lowest values are reported by Grande de Sonsonate, 0.4%, and Barra Salada, 0.2%. The remaining watersheds, Bocana de San Juan, Izalco, and San Julián do not have any records (Table 21).

TABLE 21. LEVEL OF FISH INVENTORY COMPLETENESS BY WATERSHED IN SOUTHWESTERN EL SALVADOR.

Watershed	Species Recorded	Species Expected	Level of Inventory Completeness (%)
Los Cóbanos	156	536	29
Barra de Santiago	114	483	24
Barra Salada	1	483	0
Cara Sucia	58	483	12
Bocana de San Juan	0	483	0
Cauta	25	483	5
Grande de Sonsonate	2	483	0
San Pedro	26	483	5
Coatepeque	10	31	32
Izalco	0	26	0
San Julián	0	26	0

The inventory completeness by municipality is also very low since only 7 of the 25 municipalities in the study area presented records, illustrating the sparse coverage of prior research in the study area. The highest percentages were reported by El Congo, 32%; Acajutla, 27%; Jujutla, 24%; Tacuba and San Francisco Menéndez, 22% and 19%, respectively; while the lowest percentages were reported in Sonsonate and Chalchuapa reaching 8% each (Table 22). Given the spatial arrangement of the ecosystems, it is important to coordinate municipal efforts to improve land use planning.

Knowing the completeness of the species inventory for a given ecosystem provides valuable information about its potential for maintaining biodiversity and presents an opportunity to evaluate the ecological functionality of the taxonomic groups and species in general with the purpose of identifying those with the highest relevance and providing guidance for conservation efforts. In this regard, the highest percentages for inventory completeness were reported for the Freshwater ecosystem, 62%; the Reef ecosystem reached 55%; and the Estuarine ecosystem, 56%. The lowest percentage was reported for the Marine ecosystem with only 17% (Table 23).

TABLE 22. LEVEL OF FISH INVENTORY COMPLETENESS BY MUNICIPALITY IN SOUTHWESTERN EL SALVADOR.

Municipality	Species Recorded	Species Expected	Level of Inventory Completeness (%)
Acajutla	142	529	27
Jujutla	118	485	24
San Francisco Menéndez	57	485	12
Sonsonate	41	529	8
El Congo	10	31	32
Tacuba	5	26	19
Chalchuapa	2	26	8
Apaneca	0	26	0
Armenia	0	26	0
Caluco	0	26	0
Concepción de Ataco	0	26	0
Cuisnahuat	0	26	0
Guaymango	0	26	0
Izalco	0	26	0
Juayúa	0	26	0
Nahuizalco	0	26	0
Nahulingo	0	26	0
Salcoatitán	0	26	0
San Antonio del Monte	0	26	0
San Julián	0	26	0
San Pedro Puxtla	0	26	0
Santa Catarina Masahuat	0	26	0
Santa Isabel Ishuatán	0	26	0
Santo Domingo de Guzmán	0	26	0
Sonzacate	0	26	0

TABLE 23. LEVEL OF FISH INVENTORY COMPLETENESS BY HABITAT IN SOUTHWESTERN EL SALVADOR.

Ecosystem	Species Recorded	Total Indicator Species	Level of Inventory Completeness (%)
Freshwater	35	56	63
Estuarine	57	102	56
Marine	39	222	18
Reef	89	161	55
Total	220	541	41

3.4. IMPORTANT SPECIES FOR CONSERVATION

The analysis of the information indicates that 51 species are important for conservation, of which the native freshwater species such as ~~"m~~ojarra" *Amatitlania coatepeque,* a species endemic to Lake Coatepeque (Schmitter-Soto 2007) and the only vertebrate species restricted to El Salvador, have the highest ecological importance. Likewise, the tropical gar *Atractosteus tropicus* is unique because it represents a group of fish already extinct. The freshwater mullet *Agonostomus monticola* is also important because of it's role in the diet of the local communities along the rivers where it dwells; it reaches up to 40 cm in length. This species lives in mountain rivers when it reaches maturity, but the larvae grow in coastal waters and estuaries. This species could be used as a bioindicator of environmental health.

Other freshwater species such as ~~"p~~lateada" (*Astyanax fasciatus*), ~~"j~~uilín" (*Rhamdia quelen*), ~~"b~~ute" (*Poeciliopsis gracilis*), ~~"m~~ojarra negra" (*Amphiolophus macracanthus*), are also included owing to the deterioration experienced by their populations because they are still extracted without any fishing regulation. As a result, they were defined as vulnerable in the study carried out by PREPAC (2005).

Other species important for conservation are strictly reef-dwelling, such as ~~"c~~irujanos" (*Prionurus punctatus*, *Acanthurus xanthopterus*), ~~"p~~eces tigre" (*Cirrithus rivulatus*) and (*Cirrhitichthys oxycephalus*). The shark (*Carcharhinus longimanus*), hammerhead shark (*Sphyrna lewini*), whale shark (*Rhincodon typus*), and grouper (*Epinephelus itajara*), are included on the IUCN Red List as globally threatened.

All snapper species recorded in the area have also been included as a priority for conservation since they have high value in the local market and hence generate income and provide food for more than 21 fishermen communities (Galdámez 2002, Rojas et al. 2004, CENDEPESCA 2006), but their extraction is not regulated in terms of catch volumes and commercialization sizes. The following species are included: *Lutjanus aratus, L. argentiventris, L. colorado, L. guttatus, L. novemfasciatus,* and *L. peru*.

TABLE 24. CONSERVATION-IMPORTANT FISH IN SOUTHWESTERN EL SALVADOR.

Nº	Family	Scientific Name	Spanish Common Name	Categories*	Ecosystem
1	Acanthuridae	*Acanthurus xanthopterus*	cirujano	E,1	Reef
2	Acanthuridae	*Prionurus punctatus*	cirujano	E,1	Reef
3	Carcharhinidae	*Carcharhinus falciformis*	tiburón punta	F	Marine
4	Carcharhinidae	*Carcharhinus leucas*	tiburón	F,2,3	Marine
5	Carcharhinidae	*Carcharhinus limbatus*	tiburón	F,2	Marine
6	Carcharhinidae	*Carcharhinus longimanus*	tiburón	A1; F,2	Marine Reef
7	Carcharhinidae	*Carcharhinus porosus*	tiburón	F	Marine
8	Chaetodontidae	*Chaetodon humeralis*	mariposa	E,1; F	Reef
9	Chaetodontidae	*Johnrandallia nigrirostris*	mariposa	E,1; F	Reef
10	Characidae	*Astyanax fasciatus*	plateada	B; F,4	Freshwater
11	Cichlidae	*Amatitlania coatepeque*	mojarra	C	Freshwater
12	Cichlidae	*Amatitlania nigrofasciata*	chiva	F,3	Freshwater
13	Cichlidae	*Amphilophus macracanthus*	mojarra	F,3	Freshwater
14	Cichlidae	*Vieja guttulata*	burrita	F,1,3	Freshwater
15	Cirrhitidae	*Cirrhitichthys oxycephalus*	rayado	E,1	Reef
16	Cirrhitidae	*Cirrhitus rivulatus*	tigre	E,1	Reef
17	Dasyatidae	*Dasyatis longa*	raya	F,4	Marine
18	Eleotridae	*Eleotris picta*	ilama	B	Freshwater
19	Lepisosteidae	*Atractosteus tropicus*	machorra	D	Freshwater-Estuarine
22	Lutjanidae	*Lutjanus aratus*	pargo	F,2	Reef
23	Lutjanidae	*Lutjanus argentiventris*	pargueta	F,1	Reef
24	Lutjanidae	*Lutjanus colorado*	pargo rojo	F,2	Reef
25	Lutjanidae	*Lutjanus guttatus*	lunarejo	F,1,2	Reef
26	Lutjanidae	*Lutjanus novemfasciatus*	pargo negro	F,2	Reef
27	Lutjanidae	*Lutjanus peru*	guachinango	F,2	Reef
28	Myliobatidae	*Aetobatus narinari*	gavilán	A,3; F,2	Marine
29	Mugilidae	*Agonostomus monticola*	tepemechín	B; F	Estuarine
30	Poecilidae	*Poecilia sphenops*	chimbolo	B; F,3	Freshwater
31	Poecilidae	*Poeciliopsis gracilis*	chimbolo	B; F,3	Freshwater

Nº	Family	Scientific Name	Spanish Common Name	Categories*	Ecosystem
32	Pomacanthidae	*Holocanthus passer*	sarado	E,1; F	Reef
33	Pomacanthidae	*Microspathodon bairdii*	frentudo	E	Reef
34	Pomacentridae	*Microspathodon dorsalis*	frentudo	E	Reef
35	Pomacentridae	*Pomacanthus zonipectus*	ángel	E,1; F	Reef
36	Profundulidae	*Profundulus guatemalensis*	chimbola	B; F,3	Freshwater
37	Profundulidae	*Profundulus punctatus*	chimbola	B, F3	Freshwater
38	Rhincodontidae	*Rhincodon typus*	tiburón ballena	A,1; E,2	Marine
39	Scaridae	*Scarus compressus*	lora	E,3; F	Reef
40	Scaridae	*Scarus perrico*	perico	E,3	Reef
41	Scaridae	*Scarus rubroviolaceus*	lora	E,3	Reef
42	Serranidae	*Alphestes inmacularus*	tigre	E,1	Reef
43	Serranidae	*Epinephelus analogus*	cabrilla	E,2	Reef
44	Serranidae	*Epinephelus itajara*	mero	A,2; E,2	Reef
45	Serranidae	*Epinephelus labriformis*	cabrilla	E,2	Reef
46	Serranidae	*Epinephelus niphobles*	mero	E,2	Reef
47	Serranidae	*Cephalopholis panamensis*	mero	A,2; E,2	Reef
48	Serranidae	*Paranthias colonus*		E,1	Reef
49	Sphyrnidae	*Sphyrna lewini*	charruda	F	Reef
50	Urotrygonidae	*Urotrygon chilensis*	raya	F,4	Marine
51	Urotrygonidae	*Urotrygon munda*	raya	F,4	Marine

*Criteria and justification for classifying species as important to conservation:

A) Included in the IUCN Red List (2009): 1-Vulnerable at the global level, 2-Critically Endangered at the global level, 3-Near Threatened.

B) Threatened freshwater species or environmental health indicator in El Salvador.

C) Endemic to Lake Coatepeque, El Salvador.

D) Living fossil.

E) Scuba diving tourism: 1-and aquarium; 2-and fishery importance; 3-and substrate-forming.

F) Fishery or food importance: 1-and aquaculture; 2- and sport fishing; 3-and aquariums; 4-low importance

4. DISCUSSION

The southwestern region of El Salvador is characterized by a complex network of aquatic systems that provide distinctive habitats, some of which function as migration corridors for the local and regional ichthyofauna. Recorded species richness is 220 species, which is relatively high when compared with other regions of the country. For example, Jiquilisco Bay, Jaltepeque Estuary, and the Gulf of Fonseca have reported totals of 56, 138, and 116 species, respectively (Calderón & Hernández 1974, Fuentes & Hernández 2004, Chicas et al. in prep.). Notwithstanding, the number of coastal fish species for this region is at least 541 (MARN 2003, Robertson & Allen 2008) and the inventory is southwestern El Salvador is only about 40% complete. The difference in the number of species is probably due to incomplete sampling.

Not only is the study area highly diverse and important for maintaining biodiversity, but it also features a speciation site, because a ~~-m~~ojarra" (*Amatitlania coatepeque*) is endemic to Lake Coatepeque. Mesoamerica is an important place for the evolution of certain groups of freshwater fish, particularly the family Cichlidae (Cocheiro Pérez et al. 2006). Special efforts should be made to characterize the ecology and population dynamics of this species in order to establish a sound and effective conservation program.

Another conservation priority is the Tropical gar (*Atractosteus tropicus*), considered to be a living fossil (Mora et. al. 1997, Sangado-Maldonado et al. 2004), which has three separate populations in the Mesoamerican region, two of which are located in the Atlantic slope and one in the Pacific slope. The first of them can be found in the area from the Usumacinta River to the Coatzocoalcos River in southern Mexico and Guatemala; the other, further south in Lake Nicaragua and Río San Juan. On the Pacific slope, the population is distributed in a strip from the south of Chiapas to Río Negro in Nicaragua (Bussing 1987), and Froese & Pauly (2009) mention 5 reports for Costa Rica. The only place where the species can be found in El Salvador is Zanjón del Chino and adjoining Barra de Santiago (Solís 2006).

Another important species is the freshwater mullet (*Agonostomus monticola*) in view of its important contribution to the local population's nutrition (Phillips 1983, Cruz et. al. 1987), but lack of protection is decimating the fish population. Most records are from El Imposible National Park.

On the other hand, freshwater ~~-m~~ojarra" (*Amphiolophus macracanthus, A. citrinellum* and *Vieja guttalata*), ~~-g~~uapotes" (*Parachromis managuense, P. motaguense* and *Cichlasoma trimaculatum*), among others, which occur in most of the lakes and ponds and are of nutritional importance, and indicators of environmental health such as ~~-b~~ute" *Poecilia sphenops*, ~~-p~~lateada" *Astyanax fasciatus*, ~~-b~~urra" *Amatitlania nigrofasciata*, among others, are important because they are considered in need of critical conservation efforts (PREPAC 2005), due to population decreases.

Los Cóbanos Reef System is a very particular case because coral reefs are considered among the most productive ecosystems of the world, providing habitat, feeding areas,

shelter, and spawning areas for most coastal fish. As a consequence, they can sustain a high diversity of species such as ~~b~~urras" (*Abudefduf concolor, A. troschelii, Stegastes acapulcoensis*), ~~c~~irujanos" (*Prionurus punctatus, Acanthurus xanthopterus*), ~~p~~ez tigre" (*Cirritos rivulatus*), groupers (*Alphestes inmaculatus* and *Epinephelus itajara*), ~~se~~ñoritas" (*Chaetodon humeralis* and *Johnrandallia nigrirostris*), among others. The grouper recorded, *Epinephelus itajara*, and the sharks *Carcharhinus longimanus, C. leucas, C. porosus,* and *C. limbatus*, are species characterized by low fertility and late reproduction (Baum et al. 2003, Bishop et al. 2006), making them vulnerable to overexploitation. According to FAO (2009), the shark harvest in El Salvador decreased from 1,202 t in 2005 to 715 t in 2007. This problem hinders their recovery capacity, placing them in the threatened categories of the IUCN Red List (2008).

5. CONCLUSIONS

The important sites for conservation are Los Cóbanos Reef System and Barra de Santiago estuary as well as Lake Coatepeque and the fluvial system because they function as bridges that facilitate the local and regional migration of the ichthyofauna of the Chiapas-Nicaraguan province. Los Cóbanos is the only major reef formation in the country and Barra de Santiago supports important mangrove forest coverage. For both cases, Art. 74 of the Environmental Law (MARN 2006) refers to mangroves and reefs as fragile ecosystems and therefore no disturbance whatsoever is allowed. This fragility is based on their functionality as feeding, shelter and reproduction zones for the fish species and most marine taxonomic groups. The high productivity of these ecosystems maintains a wide variety of species and contributes to the economic support and as a food source of the local population. The beautiful scenery can be used to promote environmentally sustainable tourism. The functional complexity of those ecosystems and anthropogenic damage also render them vulnerable, and for that reason, it is urgent to establish conservation measures to make them sustainable.

The sparse coverage of research conducted in the zone explains why the level of fish inventory completeness in southwestern El Salvador is just 40%. The best inventoried watershed within the study area, Lake Coatepeque, probably has only 32% of its species identified. Three watersheds present no fish records at all. Only seven municipalities in the study area present fish records.

The southwestern region of El Salvador is important for biodiversity maintenance and development of evolutionary speciation processes. There are records of 220 species, one of them is endemic to Lake Coatepeque (*Amatitlania coatepeque*) and another, the Tropical gar (*Atractosteus tropics*), represents a group of extinct fish species, and is restricted in El Salvador to Zanjón del Chino and Barra de Santiago, Ahuachapán. The location of El Salvador allows it to function as a native ichthyologic fauna reservoir, a condition that facilitates genetic material exchange among the populations distributed from the south of Mexico to the north of Costa Rica. Additionally, the native and exotic ichthyofauna is very important as a source of food and income for the local population.

6. RECOMMENDATIONS

Recommendations for improved ichthyofauna management in the watersheds of southwestern El Salvador:

1. Conduct field research on the distribution and abundance of the ichthyofauna of the area with emphasis on watersheds with few records in order to increase the level of inventory completeness. The studies should include molecular markers to establish phylogenetic relationships and distributional ranges, and the nation-wide update of species taxonomy.

2. Conduct ichthyoplancton studies, reproductive and feeding studies of the fish populations associated with the aquatic ecosystems such as estuaries, reefs, and adjacent marine waters in order to identify the areas used for spawning, reproduction, and feeding. This will elucidate species interactions and contribute to applying management and conservation strategies with an ecosystem focus.

3. The conservation programs of important sites for biodiversity management, mainly Los Cóbanos Complex and Barra de Santiago, should be strengthened, since these sites present a diversity of aquatic environments that maintain a wide variety of species and facilitate migration processes. Therefore, specific research aimed at key groups of the system, such as fish, is critical to the implementation of management alternatives with a biological foundation.

4. The ecosystemic functionality of the fluvial system made up of the river watersheds of San Julián, San Pedro, Cara Sucia, Bocana de San Juan, Cauta, Grande de Sonsonate, and Barra Salada, which as a whole form a biological corridor that facilitates local migration and provides a habitat for the species, should be conserved.

5. Establish a comprehensive watershed management program for Lake Coatepeque and other lakes in the study area since they provide habitat to native freshwater fish species, which are important food sources for local communities.

CHAPTER 4:

INVENTORY OF AMPHIBIANS AND REPTILES IN SOUTHWESTERN EL SALVADOR

Vladlen Henríquez & Xiomara Henríquez
Conservation Science Department, *Salva*NATURA
San Salvador, El Salvador
vhenriquez@salvanatura.org

1. INTRODUCTION

The southwestern region of El Salvador is a mosaic of heterogeneous vegetation communities surrounded by agricultural landscapes. The area presents a wide variety of rivers and a few lakes that together with the different types of vegetation form ideal habitats for many amphibians and reptiles (herpetofauna). However, there is not enough information about many of these sites with regard to which and how many herpetofauna species are present, which makes it difficult to make decisions and take actions concerning biodiversity protection and conservation of these zones.

In El Salvador, 132 herpetofauna species have been detected so far (Köhler et al. 2006, Herrera et al. 2007, Henríquez & Vaquerano 2008). As of 2006, 91 species were on record in the area of the Improved Management and Conservation of Critical Watersheds (IMCW) Project. The zone is formed by eleven watersheds in addition to several natural areas that function as refuges for threatened or endangered herpetofauna species. Herpetofauna research in this area has been conducted mainly at El Imposible and Los Volcanes National Parks, where national and foreign researchers have made several collecting expeditions, as recently as 2006 (Henríquez 2004, Henríquez & Komar 2006, Köhler et al. 2006).

The main objectives of this study were: to determine species of interest for conservation in 11 watersheds of the southwestern region of El Salvador; to fill information gaps regarding the presence and status of the herpetofauna populations in the municipalities and watersheds that form the IMCW Project area; and to use the results as a decision-making tool for biodiversity protection and conservation.

2. METHODOLOGY

2.1. STUDY AREA

The study was conducted in seven of the 11 watersheds in the southwestern region of El Salvador, which correspond to 11 of the 25 municipalities distributed among the Departments of Ahuachapán, Sonsonate, Santa Ana and La Libertad that make up the area of the MMCC Project. Fig. 9 and Table 25 show a detail of the sites where the herpetofauna studies were carried out.

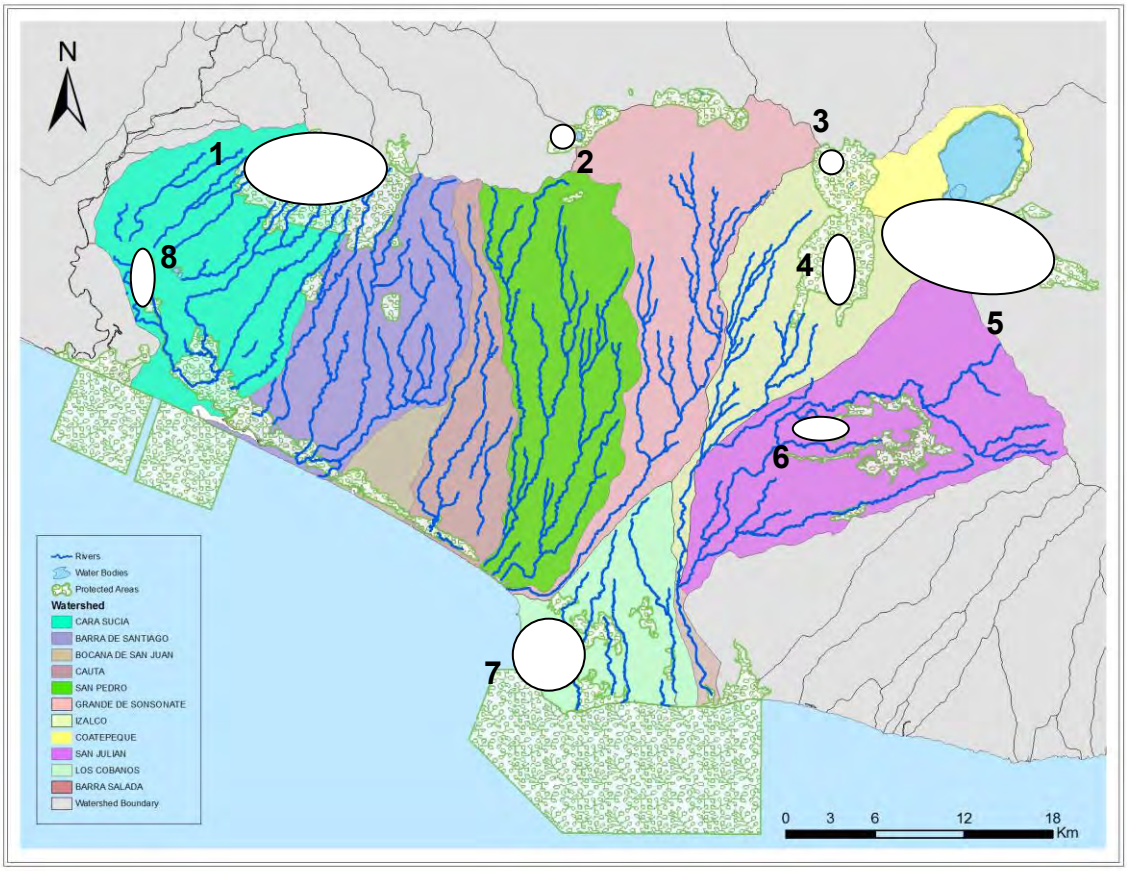

FIGURE 9. MAP OF THE SAMPLING SITES OF THE STUDY OF AMPHIBIANS AND REPTILES DURING 2007: (1) EL IMPOSIBLE NATIONAL PARK, (2) LAGUNA DE LAS NINFAS, (3) LOS ANDES SECTOR, LOS VOLCANES NATIONAL PARK, (4) LAVAS DE IZALCO/FINCA MARÍA AUXILIADORA (LOS VOLCANES NATIONAL PARK), (5) SAN MARCELINO COMPLEX, (6) PLAN DE AMAYO, (7) LOS CÓBANOS, (8) SANTA RITA FOREST.

TABLE 25. DESCRIPTION OF THE SAMPLING SITES AND EFFORT FOR THE HERPETOFAUNA STUDY.

Study Site	Watershed	Geographic Location	Description	Date	Days	Hours of Transects
El Imposible National Park	Barra de Santiago	Cerro Campana Sector, Municipality of Tacuba, between the cantones of El Sincuyo and La Montaña (13.86° N; 89.91°O), Dept. of Ahuachapán	Undisturbed very humid mountain forest.	June 25 to July 4 and July 10 to 19, 2007	20	50
El Imposible National Park	Barra de Santiago	San Francisco Menéndez Sector, Municipality of San Francisco Menéndez, between the cantones of El Corozo and El Sacramento (13.84°N; 90.01°O), Dept. of Ahuachapán	Evergreen riparian broadleaf forest with anthropogenic disturbance as there is a community within the area			
Los Volcanes National Park	Izalco	María Auxiliadora Sector, Municipality of Izalco, between the cantones of Chorro Abajo, Chorro Arriba, Shonshón, Teshcal, Las Marías, La Quebrada Española and Cuyagualo (13.89°N; 89.63°O), Dept. of Sonsonate	Lava flows that have different succesional stages and remnants of Tropical Dry Forest.	July 27 to August 05 and August 01 to October 10, 2007	20	69
Los Volcanes National Park	Santa Ana	Los Andes Sector, Municipalities of Santa	Very humid montane forest with			

Study Site	Watershed	Geographic Location	Description	Date	Days	Hours of Transects
		Ana and Chalchuapa, between the cantones of Palo de Campana, Potrero Grande Arriba and Buenos Aires (13.86°N; 89.63°O), Dept. of Santa Ana	some sites affected by the Santa Ana volcano eruption in 2005 and other sites with Cypress (*Cupressus lusitanicus*) plantations.			
Santa Rita y Zanjón El Chino Protected Natural Area	Cara Sucia	Municipality of San Francisco Menéndez, between the cantones of Cara Sucia, La Hachadura and Garita Palmera (13.80°N; 90.06°O), Dept. of Ahuachapán	Tropical evergreen floodplain forest, surrounded by intensive agricultural activity.	August 08 to 17 and October 13 to 22, 2007	20	63
Plan de Amayo Protected Natural Area	San Julián	Municipality of Caluco, between the cantones of Plan de Amayo and El Castaño, Dept. of Sonsonate	Cliff vegetation, tropical dry forest (in the parts closest to the cliff) and moist tropical forest (in the lower parts)	August 22 to 31 and October 26 to November 04, 2007	20	64
San Marcelino Complex Protected Natural Area	Lago de Coatepeque and Izalco	Municipalities of Izalco and Armenia, between the cantones of Las Lajas, El Guayabo, Los Mangos, El Rosario, San Isidro and	Successional vegetation on volcanic lava of different ages, Dry Tropical Dry Forest	September 18 to 27 and December 03 to 12, 2007	20	77

Study Site	Watershed	Geographic Location	Description	Date	Days	Hours of Transects
		Las Marías, Departament of Sonsonate. Municipalities of Santa Ana and El Congo, between the cantones of Lomas de San Marcelino, Montebello, El Rodeo and La Presa, Dept. of Santa Ana (13.69°N; 89.64°O)	(deciduous and subdeciduous).			
Laguna de Las Ninfas Protected Natural Area	Río Grande de Sonsonate	Municipality of Apaneca (13.87°N; 89.80°O), Dept. of Ahuachapán	Forested zone around the lake consists of montane humid forest with an area of 80 mz.	September 08 to 17 and November 20 to 29, 2007	20	72
Los Cóbanos Marine Park Protected Natural Area*	Los Cóbanos	Municipality of Acajutla, Dept. of Sonsonate (13°12´N; 89°30´0)	Rocky beach with volcanic origens as well as mangroves, rivers, estuaries, and agriculture fields.	August 20 to 29, 2007	10	15

*Data collected by Karla Lara Sandoval.

2.2. SAMPLING DESIGN

Extensive searches were conducted based on transects with a duration of 1 hour, separated by 15 minutes between each one, without repeating transects. The field work was carried out during 120 field days (June to December 2007) with sampling schedules from 8:00 to 13:00 hours and from 20:00 to 22:00 hours. The study included the rainy season, the transition from the rainy to the dry season, and the beginning of the dry season. The sampling sites were selected based on conditions for higher probability of finding amphibians and reptiles. For reptiles, we selected exposed sites with trunks and shrubs useful for hiding; for amphibians, very humid places, swampy areas in pastures or inside forests as well as small pools in ravines and streams. This report includes observations of amphibians and reptiles by other field teams working at the protected natural areas of Los Cóbanos Marine Park, Laguna de las Ranas, and Barra Salada. It also includes species identified through photographs taken by other researchers at sites where herpetofauna studies were not conducted. Table 25 shows a detail of the sampling effort and the number of species recorded in each natural area.

2.3. LEVEL OF INVENTORY COMPLETENESS

In order to analyze progress or completeness of the inventories in the municipalities and watersheds, we first prepared a list of species indicative of a complete inventory (a method adapted from Gómez de Silva & Medellín 2001). This list usually consists of generalist species which are those that live in a variety of habitats and eat a variety of food types, and are found in both disturbed and undisturbed habitats (for example, the black iguana *Ctenosaura similis*). We prepared lists of expected generalist species for each municipality, watershed, natural ecosystem, and protected natural area. We compared the species recorded during the study to the list of expected generalist species in order to obtain an inventory completeness index score for each site (Table 26). The index score is the percentage of expected species that have been recorded; the number of expected species recorded is divided by the total number of expected generalist species, and multiplied by one hundred.

A common list of 46 expected species was determined for watersheds and municipalities; however, specific lists of indicator species for inventory completeness were determined for each ecosystem and natural area and they differ from one ecosystem or site to another. The reason why each habitat has different indicator species for inventory completeness is that some generalist species of the low and medium elevational zones do not live in the higher zones.

Also, we used species accumulation curves to determine the degree of inventory completeness. Data from the curves were used to generate species richness estimates based on ACE (Abundance-based Coverage Estimator), ICE (Incidence-based Coverage Estimator), Chao 1, Chao 2, Jack-Knife 1 and Jack-Knife 2 indices, calculated with the program EstimateS® version 7.51 (Colwell 2006).

TABLE 26. INDICATOR SPECIES FOR INVENTORY COMPLETENESS.

Species	HF	DF	FE	CF	S	RIZ	E	CR
Dermophis mexicanus	x	x	x		x			
Craugastor rhodopis	x			x				
Craugastor rupinius	x	x		x				
Rhinella marina	x	x	x	x	x		x	
Incilius coccifer	x	x	x		x			
Incilius luetkenii	x	x	x		x			
Agalychnis moreletii	x			x				
Scinax staufferi	x	x	x		x			
Smilisca baudinii	x	x	x		x			
Trachycephalus venulosus	x	x	x		x			
Leptodactylus fragilis	x	x	x		x			
Leptodactylus melanonotus	x	x	x		x		x	
Engystomops pustulosus	x	x	x		x			
Lithobates forreri	x	x	x	x				
Lithobates maculatus	x	x		x				
Crocodylus acutus			x				x	
Caiman crocodilus			x					
Chelonia mydas						x		x
Eretmochelys imbricata						x		x
Lepidochelys olivacea						x		x
Dermochelys coriacea						x		x
Gonatodes albogularis	x	x	x				x	
Phyllodactylus tuberculosus	x	x	x					
Basiliscus vittatus	x	x	x				x	
Ctenosaura similis	x	x	x		x		x	
Iguana iguana	x	x	x				x	
Norops crassulus				x				
Norops macrophallus	x		x					
Norops sericeus	x	x	x		x	x	x	
Norops serranoi	x	x	x					
Sceloporus malachiticus	x		x	x				
Sceloporus squamosus	x	x	x		x	x		

Species	HF	DF	FE	CF	S	RIZ	E	CR
Mabuya unimarginata	x	x	x					
Ameiva undulata	x	x	x			x	x	
Aspidoscelis deppii	x	x	x		x	x		
Boa constrictor	x	x	x		x		x	
Conophis concolor	x	x	x		x	x	x	
Drymobius margaritiferus	x		x					
Drymarchon melanurus	x	x	x	x				
Leptodeira septentrionalis	x		x	x				
Masticophis mentovarius	x	x	x		x		x	
Mastigodryas dorsalis	x							
Ninia sebae	x		x					
Oxybelis aeneus	x	x	x		x		x	
Oxybelis fulgidus	x							
Scolecophis atrocinctus	x	x						
Senticolis triaspis	x	x	x					
Spilotes pullatus	x	x	x				x	
Stenorrhina freminvilli	x	x	x				x	
Trimorphodon biscutatus	x	x	x			x		
Micrurus nigrocinctus	x	x	x	x	x			
Cerrophidion godmani				x				
Crotalus simus	x	x			x			

HF: Humid forest; **DF:** Dry forest; **FE:** Freshwater Ecosystems; **CF:** Cloud Forest; **S:** Savanna; **RIZ:** Rocky Intertidal Zone; **E:** Estuaries; **CR:** Coral Reefs

2.4. SELECTION OF SPECIES CONSIDERED IMPORTANT FOR CONSERVATION

The main criterion to select species important for conservation is whether the species is included on the Red List of Endangered Species (UICN 2008) or if it is considered a threatened species in the country according to MARN (2004) or Greenbaum & Komar (2005) (Table 27).

2.5. DATA SOURCES

Most of the information on the species recorded in the project zone comes from the field stage of the study; however, these data have been complemented with information already existing from each Protected Natural Area and other parts of the study area. The bibliographic information, summarized in Komar 2007, comes from books (Leenders 2003, Köhler et al. 2006) and reports from consultancies carried out in the different Protected Natural Areas (Rivera Muñoz 2000, Paz Quevedo & Ventura Centeno 2003, Herrera & Valle Andrade 2003, Henríquez & Komar 2006) as well as from other publications (Herrera et al. 2005, Herrera et al. 2007).

3. RESULTS AND DISCUSSION

3.1. SPECIES RECORDED

The present study has recorded 73 amphibian and reptile species, bringing the total recorded for the IMCW project area to 96 species, including 91 species recorded in previous studies. The 22 amphibian and 74 reptile species represent 73% of the 132 species recorded in El Salvador (Table 28). None of the recorded species has a distribution that is fully restricted to El Salvador, however, in the country two species have only been recorded in the project area. They are the lizard *Celestus atitlanensis* and the toad *Incilius valliceps*.

Some of the species recorded are restricted in El Salvador to the western region of the country (including some regions outside of the study area), such as the Keeled Helmeted Basilisk (*Corytophanes percarinatus*), the anole lizard *Norops crassulus,* and the Godman's Montane Pitviper (*Cerrophidion godmani*). Other species found present few records in the country, such as the burrowing toad (*Rhinophrynus dorsalis*), freshwater turtles *Trachemys venusta* and *Staurotypus salvinii*, the American Crocodile (*Crocodylus acutus*), the Spectacled Cayman (*Caiman crocodilus*), a skink (*Mesoscincus managuae*), and several snakes (*Mastigodryas melanolomus*, *Imantodes gemmistratus*, *Leptodrymus pulcherrimus*, *Rhadinaea pilonaorum*, *Scaphiodontophis annulatus*, *Scolecophis atrocinctus*, *Sibon nebulatus*, *Tantilla taeniata*, *Tropidodipsas fischeri*, *Loxocemus bicolor* and *Atropoides nummifer*). Four species of sea turtles are known in the study area: the Green Sea Turtle (*Chelonia mydas*), Hawksbill Sea Turtle (*Eretmochelys imbricate*), Olive Ridley Sea Turtle (*Lepidochelys olivacea*), and Leatherback Sea Turtle (*Dermochelys coriacea*); all are endangered species worldwide.

TABLE 27. LIST OF INDICATOR SPECIES FOR CONSERVATION IMPORTANT SITES.

Family	Species	National Status (according to MARN 2004)	National Status (according to Greenbaum & Komar 2005)	Global Status (according to IUCN 2008)
Caeciliidae	*Dermophis mexicanus*	Not Threatened	Least Concern	Vulnerable
Plethodontidae	*Oedipina taylori*	Threatened	Vulnerable	Data Deficient
Bufonidae	*Incilius canaliferus*	Not Threatened	Endangered	Least Concern
	Incilius valliceps	Endangered	Critically Endangered	Least Concern
Hylidae	*Agalychnis moreletii*	Not Threatened	Endangered	Critically Endangered
	Dendropsophus robertmertensi	Threatened	Vulnerable	Least Concern
	Trachycephalus venulosus	Not Threatened	Vulnerable	Least Concern
Microhylidae	*Gastrophryne usta*	Threatened	Vulnerable	Least Concern
	Hypopachus barberii	Threatened	Endangered	Endangered
Rhinophrynidae	*Rhinophrynus dorsalis*	Threatened	Endangered	Least Concern
Cheloniidae	*Chelonia mydas*	Endangered	Vulnerable	Endangered
	Eretmochelys imbricata	Endangered	Vulnerable	Critically Endangered
	Lepidochelys olivacea	Endangered	Endangered	Endangered
Dermochelydae	*Dermochelys coriacea*	Endangered	Critically Endangered	Critically Endangered
Emydidae	*Trachemys venusta*	Endangered	Endangered	Near-threatened
Kinosternidae	*Staurotypus salvinii*	Threatened	Endangered	Near-threatened
Alligatoridae	*Caiman crocodilus*	Endangered	Critically Endangered	Near-threatened
Crocodylidae	*Crocodylus acutus*	Endangered	Vulnerable	Vulnerable
Anguidae	*Celestus atitlanensis*	Threatened	Endangered	Least Concern
Eublepharidae	*Coleonyx mitratus*	Not Threatened	Endangered	Least Concern
Iguanidae	*Corytophanes percarinatus*	Threatened	Vulnerable	Least Concern
	Iguana iguana	Threatened	Least Concern	Least Concern
Scincidae	*Mesoscincus managuae*	Not Threatened	Endangered	Least Concern
Colubridae	*Coniophanes fissidens*	Not Threatened	Vulnerable	Not Evaluated

Family	Species	National Status (according to MARN 2004)	National Status (according to Greenbaum & Komar 2005)	Global Status (according to IUCN 2008)
Colubridae	*Coniophanes piceivittis*	Not Threatened	Endangered	Least Concern
	Drymarchon melanurus	Not Threatened	Vulnerable	Least Concern
	Imantodes gemmistratus	Not Threatened	Vulnerable	Not Evaluated
	Lampropeltis triangulum	Threatened	Vulnerable	Not Evaluated
	Leptodeira nigrofasciata	Not Threatened	Endangered	Least Concern
	Leptodrymus pulcherrimus	Endangered	Critically Endangered	Not Evaluated
	Mastigodryas melanolomus	Threatened	Endangered	Least Concern
	Oxybelis fulgidus	Not Threatened	Vulnerable	Not Evaluated
	Pliocercus elapoides	Threatened	Vulnerable	Not Evaluated
	Rhadinaea godmani	Threatened	Endangered	Not Evaluated
	Rhadinaea pilonaorum	Threatened	Endangered	Not Evaluated
	Scaphiodontophis annulatus	Threatened	Endangered	Not Evaluated
	Scolecophis atrocinctus	Not Threatened	Endangered	Not Evaluated
	Senticolis triaspis	Not Threatened	Vulnerable	Not Evaluated
	Sibon anthracops	Threatened	Vulnerable	Not Evaluated
	Sibon nebulatus	Threatened	Endangered	Not Evaluated
	Spilotes pullatus	Not Threatened	Vulnerable	Not Evaluated
	Tantilla taeniata	Threatened	Endangered	Not Evaluated
	Trimorphodon biscutatus	Not Threatened	Vulnerable	Not Evaluated
	Tropidodipsas fischeri	Threatened	Endangered	Least Concern
Elapidae	*Micrurus nigrocinctus*	Threatened	Vulnerable	Not Evaluated
	Pelamis platurus	Not Threatened	Vulnerable	Not Evaluated
Viperidae	*Atropoides nummifer*	Threatened	Endangered	Not Evaluated
	Agkistrodon bilineatus	Threatened	Endangered	Near-threatened
	Cerrophidion godmani	Threatened	Endangered	Not Evaluated
	Crotalus simus	Threatened	Least Concern	Not Evaluated

TABLE 28. HERPETOFAUNA SPECIES RECORDED IN THE STUDY AREA.

Order	Family	Species
Gymnophiona	Caeciliidae	*Dermophis mexicanus*
Anura	Plethodontidae	*Oedipina taylori*
	Craugastoridae	*Craugastor rhodopis*
		Craugastor rupinius
	Bufonidae	*Rhinella marina*
		Incilius canaliferus
		Incilius coccifer
		Incilius luetkenii
		*Incilius valliceps**
	Hylidae	*Agalychnis moreletii*
		Dendropsophus robertmertensi
		Scinax staufferi
		Smilisca baudinii
		Trachycephalus venulosus
	Leiuperidae	*Engystomops pustulosus*
	Leptodactylidae	*Leptodactylus fragilis*
		Leptodactylus melanonotus
	Microhylidae	*Gastrophryne usta*
		*Hypopachus barberi**
	Ranidae	*Lithobates forreri*
		Lithobates maculatus
	Rhinophrynidae	*Rhinophrynus dorsalis*
Crocodylia	Alligatoridae	*Caiman crocodilus*
	Crocodylidae	*Crocodylus acutus**
Testudines	Cheloniidae	*Chelonia mydas**
		Eretmochelys imbricata
		*Lepidochelys olivacea**
	Dermochelydae	*Dermochelys coriacea**
	Emydidae	*Trachemys venusta*
	Geoemydidae	*Rhinoclemmys pulcherrima*
	Kinosternidae	*Kinosternon scorpioides*
		Staurotypus salvinii
Squamata	Anguidae	*Celestus atitlanensis**
	Eublepharidae	*Coleonyx mitratus*
	Gekkonidae	*Gonatodes albogularis*
		Hemidactylus frenatus
		Phyllodactylus tuberculosus
	Gymnophthalmidae	*Gymnophthalmus speciosus**
	Iguanidae	*Basiliscus vittatus*
		Corytophanes percarinatus
		Ctenosaura similis
		*Iguana iguana**
		Norops crassulus
		Norops macrophallus
		Norops sericeus
		Norops serranoi
		Sceloporus malachiticus
		Sceloporus squamosus
	Scincidae	*Mabuya unimarginata*

Order	Family	Species
		*Mesoscincus managuae**
		Sphenomorphus assatus
	Teiidae	*Ameiva undulata*
		Aspidoscelis deppii
	Xantusiidae	*Lepidophyma smithii*
	Boidae	*Boa constrictor*
	Colubridae	*Coniophanes fissidens*
		Coniophanes piceivittis
		Conophis concolor
		Drymarchon melanurus
		Drymobius margaritiferus
		Imantodes gemmistratus
		Lampropeltis triangulum
		Leptodeira annulata
		Leptodeira nigrofasciata
		Leptodeira septentrionalis
		Leptodrymus pulcherrimus
		*Matigodryas dorsalis**
		*Mastigodryas melanolomus**
		Masticophis mentovarius
		Ninia sebae
		Oxybelis aeneus
		Oxybelis fulgidus
		*Pliocercus elapoides**
		*Rhadinaea godmani**
		*Rhadinaea pilonaorum**
		Scaphiodontophis annulatus
		Scolecophis atrocinctus
		Senticolis triaspis
		Sibon anthracops
		*Sibon nebulatus**
		Spilotes pullatus
		Stenorrhina freminvillii
		Tantilla brevicauda
		*Tantilla taeniata**
		Trimorphodon biscutatus
		*Tropidodipsas fischeri**
		Tropidodipsas sartorii
	Elapidae	*Micrurus nigrocinctus*
		*Pelamis platurus**
	Leptotyphlopidae	*Leptotyphlops goudotii**
	Loxocemidae	*Loxocemus bicolor**
	Viperidae	*Atropoides nummifer*
		Agkistrodon bilineatus
		Cerrophidion godmani
		*Crotalus simus**
		Porthidium ophryomegas

* Species registered in prior studies but not during the present study.
Note: Scientific names according to Köhler et al. (2006). Recent changes in scientific name and families according to IUCN (2009).

Figure 10A. Taylor's Worm Salamander (*Oedipina taylori*), El Imposible National Park, Cerro Campana sector, July 2007.

Figure 10B. Red Toad (*Incilius canaliferus*), San Marcelino Complex Protected Natural Area, September 2007.

Figure 10C. Black-eyed Tree Frog (*Agalychnis moreletii*), El Imposible National Park, December 2006.

Figure 10D. Yellow Cricket Tree Frog (*Dendropsophus robertmertensi*), Santa Rita and Zanjón El Chino Protected Natural Area, October 2007.

Figure 10E. Milk Frog (*Trachycephalus venulosus*), Plan de Amayo Protected Natural Area, August 2007.

Figure 10F. Narrow-mouthed Toad (*Gastrophryne usta*), Plan de Amayo Protected Natural Area, August 2007.

Figure 10G. Burrowing Toad (*Rhinophrynus dorsalis*), Santa Rita and Zanjón El Chino Protected Natural Area, October 2007.

Figure 10H. Salvin's Snapping Turtle (*Staurotypus salvinii*), Santa Rita and Zanjón El Chino Protected Natural Area, August 2007.

Figure 10I. Cayman (*Caiman crocodilus*), Santa Rita and Zanjón El Chino Protected Natural Area, August 2007.

Figure 10J. Leopard Gecko (*Coleonyx mitratus*), Santa Rita and Zanjón El Chino Protected Natural Area, October 2007.

Figure 10K. Keeled Helmeted Basilisk (*Corytophanes percarinatus*), El Imposible National Park, Cerro Campana sector, July 2007.

Figure 10L. Painted Whiptail Lizard (*Ameiva undulata*), Plan de Amayo Protected Natural Area, August 2007.

Figure 10M. Boa constrictor (*Boa constrictor*), Plan de Amayo Protected Natural Area, October 2007.

Figure 10N. Yellowbelly Snake (*Coniophanes fissidens*), Santa Rita and Zanjón El Chino Protected Natural Area, August 2007.

Figure 10O. Central American Tree Snake (*Imantodes gemmistratus*), Plan de Amayo Protected Natural Area, October 2007.

Figure 10P. Milk Snake (*Lampropeltis triangulum*), Plan de Amayo Protected Natural Area, November 2004.

Figure 10Q. Black-banded Cat-eyed Snake (*Leptodeira nigrofasciata*), Plan de Amayo Protected Natural Area, November 2007.

Figure 10R. Black-banded Snake (*Scolecophis atrocinctus*), El Imposible National Park, Cerro Campana sector, July 2007.

Figure 10S. Green Rat Snake (*Senticolis triaspis*), Plan de Amayo Protected Natural Area, October 2007.

Figure 10T Cope´s Snail Sucker Snake (*Sibon anthracops*), Plan de Amayo Protected Natural Area, July 2007. By Luis Girón

Figure 10U. Tiger Rat Snake (*Spilotes pullatus*), Santa Rita and Zanjón El Chino Protected Natural Area, August 2007. By Xiomara Henríquez

Figure 10V. Merten´s Centipede Snake (*Tantilla brevicauda)*. Los Volcanes National Park, Los Andes sector, October 2007.

Figure 10W. Mexican Cantil (*Agkistrodon bilineatus*), Santa Rita and Zanjón El Chino Protected Natural Area, August 2007.

Figure 10X. Godman´s Montane Pit Viper (*Cerrophidion godmani*), Los Volcanes National Park, Los Andes sector, October 2007.

FIGURE 10. SELECTED PHOTOGRAPHS OF AMPHIBIANS AND REPTILES TAKEN DURING THE STUDY. (Photos by Vladlen Henríquez except where indicated.)

3.2 IMPORTANT SPECIES FOR CONSERVATION

The study area presents 49 species which are on the lists of threatened species nationwide and worldwide. In the case of worldwide threatened species, eight species were recorded in the project area including two amphibians and six reptiles. There are 41 other species which are included on the list of nationally endangered species (MARN 2004, Greenbaum & Komar 2005). See Table 27.

3.3 NEW RECORDS FOR THE STUDY AREA

Of the 73 species recorded during the present study, five are new records for the project area and for the departments where they were recorded. These include Narrow Mouthed Toad (*Gastrophryne usta*), an exotic (non-native) gecko *Hemidactylus frenatus*, the Black-banded Cat-eyed Snake (*Leptodeira nigrofasciata*), and False Coral Snake (*Sibon anthracops*). The Terrestrial Snail Sucker (*Tropidodipsas sartorii*), a snake encountered on the Santa Ana Volcano, is a new record for the project area but was previously recorded in the northwest zone of the Santa Ana department.

Including these five species, a total of 20 new reports were recorded at the level of department. First records for the Department of Ahuachapán include cricket tree frog (*Dendropsophus robertmertensi*), swamp tree frog (*Scinax staufferi*), milk frog (*Trachycephalus venulosus*), white lipped frog (*Leptodactylus fragilis*), narrow mouthed toad (*Gastrophryne usta*), burrowing toad (*Rhinophrynus dorsalis*), Mesoamerican slider (*Trachemys venusta*), Pacific coast giant musk turtle (*Staurotypus salvinii*), black-striped snake (*Coniophanes piceivittis*), annulated cat-eyed snake (*Leptodeira annulata*), neck-banded snake (*Scaphiodontophis annulatus*), common cantil (*Agkistrodon bilineatus*), and Godman's montane pitviper (*Cerrophidion godmani*).

First records for the Department of Sonsonate include: Narrow-mouthed Toad (*Gastrophryne usta*), Hawksbill Sea Turtle (*Eretmochelys imbricata*), Gecko (*Hemidactylus frenatus*), False Coral Snake (*Lampropeltis triangulum*), Black-banded Cat-eyed Snake (*Leptodeira nigrofasciata*), Brown Vinesnake (*Oxybelis aeneus*), and False Coral Snake (*Sibon anthracops*).

3.4 LEVEL OF INVENTORY COMPLETENESS

In general, the level of herpetofauna inventory completeness increased in nine watersheds in 2007. Currently, the watersheds with the most advanced inventories are Izalco, San Julián, Cara Sucia, and Barra de Santiago. Notwithstanding the sampling efforts made in the Río Grande de Sonsonate and Coatepeque watersheds, their levels of inventory completeness is below 50% (Table 29).

The inventory of the municipality of San Francisco Menéndez was almost completed (92%) with this study. The municipality of Caluco shows a high level of inventory completeness (65%) whereas before this study it was at 0%. The municipality of Izalco also shows a relatively high completeness level of 57%. The remaining municipalities show inventory completeness levels below 40%. Ten municipalities do not have any herpetofauna records (Table 30).

At the level of ecosystems, six present almost complete inventories (80–90%) as is the case of humid forest, freshwater ecosystems, and the rocky intertidal zone. The dry forest presents a relatively complete inventory, that is, 100% of the expected species are recorded. However, it is still possible to detect new ~~"u~~nexpected" species. The intertidal zone presents an almost complete inventory but no sampling efforts were made during this study. Research has yet to be conducted in savannas and estuaries (Table 31).

TABLE 29. INVENTORY COMPLETENESS FOR AMPHIBIANS AND REPTILES AND RELATIVE IMPORTANCE OF WATERSHEDS.

Watershed	Species Recorded	Expected Species Recorded (of 53)	Initial level of Inventory Completeness (%)	Final Level of Inventory Completeness (%)	Proportion of Conservation Important Species (%)
Cara Sucia	52	32	51	60	74
Barra de Santiago	42	31	49	58	50
San Juan	0	0	0	0	0
Río Cauta	3	1	2	2	2
San Pedro	15	14	23	26	0
Río Grande Sonsonate	10	9	10	17	2
Izalco	57	39	47	74	32
San Julian	43	35	32	66	22
Lago de Coatepeque	26	13	23	25	8
Barra Salada	2	2	0	4	0
Los Cóbanos	27	16	26	30	4

TABLE 30. INVENTORY COMPLETENESS FOR AMPHIBIANS AND REPTILES AND RELATIVE IMPORTANCE OF MUNICIPALITIES.

Municipality	Species Recorded	Expected Species Recorded (of 53)	Initial Level of Inventory Completeness (%)	Final Level of Inventory Completeness (%)	Proportion of Conservation Important Species (%)
San Francisco Menéndez	67	49	74	92	68
Concepción de Ataco	0	0	0	0	
Apaneca	9	6	6	11	2
San Pedro Puxtla	13	7	7	13	2
Guaymango	0	0	0	0	0
Tacuba	13	8	1	15	12
Jujutla	10	3	3	6	10
Acajutla	24	13	13	25	6
San Antonio del Monte	0	0	0	0	0
Salcoatitán	0	0	0	0	0
Santa Catarina Masahuat	0	0	0	0	0
Izalco	40	30	29	57	24
Juayúa	2	2	1	4	2
Nahuizalco	1	1	1	2	0
San Julián	24	16	16	30	10
Caluco	41	34	32	64	20
Armenia	0	0	0	0	0
Tepecoyo	0	0	0	0	0
Santo Domingo de Guzmán	3	3	1	7	2
Cuisnahuat	0	0	0	0	0
Nahulingo	0	0	0	0	0
Sonsonate	30	23	19	43	8
Sonzacate	1	1	2	2	0
Santa Ana	7	7	7	13	8
Chalchuapa	0	0	0	0	0

TABLE 31. INVENTORY COMPLETENESS FOR AMPHIBIANS AND REPTILES AND RELATIVE IMPORTANCE OF ECOSYSTEMS.

Ecosystem	Species Recorded	Expected Species Recorded	No. of Indicator Species for Inventory Completeness	Level of Inventory Completeness (%)	Proportion of Conservation Important Species (%)
Humid Forest	58	42	44	95	58
Dry Forest	39	36	36	100	20
Freshwater Ecosystems	45	36	40	90	26
Cloud Forest	13	10	12	83	12
Savanna	0	0	20	0	0
Rocky Intertidal Zone	8	8	10	80	8
Estuaries	9	9	15	60	1
Coral Reefs	0	0	0	0	2

With regards to the Protected Natural Areas, the analysis of inventory completeness based on the expected generalist species indicates that El Imposible National Park reports the largest number of recorded species (57 species) and the highest percentage of inventory completeness (85%). It also reports the largest number of threatened and endangered species (23 species). The rest of the natural areas have similar quantities of important species for conservation and level of inventory completeness (see Table 32). Therefore, more field efforts should be made to complete the inventories of the study areas.

We obtain the same result from an analysis based on species accumulation curves and wealth estimators. The species accumulation curves of the Protected Natural Areas indicate that most of them do not show a trend towards stabilization and therefore it is necessary to make more sampling efforts (Fig. 11). Only the curve of La Laguna Protected Natural Area shows a trend towards stabilization. The wealth estimators indicate that the inventory of some of the Protected Natural Areas could be almost complete. The wealth estimators of El Imposible National Park indicate that up to 58 species could be recorded of which 57 are already on record. The estimators of Los Volcanes National Park indicate that up to 49 species could be recorded of which 46 are already on record, and consequently, their inventory is almost complete. Some species are yet to be recorded in San Marcelino Complex, Santa Rita and Plan de Amayo Protected Natural Areas (Table 4-9). The wealth estimators of Laguna de Las Ninfas Protected Natural Area indicate that up to 9 species could be recorded but 10 species are already on record and it is possible that additional field work could discover more.

TABLE 32. INVENTORY COMPLETENESS FOR AMPHIBIANS AND REPTILES AND RELATIVE IMPORTANCE OF PROTECTED NATURAL AREAS.

Protected Natural Area	Species Recorded	Expected Species Recorded	No. of Indicator Species for Inventory Completeness	Level of Inventory Completeness (%)	Proportion of Conservation Important Species (%)
El Imposible National Park	57	39	46	85	46
Los Volcanes National Park	46	35	45	78	34
Laguna de Las Ninfas	10	8	12	67	6
San Marcelino Complex	40	32	41	78	22
Santa Rita y Zanjón El Chino	45	34	42	81	28
Plan de Amayo	41	29	41	71	16

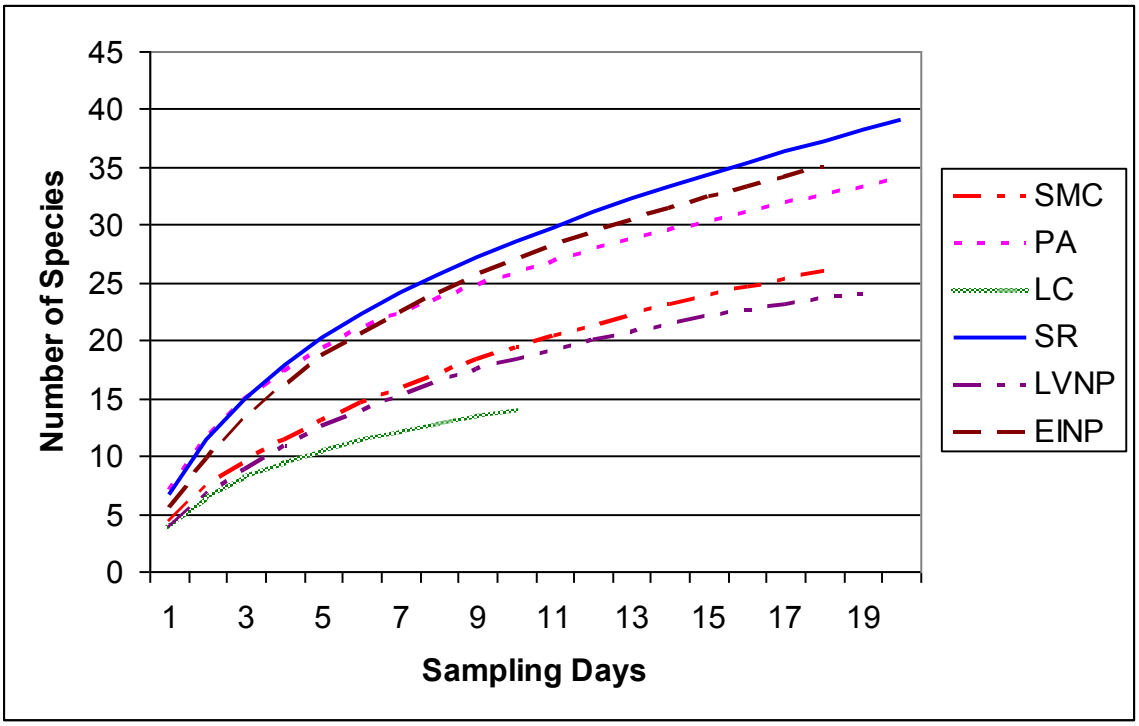

FIGURE 11. ACCUMULATION CURVE OF HERPETOFAUNA SPECIES FROM EACH PROTECTED NATURAL AREA STUDIED.

TABLE 33. ESTIMATORS OF HERPETOFAUNA SPECIES RICHNESS IN EACH PROTECTED NATURAL AREA STUDIED.

Richness Estimator	Estimated Richness						
	EINP	LVNP	SMC	SR	LLN	PA	LC
ACE	51	39	35	49	9	44	22
ICE	51	43	46	52	8	50	20
Chao 1	50	37	33	43	8	41	22
Chao 2	52	38	35	57	7	56	19
Jack-Knife 1	49	42	37	55	9	47	19
Jack-Knife 2	58	49	42	54	8	57	23

EINP = El Imposible National Park
LVNP = Los Volcanes National Park
SMC = San Marcelino Complex Protected Natural Area
SR = Santa Rita Protected Natural Area
LLN = Laguna de Las Ninfas Protected Natural Area
PA = Plan de Amayo Protected Natural Area
LC = Los Cóbanos Marine Park Protected Natural Area

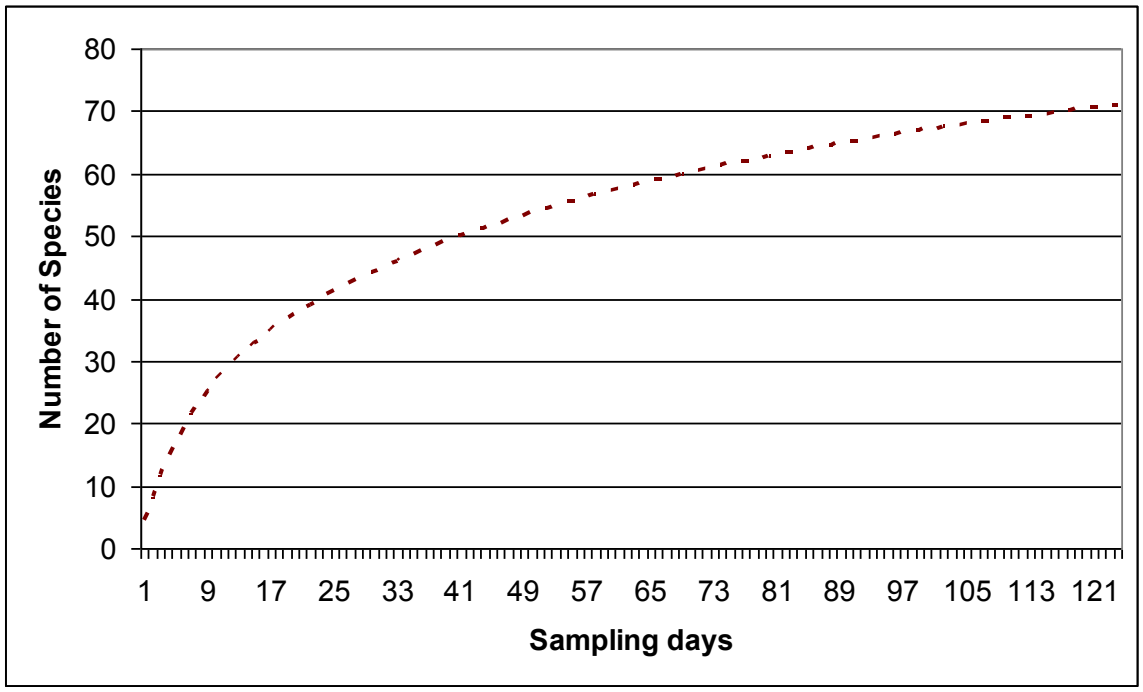

FIGURE 12. ACCUMULATION CURVE FOR HERPETOFAUNA SPECIES FROM SOUTHWESTERN EL SALVADOR.

As we have seen in the case of the Protected Natural Areas, the use of species accumulation curves is another way to determine inventory completeness. Only the data obtained during the field stage for 73 species were used to analyze the entire project area. The curve demonstrates that stabilization has not been achieved after 120 days of sampling (Fig. 12). Richness estimators based on the curve suggest that southwestern El Salvador presently has between 84 and 95 herpetofauna species (Table 34). Considering previous studies, 96 species are already recorded. This suggests that all amphibians and reptiles in the area have already been recorded. However, at a finer scale such as at the level of watershed, municipality, ecosystems, or individual natural areas, the curves and estimators show that additional field work is required.

For ecosystems, the species accumulation curve did not approach stabilization (Fig. 13). Richness estimators for the Dry Forest indicate that up to 39 species should be found; for Humid Forest up to 74, for Cloud Forest up to 17, and for Freshwater Ecosystems, up to 64 (Table 4-9). In the case of Dry Forest, considering previous studies, the species list already reached a total of 39, and therefore it is likely that the inventory for this habitat is already complete. The estimators for the Humid Forest, Cloud Forest, and Freshwater Ecosystems indicate that other species are yet to be recorded.

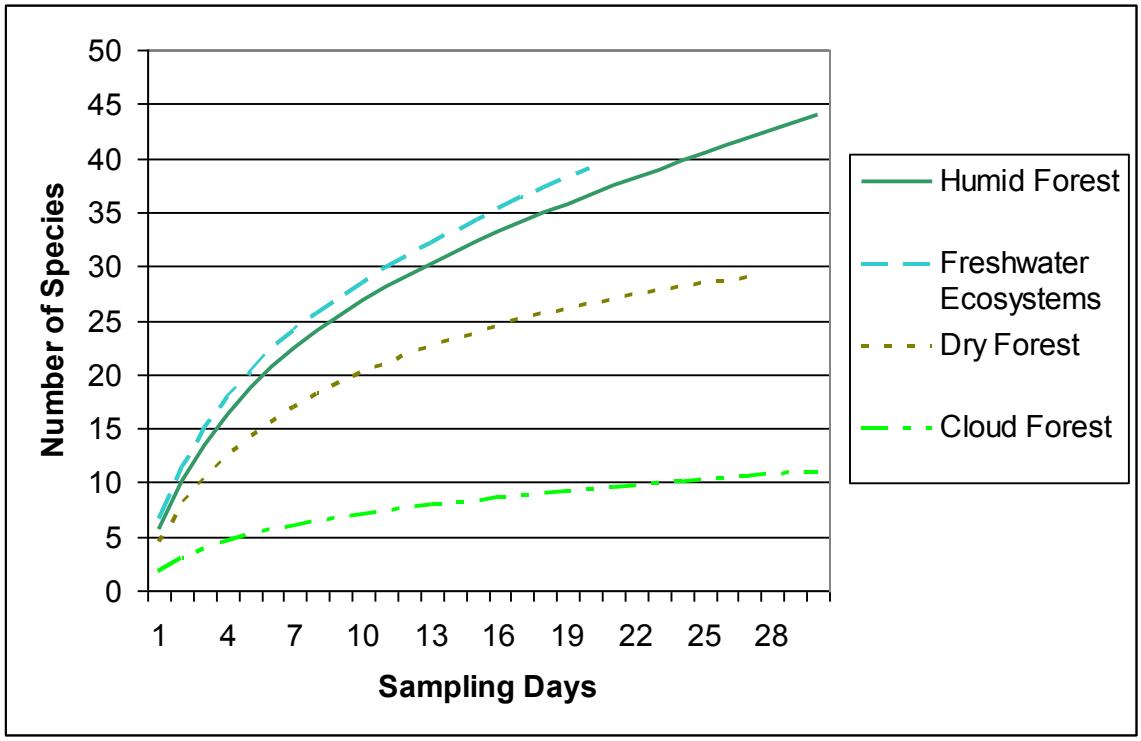

FIGURE 13. ACCUMULATION CURVE FOR HERPETOFAUNA SPECIES FROM EACH ECOSYSTEM STUDIED.

TABLE 34. ESTIMATORS OF HERPETOFAUNA SPECIES RICHNESS IN EACH ECOSYSTEM STUDIED.

Richness Estimator	Estimated Richness				
	Project Area	Dry Forest	Humid Forest	Cloud Forest	Freshwater Ecosystems
ACE	87	34	66	15	49
ICE	86	36	74	17	62
Chao 1	86	31	67	13	43
Chao 2	84	33	70	13	56
Jack-Knife 1	89	37	64	17	55
Jack-Knife 2	95	39	71	15	64

3.5 IMPORTANCE OF THE AREAS FOR CONSERVATION

The level of inventory completeness in watersheds and municipalities is not adequate to evaluate the relative importance of these areas for herpetofauna conservation. However, at the level of Protected Natural Area and ecosystem, the inventories are relatively complete (67%–85% for Protected Natural Areas and five ecosystems have reached a completeness level of 80%), suggesting that the proportion of indicator species for conservation recorded in these areas will be useful as an importance index.

Among the Protected Natural Areas, El Imposible reports the highest importance index followed by Los Volcanes, Santa Rita, San Marcelino Complex, Plan de Amayo, and Laguna de Las Ninfas (Table 32).

Among the ecosystems, the Humid Forest presents the largest number of threatened and endangered species with a total of 28 species (Table 31). It also presents the highest species richness (58 species). The Freshwater ecosystem presents 12 species important for conservation and the second richest ecosystem with 45 species. The Dry Forest presents 10 threatened species and 39 species in total. The Cloud Forest presents six threatened species (out of 13 total). The habitat of the Intertidal and Rocky Zone reports only two endangered species; however, it should be considered that this type of habitat is only used by sea turtles to lay their eggs and by some lizard species which are not threatened. The Coral Reef and the Savanna do not yet have formal herpetofauna records. Considering that the inventories of the five ecosystems are well advanced, it is unlikely that the order of importance will change if more studies are conducted. However, our understanding of the conservation status of each species could change, which could modify the relative importance of each ecosystem.

4. RECOMMENDATIONS

Below are some recommendations for educational and scientific purposes:

- Further efforts should be made to carry out inventories of the coastal zone habitats such as reefs, estuaries, intertidal and rocky zone, and savanna since these habitats were not included in the sampling. It is particularly urgent to conduct studies in the savannas since it is a distinct and reduced ecosystem of the study area that could have species important for biodiversity maintenance in the study area.

- Monitoring protocols should be prepared for the eight globally threatened herpetofauna species that have been recorded in the project area.

- Training workshops for park rangers in the Protected Natural Areas should be provided, focusing on the threatened and endangered species recorded in those areas.

- Park rangers and members of the communities near the Protected Natural Areas should receive environmental education about venomous snakes and first-aid training.

CHAPTER 5:

INVENTORY OF BIRDS IN SOUTHWESTERN EL SALVADOR

Oliver Komar
SalvaNATURA, Conservation Science Department
San Salvador, El Salvador
okomar@salvanatura.org

1. INTRODUCTION

Of all of the classes of flora and fauna, birds (Aves) are the best known, not only by scientists but also by the general public. They are more easily seen and heard than mammals, amphibians, reptiles, insects and fish. As intelligent vertebrates, they capture people's attention and imagination more so than other life forms, such as plants and insects. At the level of sites, such as particular Protected Natural Areas or forests, birds are frequently more completely documented then other kinds of animals or plants. Most species have been studied in some depth, and virtually all species were long ago described for science. Numerous books have been written to help people know birds; all of El Salvador's birds are illustrated in several field guides written for the public (such as Howell and Webb 1995). That cannot be said for some other groups of animals and especially for plants. In fact, annually, several new plants, insects, fish, and amphibians are still being described for science in Central America. The rate of discovery for other vertebrates (reptiles and mammals) is lower, but still higher than for birds. This high level of knowledge available for birds allows this taxonomic group to serve as good indicators for environmental change or for relative importance of sites as biodiversity refuges.

There are three characteristic criteria for identifying a good indicator species: it must be easily identifiable, detectable, and sensitive to change. Birds can typically be identified in the field by experienced observers, and there is abundant literature available to assist biologists in learning to identify them. Most birds are reasonably easy to detect, being generally showy creatures, and often advertising their own presence by singing. Finally, many birds are sensitive to changes in the environment: birds are diverse creatures and in virtually any bird community, one can find at least some species that are sensitive to ecological change. The mere presence of certain generalist species can signal perturbations in the environment; population declines can reflect disturbances such as contamination or habitat fragmentation. The presence of certain habitat specialists can signal sites of conservation value. Thus, birds can be indicators of sites with high quality habitat, or sites useful as biological corridors. In order to be able to use birds as indicators for site quality, they must be inventoried and monitored.

The birds of southwestern El Salvador, in the area where USAID has sponsored the Improved Management and Conservation of Critical Watersheds (IMCW) project, have been studied frequently since 1925. Through 2006, there were at least 25 field studies, generating 21,724 records of birds, based on approximately 1,388 days of field observations (detailed in Komar 2007b). All of this work documented 413 bird species, including 100% of the 74 widespread, generalist bird species that serve as indicators of a complete inventory. A baseline study has documented the relative completeness of the bird inventory in each of 11 watersheds and in each of 25 municipalities within southwestern El Salvador (Komar 2007b). The mean completeness of the inventories, based on the presence of expected generalist species was 68% for watersheds, and 36% for municipalities.

While the bird inventory for the entire region of southwestern El Salvador appeared to be complete, the inventories for specific sites within that region were considerably less complete. Some entire municipalities and some specific Protected Natural Areas within southwestern El Salvador had never had their birds documented at all. The IMCW project was interested in determining if specific watersheds or municipalities within southwestern El Salvador were more important than others for conserving biodiversity. Comparison of sites, using indicator species, requires the existence of complete inventories at the site level (Remsen 1994, Komar 2003). Otherwise, the sites with more complete inventories will simply appear to be of greater value, regardless of their true relative value. The purpose of the present study was to advance the state of the bird inventories for a series of sites and ecosystems in southwestern El Salvador, such that relative value for biodiversity conservation could be assessed.

2. STUDY AREA AND METHODS

The study area included seven of the 11 watersheds within the IMCW project area (Fig.14). The Río Banderas watershed was divided into three watersheds for the purpose of biological analysis: the lower Río Banderas (coastal plain), the Izalco watershed which drains most of Los Volcanes National Park, and the San Julian watershed which drains the northwestern sector of the Sierra del Bálsamo. The Los Cóbanos watershed actually consists of a series of approximately seven minor watersheds, each emptying into the Pacific Ocean, and almost indistinguishable on the ground. The Barra de Santiago watershed was divided into two: "Cara Sucia," which drains the western two-thirds of El Imposible National Park and "Barra de Santiago" which drains the eastern third of the national park and several valleys to the east. Most of the rivers in the Cara Sucia watershed are drained or go underground before they reach the estuary.

The IMCW project area encompasses 28 municipalities, although three only marginally. Field work was carried out at eight sites located within eight municipalities (Table 35). Not reported here are the results of monitoring of bird populations carried out during 2007 and 2008, at numerous additional sites. These results also contribute to the ongoing inventory but will be reported separately.

Below I describe the process for creating lists of three types of indicator bird species, used for the evaluation of the completeness of the inventory work or the evaluation of site

importance for the conservation of biodiversity. First is the list of widespread, common species that are guaranteed to occur in any reasonably large and heterogeneous area, such as a municipality or a watershed. These species serve as indicators of inventory completeness at the site level (Gómez de Silva & Medellín 2001, Komar 2007). Second is the list of common ecosystem indicators, which can be generalist or specialist species, and that are expected to be found in any existing patch of appropriate habitat. These species serve as indicators of inventory completeness at the ecosystem level. Third is the list of threatened species, which should serve as indicators of conservation importance for the sites where they occur (Komar 2007). For example, conservation priority should be assigned to a site with higher richness of threatened species. This is an important distinction, since some sites may have higher overall species richness but have low richness for conservation-importance indicator species; such sites should not be mistakenly considered to be important for conservation simply for having high numbers of species and high levels of biodiversity (Komar 2003).

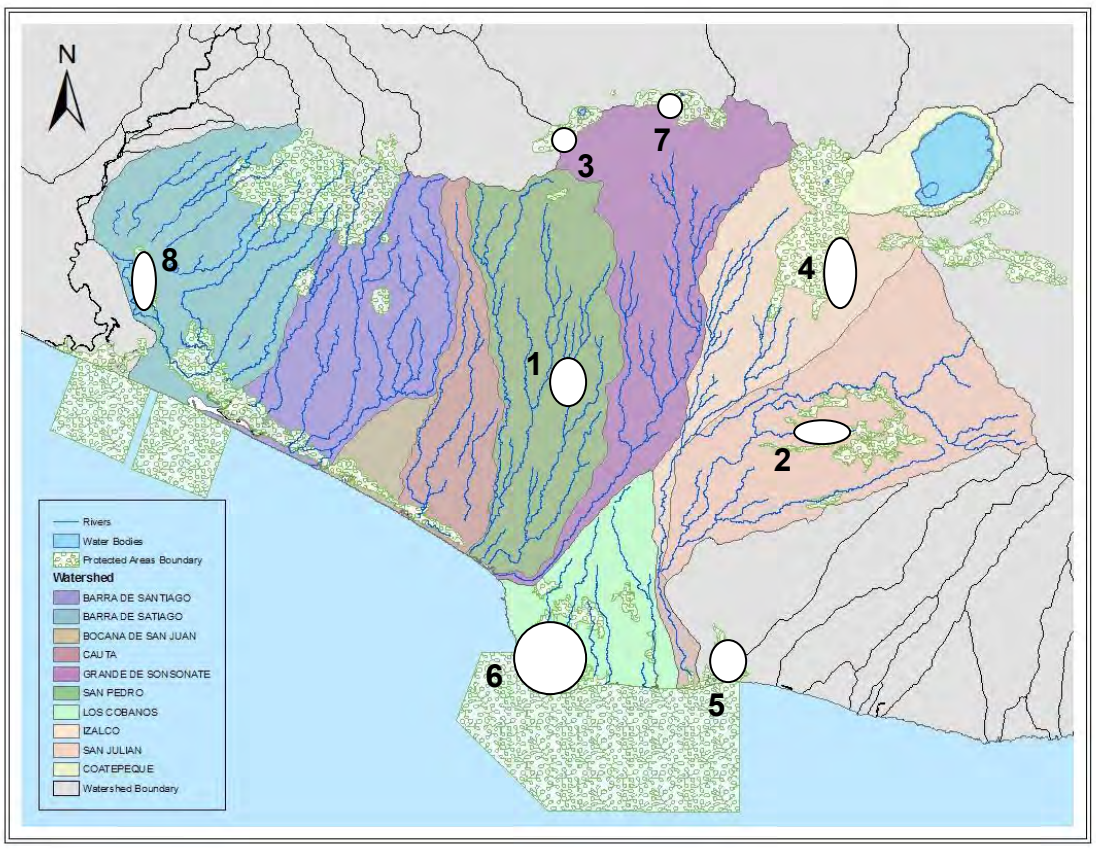

FIGURE 14. MAP OF BIRD INVENTORY FIELD SITES DURING 2007: (1) SANTO DOMINGO DE GUZMÁN, (2) PLAN DE AMAYO, (3) LAGUNA DE LAS NINFAS, (4) LAVAS DE IZALCO/FINCA MARÍA AUXILIADORA, (5) BARRA SALADA, (6) LOS CÓBANOS, (7) LAGUNA DE LAS RANAS, (8) BOSQUE SANTA RITA.

TABLE 35. LOCALITIES WHERE BIRD INVENTORY FIELD WORK WAS CARRIED OUT BY THE IMCW PROJECT.

Site	Watershed	Municipality	Ecosystems	Dates (in 2007)	Field team[1]
Santo Domingo de Guzmán	San Pedro	Santo Domingo de Guzmán	Freshwater wetlands (Riparian forest and rivers)	4 days (16–19 July)	JF, CF, JJ, ST, IV
Plan de Amayo	San Julian	Caluco	Dry forest	12 days (20–24 June, 15–21 October)	CF, JF, JJ, ST, IV, CZ
Laguna de las Ninfas	Río Grande de Sonsonate	Apaneca	Humid montane forest	11 days (29 June to 8 July and then 20 July)	JF, CF, KL, ST, IV, CZ
Lavas de Izalco/Finca María Auxiliadora	Izalco	Izalco	Dry forest	20 days (3–12 August and 1–10 November)	CF, LA, JF, JJ. LS, IV, CZ
Barra Salada	Barra Salada	Sonsonate	Estuary (including mangrove forest)	19 days (3–12 September and 15–23 December)	CF, JJ, OK, LS, ST, IV, CZ
Los Cóbanos	Los Cóbanos	Acajutla y Sonsonate	Savanna, dry forest, and beach	20 days (20–29 August, and 3–12 December)	CF, JJ, OK, KL, LS, ST, IV, CZ
Laguna de las Ranas	Río Grande de Sonsonate	Juayúa	Humid montane forest	10 days (1–10 October)	CF, JF, JJ, ST, IV, CZ
Bosque Santa Rita	Cara Sucia	San Francisco Menéndez	Freshwater wetlands (swamp forest)	20 days (17–26 September, 14–23 November)	JF, CF, JJ, KL, LS, IV, CZ

[1]LA=Lety Andino, CF=Carlos Funes, JF=Jesse Fagan, JJ=Jorge Jiménez, OK=Oliver Komar, KL=Karla Lara, LS=Lya Samayoa, ST=Sofía Trujillo, IV=Iselda Vega, CZ=Carlos Zaldaña

2.1. INDICATORS OF INVENTORY COMPLETENESS

Following the methodology of Gómez de Silva and Medellín (2001), I first considered which resident bird species are widespread generalists and expected in virtually any watershed or municipality of the study area. Such species can be considered ~~"~~test" species, for testing how complete inventory efforts have been at any given site. To determine the test species appropriate for sites within the IMCW project area, I selected species from the revised bird list of El Salvador (Komar et al. 2009), which includes a total of 548 species each classified for status as habitat generalists or specialists, residents or migrants, and for threat at the national level. To build the list of test species, I first selected species classified as permanent residents or partially migratory residents that are also forest generalists. From the resulting list of 94 permanent residents and seven partially migratory residents, I eliminated 57 species classified as nationally threatened (including critically endangered, endangered, vulnerable, or near-threatened), because these are rare species not likely to be widespread in the study area. Of the remaining 44 species, I eliminated 4 species restricted to highlands above 1000 m elevation. I considered if some of the species on the remaining list may be restricted only to the lowest elevations, but although several are more common in the lowlands, none were restricted to them. As would be predicted, the remaining 40 species are widespread in El Salvador and should be found in every municipality or watershed within Ahuachapán and Sonsonate. Although these species are all forest species, they can be found in disturbed forests including tree plantations and urban parks, and are by no means restricted to natural areas or Protected Natural Areas.

I then added to the list of test species resident birds that live in open areas rather than forests. I culled the overall bird list for resident species (including species that are partially migratory) classified as open area generalists. From the resulting lists of 49 permanent residents and 5 partially migratory resident species, I eliminated 12 threatened and near-threatened species, and 3 species restricted to high altitudes, generating a list of 39 species that should be registered at any given non-forest site within Ahuachapán or Sonsonate. Several species were eliminated from this list for various reasons. The Tropical Mockingbird (*Mimus gilvus*) was considered to be restricted to very low elevations close to the coast. The Rock Pigeon (*Columba livia*) and House Sparrow (*Passer domesticus*), both introduced species, were considered to be restricted to urban and other non- natural habitats. The Nutting's Flycatcher (*Myiarchus nuttingi*) is probably restricted to low elevations (<500 m) and is of uncertain occurrence in the study area. The Zone-tailed Hawk (*Buteo albonotatus*) has a breeding range in El Salvador restricted to areas outside the study area. The resulting list of open area generalist species, useful as indicators for inventory completeness (i.e., test species) was 34 species. The combination of forest and open-area site inventory indicators was 74 species (Table 36).

The species in Table 36 should be registered in any complete inventory of a heterogeneous area with both forest and non-forest habitats. All of these species should occupy every municipality or watershed in the study area. These are all common, widespread species, and are useful for identifying gaps in the inventory. Nonetheless, an area with 100% of these species recorded may still have an incomplete inventory, as rare species may still not be included in a site's inventory despite being present and despite all of the common species having been detected.

TABLE 36. THE 74 RESIDENT BIRD SPECIES, EXPECTED IN ANY MUNICIPALITY OR WATERSHED OF THE STUDY AREA, THAT SERVE AS INDICATORS OF INVENTORY COMPLETENESS ("TEST" SPECIES) AT THE SITE LEVEL.

Family	Species	Spanish name	English name
Tinamidae	*Crypturellus cinnamomeus*	Tinamú Canelo	Thicket Tinamou
Cracidae	*Ortalis leucogastra*	Chachalaca Vientre-blanco	White-bellied Chachalaca
Odontophoridae	*Colinus cristatus*	Codorniz-cotui Centroamericana	Crested Bobwhite
Cathartidae	*Coragyps atratus*	Zopilote Negro	Black Vulture
Cathartidae	*Cathartes aura*	Aura Cabecirroja	Turkey Vulture
Accipitridae	*Buteogallus anthracinus*	Aguililla Negra Menor	Common Black-Hawk
Accipitridae	*Buteo magnirostris*	Aguililla Caminera	Roadside Hawk
Accipitridae	*Buteo nitidus*	Aguililla Gris	Gray Hawk
Falconidae	*Herpetotheres cachinnans*	Halcón Guaco (Guas)	Laughing Falcon
Columbidae	*Patagioenas flavirostris*	Paloma Morada	Red-billed Pigeon
Columbidae	*Zenaida asiatica*	Paloma Aliblanca	White-winged Dove
Columbidae	*Columbina inca*	Tórtola Colilarga	Inca Dove
Columbidae	*Columbina talpacoti*	Tortolita Rojiza	Ruddy Ground-Dove
Columbidae	*Leptotila verreauxi*	Paloma Arroyera (Rodadora)	White-tipped Dove
Psittacidae	*Aratinga canicularis*	Perico Frentinaranja	Orange-fronted Parakeet
Psittacidae	*Brotogeris jugularis*	Periquito Barbinaranja	Orange-chinned Parakeet
Cuculidae	*Piaya cayana*	Chocolatero, Piscoy	Squirrel Cuckoo
Cuculidae	*Morococcyx erythropygus*	Cuco-terrestre Menor	Lesser Ground-Cuckoo
Cuculidae	*Crotophaga sulcirostris*	Pijuyo	Groove-billed Ani
Strigidae	*Glaucidium brasilianum*	Tecolotito Común (Aurorita)	Ferruginous Pygmy-Owl
Strigidae	*Ciccaba virgata*	Búho Café	Mottled Owl
Caprimulgidae	*Nyctidromus albicollis*	Tapacaminos Pucuyo (Caballero)	Common Pauraque
Apodidae	*Streptoprocne rutila*	Vencejo Cuellicastaño	Chestnut-collared Swift
Apodidae	*Streptoprocne zonaris*	Vencejo Cuelliblanco	White-collared Swift
Apodidae	*Chaetura vauxi*	Vencejo de Vaux	Vaux's Swift

Family	Species	Spanish name	English name
Trochilidae	*Campylopterus hemileucurus*	Fandanguero Morado	Violet Sabrewing
Trochilidae	*Chlorostilbon canivetii*	Esmeralda de Canivet	Canivet's Emerald
Trochilidae	*Amazilia beryllina*	Colibrí de Berilo	Berylline Hummingbird
Trochilidae	*Amazilia rutila*	Colibrí Canelo	Cinnamon Hummingbird
Trogonidae	*Trogon violaceus*	Trogón Violaceo (Coa Pechiamarilla)	Violaceous Trogon
Trogonidae	*Trogon elegans*	Trogón Elegante (Coa Pechiroja)	Elegant Trogon
Momotidae	*Momotus momota*	Momoto Coroniazul (Talapo)	Blue-crowned Motmot
Momotidae	*Eumomota superciliosa*	Momoto Cejiturqueza (Torogoz)	Turquoise-browed Motmot
Picidae	*Melanerpes aurifrons*	Carpintero Frentidorado	Golden-fronted Woodpecker
Picidae	*Piculus rubiginosus*	Carpintero Olivaceo	Golden-olive Woodpecker
Furnariidae	*Xiphorhynchus flavigaster*	Trepatroncos Piquiclaro	Ivory-billed Woodcreeper
Thamnophilidae	*Thamnophilus doliatus*	Batará Barrada	Barred Antshrike
Tyrannidae	*Tolmomyias sulphurescens*	Picoplano Ojiblanco	Yellow-olive Flycatcher
Tyrannidae	*Contopus cinereus*	Pibí Tropical	Tropical Pewee
Tyrannidae	*Myiarchus tuberculifer*	Copetón Triste	Dusky-capped Flycatcher
Tyrannidae	*Pitangus sulphuratus*	Luis Grande (Cristo Fue)	Great Kiskadee
Tyrannidae	*Megarynchus pitangua*	Luis Piquigrueso	Boat-billed Flycatcher
Tyrannidae	*Myiozetetes similis*	Luis Gregario (Chio)	Social Flycatcher
Tyrannidae	*Tyrannus melancholicus*	Tirano Tropical	Tropical Kingbird
Incertae sedis	*Pachyramphus aglaiae*	Cabezón Degollado	Rose-throated Becard
Incertae sedis	*Tityra semifasciata*	Titira Enmascarada (Torreja)	Masked Tityra
Vireonidae	*Cyclarhis gujanensis*	Vireón Cejirrufo	Rufous-browed Peppershrike
Corvidae	*Calocitta formosa*	Urraca-hermosa Cariblanca (Urraca)	White-throated Magpie-Jay
Hirundinidae	*Progne chalybea*	Martín Pechigris	Gray-breasted Martin

Family	Species	Spanish name	English name
Hirundinidae	*Stelgidopteryx serripennis*	Golondrina-aliserrada Norteña	Northern Rough-winged Swallow
Troglodytidae	*Campylorhynchus rufinucha*	Guacalchía (Matraquita Nuquirrufa)	Rufous-naped Wren
Troglodytidae	*Thryothorus modestus*	Saltapared Sencillo	Plain Wren
Troglodytidae	*Troglodytes aedon*	Saltapared Continental Norteño	House Wren
Sylviidae	*Polioptila albiloris*	Perlita Cejiblanca	White-lored Gnatcatcher
Turdidae	*Turdus grayi*	Zorzal Pardo	Clay-colored Robin
Parulidae	*Euthlypis lachrymosa*	Chipe Roquero	Fan-tailed Warbler
Parulidae	*Basileuterus rufifrons*	Chipe Gorrirrufo	Rufous-capped Warbler
Thraupidae	*Thraupis episcopus*	Tángara Azuligris	Blue-gray Tanager
Thraupidae	*Thraupis abbas*	Tángara Aliamarilla	Yellow-winged Tanager
Emberizidae	*Volatinia jacarina*	Semillero Brincador	Blue-black Grassquit
Emberizidae	*Sporophila torqueola*	Semillero Collarejo	White-collared Seedeater
Emberizidae	*Aimophila ruficauda*	Zacatonero Cabecirrayado	Stripe-headed Sparrow
Cardinalidae	*Saltator coerulescens*	Saltator Grisáceo (Dichoso-fuí)	Grayish Saltator
Cardinalidae	*Saltator atriceps*	Saltator Cabecinegro (Chepito)	Black-headed Saltator
Cardinalidae	*Passerina caerulea*	Picogrueso Azul	Blue Grosbeak
Icteridae	*Dives dives*	Tordo Cantor	Melodious Blackbird
Icteridae	*Quiscalus mexicanus*	Zanate Mayor (Zanate♀, Clarinero♂)	Great-tailed Grackle
Icteridae	*Molothrus aeneus*	Vaquero Ojirrojo	Bronzed Cowbird
Icteridae	*Icterus pustulatus*	Bolsero Dorsirrayado	Streak-backed Oriole
Icteridae	*Icterus pectoralis*	Bolsero Pechimanchado	Spot-breasted Oriole
Icteridae	*Icterus gularis*	Bolsero de Altamira	Altamira Oriole
Icteridae	*Amblycercus holosericeus*	Cacique Piquiclaro	Yellow-billed Cacique
Fringillidae	*Euphonia affinis*	Eufonia Gorjinegro	Scrub Euphonia
Fringillidae	*Carduelis psaltria*	Dominico Dorsioscuro	Lesser Goldfinch

To evaluate the level of completeness for the bird inventory at the level of ecosystems (or habitats), first I adopted as the ecosystems of interest the eight ecosystems identified as priority conservation objects for the study area by the IMCW project (Komar & Girón 2007). These included cloud forest, humid montane forest, dry forest, estuarine habitat (including mangrove forest and mudflats), beaches, savannas, and coral reefs. Also included were freshwater wetlands, a broad category that includes lakes, rivers, swamp forest (such as at Bosque Santa Rita, which is seasonally flooded), and riparian habitat at the edges of waterways. I assembled lists of habitat specialists and generalists that are sufficiently common to be expected in every existing patch of natural habitat within each of these ecosystem categories. For forest ecosystems, these lists tended to include all 40 of the forest generalists included in Table 36, but in the case of forest habitats restricted to narrow elevational ranges, such as cloud forest and mangrove, not all 40 were included. Added to the lists of indicators were specialist species found only in the given habitat, if the species is sufficiently common to be expected in every patch. For non-forest ecosystems, the 34 open-area generalists were likely to all be included, as well as a few additional open-area specialist species if these are quite common or widespread across patches. The resulting lists of inventory indicator species are presented in Table 37.

2.2. INDICATORS OF CONSERVATION IMPORTANCE

Globally-threatened species are often considered the best indicators for identifying sites of conservation importance; such species are listed annually by the World Conservation Union (IUCN 2008). Globally-threatened species are used worldwide as principal indicators for identifying Important Bird Areas, Key Biodiversity Areas, and Alliance for Zero Extinction sites. Relatively few globally-threatened species, however, occur in El Salvador. In fact, no resident bird species recorded in the study area are globally-threatened, and just one, the Great Curassow (*Crax rubra*), is classified as globally near-threatened (several migratory visitors—non-residents—are also globally near-threatened). The curassow is believed to be restricted in El Salvador to the forests of El Imposible National Park.

Another group of species sometimes used as indicators of conservation importance are migratory birds. U.S.-based bird conservation donors tend to support projects that aim to protect migratory birds that breed in northern latitudes and winter in Central America. Such species are often thought to be vulnerable because their migratory habits expose them to diverse threats in different places at different times. The accumulation of threats on the breeding grounds, migratory stopover sites, and wintering grounds suggests that these species should be protected wherever they go, to minimize the accumulation of threats. However, most migratory species are actually well adapted to diverse conditions, including severe habitat disturbance. Most of these species are widely distributed, with abundant populations, and are not considered threatened in any of the areas where they breed or winter. The Swainson's Thrush (*Catharus ustulatus*), for example, has an estimated North American population of over 100 million individuals (Rich et al. 2004). Nearly 200 migratory species visit El Salvador each year. Just a few of these species have been classified in continent-wide conservation plans and analyses as of conservation concern (Kushlan et al. 2002, Rich et al. 2004).

TABLE 37. BIRD SPECIES USED AS "TEST SPECIES" TO INDICATE RELATIVE LEVELS OF INVENTORY COMPLETENESS AT THE ECOSYSTEM LEVEL, IN SOUTHWESTERN EL SALVADOR.

Species	English name	Humid forest	Dry forest	Cloud forest	Estuaries & mangroves	Beaches	Freshwater wetlands	Savannas	Coral reef
Crypturellus cinnamomeus	Thicket Tinamou		x						
Ortalis leucogastra	White-bellied Chachalaca		x		x				
Dendrortyx leucophrys	Buffy-crowned Wood-Partridge	x							
Colinus cristatus	Crested Bobwhite							x	
Dactylortyx thoracicus	Singing Quail	x		x					
Sula granti	Nazca Booby								x
Sula leucogaster	Brown Booby								x
Pelecanus occidentalis	Brown Pelican				x	x			x
Phalacrocorax brasilianus	Neotropic Cormorant				x				
Fregata magnificens	Magnificent Frigatebird				x	x			x
Ardea herodias	Great Blue Heron				x		x		
Ardea alba	Great Egret				x		x		
Egretta thula	Snowy Egret				x				
Egretta tricolor	Tricolored Heron				x				
Bubulcus ibis	Cattle Egret						x	x	
Butorides virescens	Green Heron				x		x		
Nyctanassa violacea	Yellow-crowned Night-Heron				x				
Eudocimus albus	White Ibis				x				
Coragyps atratus	Black Vulture	x	x		x	x	x	x	
Cathartes aura	Turkey Vulture	x	x		x	x	x	x	
Pandion haliaetus	Osprey				x				
Elanus leucurus	White-tailed Kite							x	
Accipiter striatus	Sharp-shinned Hawk	x	x						
Buteogallus anthracinus	Common Black-Hawk	x	x		x	x	x		
Buteo magnirostris	Roadside Hawk		x	x	x	x	x	x	

Species	English name	Humid forest	Dry forest	Cloud forest	Estuaries & mangroves	Beaches	Freshwater wetlands	Savannas	Coral reef
Buteo platypterus	Broad-winged Hawk	x	x						
Buteo nitidus	Gray Hawk	x	x		x		x	x	
Buteo brachyurus	Short-tailed Hawk	x	x						
Buteo swainsoni	Swainson's Hawk							x	
Buteo albonotatus	Zone-tailed Hawk		x		x	x		x	
Buteo jamaicensis	Red-tailed Hawk	x							
Micrastur semitorquatus	Collared Forest-Falcon	x	x		x				
Caracara cheriway	Crested Caracara					x		x	
Herpetotheres cachinnans	Laughing Falcon		x				x	x	
Falco sparverius	American Kestrel					x		x	
Falco columbarius	Merlin					x		x	
Falco peregrinus	Peregrine Falcon				x	x		x	
Burhinus bistriatus	Double-striped Thick-knee							x	
Pluvialis squatarola	Black-bellied Plover				x				
Charadrius wilsonia	Wilson's Plover				x	x			
Charadrius semipalmatus	Semipalmated Plover				x	x			
Charadrius vociferus	Killdeer				x				
Himantopus mexicanus	Black-necked Stilt				x				
Jacana spinosa	Northern Jacana						x		
Actitis macularius	Spotted Sandpiper				x	x	x		
Tringa melanoleuca	Greater Yellowlegs				x				
Tringa semipalmata	Willet				x	x			
Tringa flavipes	Lesser Yellowlegs				x				
Numenius phaeopus	Whimbrel				x	x			
Arenaria interpres	Ruddy Turnstone				x				
Calidris alba	Sanderling				x	x			
Calidris pusilla	Semipalmated Sandpiper				x				

Species	English name	Humid forest	Dry forest	Cloud forest	Estuaries & mangroves	Beaches	Freshwater wetlands	Savannas	Coral reef
Calidris mauri	Western Sandpiper				x				
Calidris minutilla	Least Sandpiper				x				
Limnodromus griseus	Short-billed Dowitcher				x				
Larus atricilla	Laughing Gull				x	x			x
Larus pipixcan	Franklin's Gull				x	x			
Chlidonias niger	Black Tern				x	x			x
Sterna hirundo	Common Tern				x				
Thalasseus maximus	Royal Tern				x	x			x
Thalasseus sandvicensis	Sandwich Tern				x	x			x
Thalasseus elegans	Elegant Tern				x	x			x
Rynchops niger	Black Skimmer				x				
Stercorarius pomarinus	Pomarine Jaeger								x
Stercorarius parasiticus	Parasitic Jaeger								x
Patagioenas flavirostris	Red-billed Pigeon	x	x		x		x	x	
Zenaida asiatica	White-winged Dove	x	x		x	x	x	x	
Zenaida macroura	Mourning Dove							x	
Columbina inca	Inca Dove		x		x	x	x	x	
Columbina passerina	Common Ground-Dove							x	
Columbina minuta	Plain-breasted Ground-Dove							x	
Columbina talpacoti	Ruddy Ground-Dove		x		x	x	x	x	
Leptotila verreauxi	White-tipped Dove	x	x				x		
Geotrygon albifacies	White-faced Quail-Dove			x					
Aratinga canicularis	Orange-fronted Parakeet		x		x		x	x	
Brotogeris jugularis	Orange-chinned Parakeet	x	x		x		x	x	
Piaya cayana	Squirrel Cuckoo	x	x	x	x		x		
Morococcyx erythropygus	Lesser Ground-Cuckoo		x						
Crotophaga sulcirostris	Groove-billed Ani		x		x	x	x	x	

Species	English name	Humid forest	Dry forest	Cloud forest	Estuaries & mangroves	Beaches	Freshwater wetlands	Savannas	Coral reef
Megascops cooperi	Pacific Screech-Owl		x		x				
Glaucidium brasilianum	Ferruginous Pygmy-Owl	x	x		x		x		
Ciccaba virgata	Mottled Owl	x	x	x	x		x		
Chordeiles acutipennis	Lesser Nighthawk		x		x	x		x	
Nyctidromus albicollis	Common Pauraque		x		x	x	x	x	
Chaetura vauxi	Vaux's Swift	x	x	x					
Campylopterus rufus	Rufous Sabrewing			x					
Campylopterus hemileucurus	Violet Sabrewing	x	x	x					
Colibri thalassinus	Green Violet-ear			x					
Anthracothorax prevostii	Green-breasted Mango		x		x				
Chlorostilbon canivetii	Canivet's Emerald	x	x	x					
Amazilia beryllina	Berylline Hummingbird	x	x						
Amazilia rutila	Cinnamon Hummingbird		x		x	x	x	x	
Lampornis viridipallens	Green-throated Mountain-gem			x					
Eugenes fulgens	Magnificent Hummingbird			x					
Archilochus colubris	Ruby-throated Hummingbird		x						
Trogon melanocephalus	Black-headed Trogon				x				
Trogon violaceus	Violaceous Trogon	x	x						
Trogon elegans	Elegant Trogon	x	x						
Momotus momota	Blue-crowned Motmot	x	x						
Eumomota superciliosa	Turquoise-browed Motmot		x		x			x	
Ceryle alcyon	Belted Kingfisher				x		x		
Chloroceryle americana	Green Kingfisher				x		x		
Aulacorhynchus prasinus	Emerald Toucanet			x					
Melanerpes aurifrons	Golden-fronted Woodpecker	x	x		x		x	x	
Piculus rubiginosus	Golden-olive Woodpecker	x	x	x			x		

Species	English name	Humid forest	Dry forest	Cloud forest	Estuaries & mangroves	Beaches	Freshwater wetlands	Savannas	Coral reef
Dryocopus lineatus	Lineated Woodpecker				x				
Xiphorhynchus flavigaster	Ivory-billed Woodcreeper	x	x						
Lepidocolaptes affinis	Spot-crowned Woodcreeper			x					
Thamnophilus doliatus	Barred Antshrike	x	x				x	x	
Grallaria guatimalensis	Scaled Antpitta			x					
Camptostoma imberbe	Northern Beardless-Tyrannulet		x						
Elaenia flavogaster	Yellow-bellied Elaenia				x				
Elaenia frantzii	Mountain Elaenia			x					
Zimmerius vilissimus	Paltry Tyrannulet	x							
Todirostrum cinereum	Common Tody-Flycatcher				x				
Rhynchocyclus brevirostris	Eye-ringed Flatbill			x					
Tolmomyias sulphurescens	Yellow-olive Flycatcher		x						
Contopus cinereus	Tropical Pewee		x				x		
Empidonax flaviventris	Yellow-bellied Flycatcher	x							
Empidonax traillii	Willow Flycatcher						x		
Empidonax minimus	Least Flycatcher		x						
Empidonax flavescens	Yellowish Flycatcher			x					
Myiarchus tuberculifer	Dusky-capped Flycatcher	x	x		x		x		
Myiarchus tyrannulus	Brown-crested Flycatcher		x		x				
Pitangus sulphuratus	Great Kiskadee	x	x		x	x	x	x	
Megarynchus pitangua	Boat-billed Flycatcher	x	x				x		
Myiozetetes similis	Social Flycatcher	x	x		x	x	x	x	
Myiodynastes luteiventris	Sulphur-bellied Flycatcher	x					x		
Tyrannus melancholicus	Tropical Kingbird				x	x	x	x	
Tyrannus verticalis	Western Kingbird		x					x	
Tyrannus tyrannus	Eastern Kingbird						x	x	
Tyrannus forficatus	Scissor-tailed Flycatcher				x	x		x	

Species	English name	Humid forest	Dry forest	Cloud forest	Estuaries & mangroves	Beaches	Freshwater wetlands	Savannas	Coral reef
Pachyramphus aglaiae	Rose-throated Becard		x		x		x		
Tityra semifasciata	Masked Tityra	x	x		x		x		
Vireo pallens	Mangrove Vireo				x				
Vireo flavifrons	Yellow-throated Vireo		x						
Vireo solitarius	Blue-headed Vireo	x							
Vireo gilvus	Warbling Vireo		x						
Vireo leucophrys	Brown-capped Vireo			x					
Vireo flavoviridis	Yellow-green Vireo	x	x				x		
Hylophilus decurtatus	Lesser Greenlet	x							
Cyclarhis gujanensis	Rufous-browed Peppershrike	x	x	x	x		x		
Cyanocitta stelleri	Steller's Jay								
Calocitta formosa	White-throated Magpie-Jay		x		x		x	x	
Cyanocorax melanocyaneus	Bushy-crested Jay	x		x					
Progne chalybea	Gray-breasted Martin		x		x	x	x	x	
Tachycineta albilinea	Mangrove Swallow				x	x			
Tachycineta thalassina	Violet-green Swallow	x	x						
Stelgidopteryx serripennis	Northern Rough-winged Swallow				x	x	x	x	
Petrochelidon pyrrhonota	Cliff Swallow		x				x		
Hirundo rustica	Barn Swallow		x		x	x	x	x	
Campylorhynchus rufinucha	Rufous-naped Wren		x		x	x	x	x	
Thryothorus maculipectus	Spot-breasted Wren	x							
Thryothorus rufalbus	Rufous-and-white Wren	x		x					
Thryothorus pleurostictus	Banded Wren		x						
Thryothorus modestus	Plain Wren	x	x	x			x		
Troglodytes aedon	House Wren	x		x					
Troglodytes rufociliatus	Rufous-browed Wren			x					
Ramphocaenus melanurus	Long-billed Gnatwren	x							

Species	English name	Humid forest	Dry forest	Cloud forest	Estuaries & mangroves	Beaches	Freshwater wetlands	Savannas	Coral reef
Polioptila caerulea	Blue-gray Gnatcatcher	x	x						
Polioptila albiloris	White-lored Gnatcatcher		x		x	x		x	
Myadestes occidentalis	Brown-backed Solitaire			x					
Catharus aurantiirostris	Orange-billed Nightingale-Thrush	x							
Catharus frantzii	Ruddy-capped Nightingale-Thrush			x					
Catharus ustulatus	Swainson's Thrush	x	x	x					
Turdus infuscatus	Black Robin			x					
Turdus grayi	Clay-colored Robin	x	x		x	x	x	x	
Turdus assimilis	White-throated Robin	x		x					
Mimus gilvus	Tropical Mockingbird				x	x		x	
Melanotis hypoleucus	Blue-and-white Mockingbird			x					
Bombycilla cedrorum	Cedar Waxwing	x	x	x					
Vermivora peregrina	Tennessee Warbler	x	x	x	x	x	x	x	
Parula superciliosa	Crescent-chested Warbler			x					
Dendroica petechia	Yellow Warbler		x		x	x	x	x	
Dendroica petechia xantholora	Mangrove Warbler				x				
Dendroica magnolia	Magnolia Warbler	x	x						
Dendroica virens	Black-throated Green Warbler	x	x						
Dendroica townsendi	Townsend's Warbler	x		x					
Mniotilta varia	Black-and-white Warbler	x	x						
Setophaga ruticilla	American Redstart				x				
Helmitheros vermivorum	Worm-eating Warbler	x	x	x					
Seiurus aurocapillus	Ovenbird	x	x	x	x				
Seiurus noveboracensis	Northern Waterthrush				x		x		

Species	English name	Humid forest	Dry forest	Cloud forest	Estuaries & mangroves	Beaches	Freshwater wetlands	Savannas	Coral reef
Geothlypis trichas	Common Yellowthroat						x		
Wilsonia pusilla	Wilson's Warbler	x		x					
Wilsonia canadensis	Canada Warbler	x	x						
Myioborus miniatus	Slate-throated Redstart	x		x					
Euthlypis lachrymosa	Fan-tailed Warbler	x	x						
Basileuterus rufifrons	Rufous-capped Warbler	x	x						
Icteria virens	Yellow-breasted Chat				x				
Habia rubica	Red-crowned Ant-Tanager	x							
Habia fuscicauda	Red-throated Ant-Tanager				x				
Piranga rubra	Summer Tanager		x						
Piranga ludoviciana	Western Tanager	x	x	x					
Piranga bidentata	Flame-colored Tanager			x					
Piranga leucoptera	White-winged Tanager	x							
Thraupis episcopus	Blue-gray Tanager		x		x	x	x	x	
Thraupis abbas	Yellow-winged Tanager	x	x	x					
Cyanerpes cyaneus	Red-legged Honeycreeper	x	x						
Volatinia jacarina	Blue-black Grassquit						x	x	
Sporophila torqueola	White-collared Seedeater		x		x	x	x	x	
Sporophila minuta	Ruddy-breasted Seedeater				x			x	
Diglossa baritula	Cinnamon-bellied Flowerpiercer			x					
Melozone leucotis	White-eared Ground-Sparrow	x							
Aimophila ruficauda	Stripe-headed Sparrow		x		x	x	x	x	
Ammodramus savannarum	Grasshopper Sparrow							x	
Saltator coerulescens	Grayish Saltator		x		x	x	x	x	
Saltator atriceps	Black-headed Saltator	x	x						
Pheucticus ludovicianus	Rose-breasted Grosbeak	x	x	x					
Cyanocompsa parellina	Blue Bunting		x						

Species	English name	Humid forest	Dry forest	Cloud forest	Estuaries & mangroves	Beaches	Freshwater wetlands	Savannas	Coral reef
Passerina caerulea	Blue Grosbeak		x				x	x	
Passerina cyanea	Indigo Bunting		x					x	
Passerina ciris	Painted Bunting		x					x	
Spiza americana	Dickcissel							x	
Agelaius phoeniceus	Red-winged Blackbird				x				
Sturnella magna	Eastern Meadowlark							x	
Dives dives	Melodious Blackbird	x	x		x	x	x	x	
Quiscalus mexicanus	Great-tailed Grackle		x		x	x	x	x	
Molothrus aeneus	Bronzed Cowbird	x	x		x		x	x	
Icterus maculialatus	Bar-winged Oriole	x							
Icterus spurius	Orchard Oriole		x		x	x	x	x	
Icterus pustulatus	Streak-backed Oriole	x	x		x	x	x	x	
Icterus pectoralis	Spot-breasted Oriole	x	x		x		x		
Icterus gularis	Altamira Oriole	x	x		x	x	x	x	
Icterus galbula	Baltimore Oriole	x	x		x	x	x		
Amblycercus holosericeus	Yellow-billed Cacique	x	x		x		x		
Euphonia affinis	Scrub Euphonia		x		x	x	x	x	
Euphonia hirundinacea	Yellow-throated Euphonia	x							
Chlorophonia occipitalis	Blue-crowned Chlorophonia			x					
COUNT		83	106	46	110	55	71	66	11

A third option, and one which should be followed in El Salvador, is to use nationally threatened bird species as the indicators for conservation importance of sites (Komar 2002). Komar et al. (2009) recently reevaluated all El Salvador birds to determine the national threat status. They produced a list of 246 nationally threatened species, based on international standards promoted by the World Conservation Union (IUCN 2003), and including migratory species recognized as of conservation importance by any of the several continental wide conservation plans developed for North American migratory birds. This large list of rare and threatened species permits more options for prioritizing areas for conservation than would a very small list of globally threatened or near-threatened bird species (Komar 2002). Not all of the country's nationally threatened bird species are found in the study area, as some are restricted to other areas such as the pine-oak forests and cloud forests along the Honduran border. Approximately 188 nationally threatened species are useful indicators for prioritizing sites of national conservation importance within the study area (Table 38). These species can be stratified by level of threat. For example, 31 are critically endangered, 69 endangered, and 88 vulnerable.

2.3. SOURCE OF LOCALITY DATA

At the start of field work, SalvaNATURA's flora y fauna database included 21,724 avian locality records from the Project area, including mostly unpublished observations from field notes, but also mist net captures and some museum specimens (Table 39). The 14,679 observation records represented over 76,000 individual birds. During field work, thousands of new locality records were collected, and the database for the project area was increased to 25,792 avian records. Of these, 4,068 were collected during the field study by project staff. The 1,767 new observation records represent 6,083 individual birds.

2.4. FIELD METHODS

New information on bird distribution and abundance was collected in the field via observations and net captures. Observations were made during 296 hours by walking through the study areas during most mornings, covering new territory each day as much as possible, noting all birds identified in a field notebook. Observers varied, but generally two people per field trip were assigned to this task, and they worked together, such that each observation hour represents a team of two observers working for one hour. Observations effort was distributed among all of the field sites (Table 40). When possible, species observed were documented by photographs.

Birds were captured in standard, black nylon, 36 mm mesh mist nets, measuring 12 m long by 2.6 m high purchased from the Association of Field Ornithologists (USA). The nets were placed at ground-level, in various configurations adapted to the terrain, considered by the field team to be useful for maximizing captures. No attempt was made to standardize mist net effort among sites, since the purpose was to contribute to the advancement of the existing inventory, rather than compare capture rates among sites. Nonetheless, mist-netting effort (net-hours) were recorded so as to better interpret the results from each site (Table 40). Once captured, birds were identified in

TABLE 38. BIRDS OF NATIONAL CONSERVATION CONCERN (188 SPECIES), USEFUL AS INDICATORS FOR SITE PRIORITIZATION IN THE STUDY AREA.

Family	Species	Spanish name	English name	Status[1]
Anatidae	*Cairina moschata*	Pato Real	Muscovy Duck	VU
Cracidae	*Penelope purpurascens*	Pavo Cojolito	Crested Guan	CR
Cracidae	*Penelopina nigra*	Pajuil (Pava Negra)	Highland Guan	EN
Cracidae	*Crax rubra*	Hocofaisán (Pajuil)	Great Curassow	CR
Podicipedidae	*Tachybaptus dominicus*	Zambullidor Menor	Least Grebe	EN
Podicipedidae	*Podilymbus podiceps*	Zambullidor Piquipinto	Pied-billed Grebe	EN
Pelicanidae	*Pelecanus erythrorhynchos*	Pelicano Blanco Americano	American White Pelican	VU
Pelicanidae	*Pelecanus occidentalis*	Pelicano Café	Brown Pelican	VU
Anhingidae	*Anhinga anhinga*	Pato Aguja	Anhinga	CR
Fregatidae	*Fregata magnificens*	Fragata	Magnificent Frigatebird	EN
Ardeidae	*Botaurus pinnatus*	Avetoro Neotropical	Pinnated Bittern	CR
Ardeidae	*Ixobrychus exilis*	Avetorito Americano	Least Bittern	CR
Ardeidae	*Tigrisoma mexicanum*	Garza Tigre Gorjinuda	Bare-throated Tiger-Heron	EN
Ardeidae	*Egretta thula*	Garza Nivea	Snowy Egret	EN
Ardeidae	*Egretta caerulea*	Garza Azul	Little Blue Heron	EN
Ardeidae	*Egretta tricolor*	Garza Tricolor	Tricolored Heron	CR
Ardeidae	*Egretta rufescens*	Garza Rojiza	Reddish Egret	VU
Ardeidae	*Nycticorax nycticorax*	Garza-nocturna Coroninegra	Black-crowned Night-Heron	EN

Family	Species	Spanish name	English name	Status[1]
Ardeidae	*Nyctanassa violacea*	Garza-nocturna Coroniclara	Yellow-crowned Night-Heron	VU
Ardeidae	*Cochlearius cochlearius*	Garza Cucharón	Boat-billed Heron	EN
Threskiornithidae	*Eudocimus albus*	Ibis Blanco	White Ibis	VU
Threskiornithidae	*Platalea ajaja*	Espátula Rosada	Roseate Spoonbill	EN
Ciconiidae	*Mycteria americana*	Cigueña Americana (Pulido)	Wood Stork	EN
Cathartidae	*Sarcoramphus papa*	Zopilote Rey (Rey Zope)	King Vulture	CR
Accipitridae	*Leptodon cayanensis*	Milano Cabecigris	Gray-headed Kite	EN
Accipitridae	*Elanoides forficatus*	Milano Tijereta	Swallow-tailed Kite	EN
Accipitridae	*Elanus leucurus*	Milano Coliblanco	White-tailed Kite	VU
Accipitridae	*Rostrhamus sociabilis*	Milano Caracolero	Snail Kite	EN
Accipitridae	*Ictinia plumbea*	Milano Plomizo	Plumbeous Kite	EN
Accipitridae	*Busarellus nigricollis*	Aguililla Canela	Black-collared Hawk	CR
Accipitridae	*Geranospiza caerulescens*	Gavilán Zancudo	Crane Hawk	CR
Accipitridae	*Leucopternis albicollis*	Aguililla Blanca	White Hawk	CR
Accipitridae	*Buteogallus urubitinga*	Aguililla Negra Mayor	Great Black-Hawk	EN
Accipitridae	*Parabuteo unicinctus*	Aguililla de Harris	Harris's Hawk	EN
Accipitridae	*Buteo swainsoni*	Aguililla de Swainson	Swainson's Hawk	VU
Accipitridae	*Buteo albicaudatus*	Aguililla Coliblanca	White-tailed Hawk	CR

Family	Species	Spanish name	English name	Status[1]
Accipitridae	*Spizaetus tyrannus*	Águila Tirana (Águila Crestada Negra)	Black Hawk-Eagle	CR
Accipitridae	*Spizaetus ornatus*	Águila Elegante	Ornate Hawk-Eagle	CR
Falconidae	*Micrastur ruficollis*	Halcón-selvático Barrado	Barred Forest-Falcon	EN
Falconidae	*Caracara cheriway*	Caracara Común (Querque)	Crested Caracara	VU
Falconidae	*Falco rufigularis*	Halcón Murcielaguero	Bat Falcon	CR
Rallidae	*Laterallus ruber*	Polluela Rojiza	Ruddy Crake	VU
Rallidae	*Aramides axillaris*	Rascón Cuellirrufo	Rufous-necked Wood-Rail	VU
Rallidae	*Aramides cajanea*	Rascón Cuelligris	Gray-necked Wood-Rail	CR
Rallidae	*Porzana flaviventer*	Polluela Pechiamarilla	Yellow-breasted Crake	EN
Rallidae	*Porphyrio martinica*	Gallineta Morada	Purple Gallinule	VU
Rallidae	*Gallinula chloropus*	Gallineta Común	Common Moorhen	EN
Rallidae	*Fulica americana*	Gallareta Americana	American Coot	CR
Aramidae	*Aramus guarauna*	Carao (Garza Caracolera)	Limpkin	VU
Burhinidae	*Burhinus bistriatus*	Alcaraván Americana	Double-striped Thick-knee	VU
Charadriidae	*Pluvialis squatarola*	Chorlo Gris	Black-bellied Plover	VU
Charadriidae	*Pluvialis dominica*	Chorlo Dorado Americano	American Golden-Plover	EN
Charadriidae	*Charadrius alexandrinus*	Chorlito Niveo	Snowy Plover	CR
Charadriidae	*Charadrius wilsonia*	Chorlito Piquigrueso	Wilson's Plover	EN

Family	Species	Spanish name	English name	Status[1]
Charadriidae	*Charadrius vociferus*	Chorlito Tildío	Killdeer	VU
Haematopodidae	*Haematopus palliatus*	Ostrero Americano	American Oystercatcher	CR
Recurvirostridae	*Himantopus mexicanus*	Cadelero Americano (Policía)	Black-necked Stilt	EN
Recurvirostridae	*Recurvirostra americana*	Avoceta Americana	American Avocet	VU
Scolopacidae	*Tringa solitaria*	Playero Solitario	Solitary Sandpiper	EN
Scolopacidae	*Tringa incana*	Playero Vagabundo	Wandering Tattler	VU
Scolopacidae	*Tringa melanoleuca*	Patamarilla Mayor	Greater Yellowlegs	VU
Scolopacidae	*Tringa semipalmata*	Playero Pihuihui	Willet	VU
Scolopacidae	*Tringa flavipes*	Patamarilla Menor	Lesser Yellowlegs	VU
Scolopacidae	*Bartramia longicauda*	Zarapito Ganga	Upland Sandpiper	EN
Scolopacidae	*Numenius phaeopus*	Zarapito Trinador	Whimbrel	EN
Scolopacidae	*Numenius americanus*	Zarapito Piquilargo	Long-billed Curlew	CR
Scolopacidae	*Limosa fedoa*	Picopando Canelo	Marbled Godwit	EN
Scolopacidae	*Arenaria interpres*	Vuelvepiedras Rojizo	Ruddy Turnstone	EN
Scolopacidae	*Aphriza virgata*	Playero de Marejada	Surfbird	EN
Scolopacidae	*Calidris canutus*	Playero Gordo	Red Knot	EN
Scolopacidae	*Calidris alba*	Playero Blanco	Sanderling	EN
Scolopacidae	*Calidris pusilla*	Playerito Semipalmado	Semipalmated Sandpiper	VU
Scolopacidae	*Calidris mauri*	Playerito Occidental	Western Sandpiper	EN

Family	Species	Spanish name	English name	Status[1]
Scolopacidae	*Calidris minutilla*	Playerito Mínimo	Least Sandpiper	VU
Scolopacidae	*Calidris himantopus*	Playero Zancudo	Stilt Sandpiper	VU
Scolopacidae	*Tryngites subruficollis*	Playerito Pradero	Buff-breasted Sandpiper	CR
Scolopacidae	*Limnodromus griseus*	Costurero Piquicorto	Short-billed Dowitcher	EN
Scolopacidae	*Gallinago delicata*	Agachona de Wilson	Wilson's Snipe	VU
Scolopacidae	*Phalaropus tricolor*	Falarapo de Wilson	Wilson's Phalarope	EN
Scolopacidae	*Phalaropus lobatus*	Falarapo Cuellirojo	Red-necked Phalarope	VU
Scolopacidae	*Phalaropus fulicarius*	Falarapo Piquigrueso	Red Phalarope	VU
Laridae	*Larus pipixcan*	Gaviota de Franklin	Franklin's Gull	VU
Laridae	*Sternula antillarum*	Golondrina-marina Mínima	Least Tern	CR
Laridae	*Gelochelidon nilotica*	Golondrina-marina Piquigruesa	Gull-billed Tern	EN
Laridae	*Chlidonias niger*	Golondrina-marina Negra	Black Tern	VU
Laridae	*Sterna dougallii*	Golondrina-marina Rosada	Roseate Tern	EN
Laridae	*Sterna forsteri*	Golondrina-marina de Forster	Forster's Tern	VU
Laridae	*Thalasseus maximus*	Golondrina-marina Real	Royal Tern	VU
Laridae	*Thalasseus elegans*	Golondrina-marina Elegante	Elegant Tern	VU
Laridae	*Rynchops niger*	Rayador Americano	Black Skimmer	CR
Columbidae	*Columbina minuta*	Tórtola Pechilisa	Plain-breasted Ground-Dove	EN

Family	Species	Spanish name	English name	Status[1]
Columbidae	*Claravis pretiosa*	Tórtola Azul	Blue Ground-Dove	EN
Columbidae	*Geotrygon albifacies*	Paloma-perdiz Cariblanca	White-faced Quail-Dove	VU
Columbidae	*Geotrygon montana*	Paloma-perdiz Rojiza	Ruddy Quail-Dove	VU
Psittacidae	*Aratinga holochlora*	Perico Gorjirrojo	Green Parakeet	EN
Psittacidae	*Aratinga strenua*	Perico Verde Centroamericano	Pacific Parakeet	VU
Psittacidae	*Amazona albifrons*	Loro Frentiblanco	White-fronted Parrot	VU
Psittacidae	*Amazona auropalliata*	Loro Nuquiamarillo	Yellow-naped Parrot	EN
Cuculidae	*Coccyzus minor*	Cuco Manglero	Mangrove Cuckoo	VU
Tytonidae	*Tyto alba*	Lechuza de Campanario	Barn Owl	VU
Strigidae	*Megascops trichopsis*	Tecolote Bigotudo	Whiskered Screech-Owl	EN
Strigidae	*Pulsatrix perspicillata*	Búho de Anteojos	Spectacled Owl	VU
Strigidae	*Bubo virginianus*	Búho Cornudo	Great Horned Owl	EN
Strigidae	*Ciccaba nigrolineata*	Búho Blanquinegro	Black-and-white Owl	CR
Caprimulgidae	*Chordeiles acutipennis*	Chotacabras Menor	Lesser Nighthawk	EN
Nyctibiidae	*Nyctibius jamaicensis*	Bienparado Norteño	Northern Potoo	VU
Apodidae	*Cypseloides niger*	Vencejo Negro	Black Swift	VU
Apodidae	*Aeronautes saxatalis*	Vencejo Gorjiblanco	White-throated Swift	VU
Apodidae	*Panyptila cayennensis*	Vencejo-tijereta Menor	Lesser Swallow-tailed Swift	EN

Family	Species	Spanish name	English name	Status[1]
Trochilidae	*Anthracothorax prevostii*	Mango Pechiverde	Green-breasted Mango	VU
Trochilidae	*Abeillia abeillei*	Colibrí Barbiesmeralda	Emerald-chinned Hummingbird	VU
Trochilidae	*Hylocharis eliciae*	Zafiro Gorjiazul	Blue-throated Goldentail	VU
Trochilidae	*Hylocharis leucotis*	Colibrí Orejiblanco	White-eared Hummingbird	VU
Trochilidae	*Lampornis viridipallens*	Colibrí-serrano Gorjiverde	Green-throated Mountain-gem	VU
Trochilidae	*Lampornis amethystinus*	Colibrí-serrano Gorjiamatisto	Amethyst-throated Hummingbird	VU
Trochilidae	*Eugenes fulgens*	Colibrí Magnífico	Magnificent Hummingbird	VU
Trochilidae	*Doricha enicura*	Tijereta Centroamericana	Slender Sheartail	EN
Trochilidae	*Tilmatura dupontii*	Colibrí Colipinto	Sparkling-tailed Hummingbird	EN
Trochilidae	*Atthis ellioti*	Zumbador Centroamericano	Wine-throated Hummingbird	EN
Trogonidae	*Trogon melanocephalus*	Trogón Cabecinegro	Black-headed Trogon	VU
Momotidae	*Hylomanes momotula*	Momoto Enano	Tody Motmot	CR
Alcedinidae	*Ceryle torquatus*	Martín-pescador Collarejo	Ringed Kingfisher	CR
Alcedinidae	*Chloroceryle aenea*	Martín-pescador Enano	American Pygmy Kingfisher	VU
Ramphastidae	*Aulacorhynchus prasinus*	Tucaneta Verde (Tucán Verde)	Emerald Toucanet	VU
Ramphastidae	*Pteroglossus torquatus*	Tucancillo Collarejo (Pico de Navaja)	Collared Aracari	VU

Family	Species	Spanish name	English name	Status[1]
Picidae	*Veniliornis fumigatus*	Carpintero Café	Smoky-brown Woodpecker	EN
Picidae	*Dryocopus lineatus*	Carpintero Lineado	Lineated Woodpecker	VU
Picidae	*Campephilus guatemalensis*	Carpintero Piquiclaro	Pale-billed Woodpecker	EN
Furnariidae	*Synallaxis erythrothorax*	Guitío Pechirrufo	Rufous-breasted Spinetail	EN
Furnariidae	*Dendrocincla homochroa*	Trepatroncos Rojizo	Ruddy Woodcreeper	CR
Furnariidae	*Sittasomus griseicapillus*	Trepatroncos Olivaceo	Olivaceous Woodcreeper	EN
Furnariidae	*Xiphocolaptes promeropirhynchus*	Trepatroncos Gigante	Strong-billed Woodcreeper	EN
Furnariidae	*Dendrocolaptes sanctithomae*	Trepador Barrado	Northern Barred-Woodcreeper	CR
Furnariidae	*Lepidocolaptes souleyetii*	Trepatroncos Corona-rayada	Streak-headed Woodcreeper	VU
Formicariidae	*Grallaria guatimalensis*	Hormiguero-cholino Escamoso	Scaled Antpitta	EN
Tyrannidae	*Mionectes oleagineus*	Mosquero Vientre-ocre	Ochre-bellied Flycatcher	VU
Tyrannidae	*Zimmerius vilissimus*	Mosquerito Cejiblanco	Paltry Tyrannulet	VU
Tyrannidae	*Oncostoma cinereigulare*	Picocurvo Norteño	Northern Bentbill	VU
Tyrannidae	*Rhynchocyclus brevirostris*	Picoplano de Anteojos	Eye-ringed Flatbill	EN
Tyrannidae	*Platyrinchus cancrominus*	Picochato Rabón	Stub-tailed Spadebill	CR
Tyrannidae	*Contopus cooperi*	Pibí Boreal	Olive-sided Flycatcher	VU
Tyrannidae	*Empidonax traillii*	Mosquero Saucero	Willow Flycatcher	VU
Tyrannidae	*Sayornis nigricans*	Mosquero Negro	Black Phoebe	EN

Family	Species	Spanish name	English name	Status[1]
Tyrannidae	*Attila spadiceus*	Atila Rabadilla-brillante	Bright-rumped Attila	EN
Tyrannidae	*Myiarchus tyrannulus*	Copetón Tirano	Brown-crested Flycatcher	EN
Incertae sedis	*Pachyramphus major*	Cabezón Cuelligris	Gray-collared Becard	VU
Pipridae	*Chiroxiphia linearis*	Saltarín Colilargo (Toledo)	Long-tailed Manakin	VU
Vireonidae	*Vireo pallens*	Vireo Manglero	Mangrove Vireo	VU
Vireonidae	*Vireo bellii*	Vireo de Bell	Bell's Vireo	EN
Vireonidae	*Vireo leucophrys*	Vireo Gorripardo	Brown-capped Vireo	EN
Vireonidae	*Vireolanius pulchellus*	Vireón Esmeraldo	Green Shrike-Vireo	CR
Troglodytidae	*Salpinctes obsoletus*	Saltapared Roquero	Rock Wren	EN
Troglodytidae	*Troglodytes rufociliatus*	Saltapared Cejirrufo	Rufous-browed Wren	VU
Sylviidae	*Ramphocaenus melanurus*	Soterillo Picudo	Long-billed Gnatwren	VU
Turdidae	*Sialia sialis*	Azulejo Gorjicanelo	Eastern Bluebird	VU
Turdidae	*Catharus frantzii*	Zorzalito de Frantzius	Ruddy-capped Nightingale-Thrush	EN
Turdidae	*Hylocichla mustelina*	Zorzalito Maculado	Wood Thrush	VU
Turdidae	*Turdus infuscatus*	Zorzal Negro	Black Robin	VU
Turdidae	*Turdus assimilis*	Zorzal Gorjiblanco	White-throated Robin	VU
Turdidae	*Turdus rufitorques*	Zorzal Cuellirufo	Rufous-collared Robin	EN
Mimidae	*Melanotis hypoleucus*	Mulato Pechiblanco	Blue-and-white Mockingbird	VU

Family	Species	Spanish name	English name	Status[1]
Parulidae	*Vermivora pinus*	Chipe Aliazul	Blue-winged Warbler	VU
Parulidae	*Vermivora chrysoptera*	Chipe Alidorado	Golden-winged Warbler	EN
Parulidae	*Parula superciliosa*	Chipe Cejiblanco	Crescent-chested Warbler	VU
Parulidae	*Dendroica petechia xantholora*	Chipe de Manglar	Mangrove Warbler	VU
Parulidae	*Dendroica chrysoparia*	Chipe Caridorado	Golden-cheeked Warbler	CR
Parulidae	*Dendroica occidentalis*	Chipe Cabeciamarillo	Hermit Warbler	VU
Parulidae	*Dendroica graciae*	Chipe de Grace	Grace's Warbler	EN
Parulidae	*Protonotaria citrea*	Chipe Protonotario	Prothonotary Warbler	VU
Parulidae	*Helmitheros vermivorum*	Chipe Gusanero	Worm-eating Warbler	VU
Parulidae	*Oporornis formosus*	Chipe de Kentucky	Kentucky Warbler	VU
Parulidae	*Geothlypis poliocephala*	Mascarita Piquigruesa	Gray-crowned Yellowthroat	VU
Parulidae	*Wilsonia canadensis*	Chipe Collarejo	Canada Warbler	VU
Parulidae	*Cardellina rubrifrons*	Chipe Carirrojo	Red-faced Warbler	VU
Parulidae	*Myioborus pictus*	Pavito Aliblanco	Painted Redstart	VU
Parulidae	*Basileuterus culicivorus*	Chipe Corona-dorada	Golden-crowned Warbler	EN
Thraupidae	*Habia rubica*	Tángara-hormiguera Coronirroja	Red-crowned Ant-Tanager	EN

Family	Species	Spanish name	English name	Status[1]
Thraupidae	*Piranga bidentata*	Tángara Dorsirrayada	Flame-colored Tanager	VU
Emberizidae	*Amaurospiza concolor*	Semillero Azul	Blue Seedeater	EN
Emberizidae	*Diglossa baritula*	Picaflor Vientre-canelo	Cinnamon-bellied Flowerpiercer	VU
Emberizidae	*Melozone leucotis*	Rascador Orejiblanco	White-eared Ground-Sparrow	VU
Cardinalidae	*Passerina ciris*	Colorín Sietecolores	Painted Bunting	EN
Cardinalidae	*Spiza americana*	Arrocero Americano	Dickcissel	VU
Icteridae	*Icterus wagleri*	Bolsero de Wagler	Black-vented Oriole	EN
Icteridae	*Cacicus melanicterus*	Cacique Mexicano	Yellow-winged Cacique	CR
Fringillidae	*Euphonia hirundinacea*	Eufonia Gorjiamarillo	Yellow-throated Euphonia	VU
Fringillidae	*Euphonia elegantissima*	Eufonia Capucha-azul	Elegant Euphonia	VU
Fringillidae	*Chlorophonia occipitalis*	Clorofonia Coroniazul	Blue-crowned Chlorophonia	VU

[1]CR=Critically Endangered, EN=Endangered, VU=Vulnerable. Source: Komar et al. (2009).

the hand and recorded in the field notes. Each species was documented by digital photographs. Most individuals were released unharmed after capture, although some individuals, generally one or two per species at each site, were collected as voucher specimens and deposited in the scientific collections of the El Salvador Natural History Museum and the Univeristy of Kansas Natural History Museum and Biodiversity Research Center (Lawrence, Kansas, USA). All handling and collecting of birds was carried out with authorization from the Ministry of Environment and Natural Resources.

TABLE 39. TYPES OF AVIAN LOCALITY RECORDS AVAILABLE FOR THE PRESENT ANALYSIS.

Record type	Ahuachapán	Sonsonate	Santa Ana	IMCW Project Area
Prior to Field Study				
Museum specimens	467	876	327	1,670
Photographic records	136	8	271	415
Mist net captures	1,708	1,484	1768	4,960
Observational records	10,470	2,122	2087	14,679
During Field Study				
Museum specimens	126	266	14	406
Mist net captures	667	547	681	1895
Observational records	491	1197	79	1767
Total record count	14,065	6,500	5,227	25,792

Source: SalvaNATURA Flora & Fauna Database.

TABLE 40. SAMPLING EFFORT FOR BIRDS AT EACH STUDY SITE DURING 2007 FIELD WORK.

Site	Observation hours	Mist-netting hours
Santo Domingo de Guzmán	21	0
Plan de Amayo	50	837
Laguna de las Ninfas	15	1,545
Lavas de Izalco/Finca María Auxiliadora	10	1,940
Barra Salada	35	1,536
Los Cóbanos	63	1,933
Laguna de las Ranas	30	567
Bosque Santa Rita	72	2,366
Totals	296	10,724

3. RESULTS AND DISCUSSION

3.1. SPECIES RECORDED

At the start of the study (mid 2007), 412 bird species (75% of the 548 species recorded in the country) were recorded within the IMCW project area, including all of the 74 inventory indicator (test) bird species, as well as 167 conservation important species. In general, the Project area was already well inventoried for birds, with recording localities scattered across all 11 watersheds and 16 of the 25 municipalities (Komar 2007). Contemporaneous with this study, one new species was added to the national bird list, and shortly after the field study, two additional species were discovered for the national list. All three were wandering migratory species that were recorded inside the project area: one was a Magellanic Penguin (*Spheniscus magellanicus*) washed ashore at Barra de Santiago in June 2007 and found by park guards (reported in Jones and Komar 2008); the other was a White-eyed Vireo (*Vireo griseus*) captured at a bird monitoring station in El Imposible National Park in March 2008, by IMCW project workers (Lety Andino, *pers. comm.*). The third was a group of Black-vented Shearwaters (*Puffinus opisthomelas*) found in off-shore waters of Los Cóbanos Protected Natural Area by Ministry of Environment and Natural Resources staff in October 2008 (Ricardo Ibarra, *pers. comm*.). Studies of marine birds off Los Cóbanos have since discovered at least four additional species for the study area (R. Ibarra, pers. comm.).

Although the ornithology team in this study did not detect any new species for El Salvador, they did detect many new species for the project area, and for the Ahuachapán and Sonsonate departments, despite the inventory having already been relatively complete (100% of test species had already been recorded). The proportion of test species recorded serves as a relative indicator, or index, of inventory completeness, but the possibility of finding new, rare species once all of the test species are encountered always exists. The team detected 12 new bird species for the Project Area, bringing the total bird list for the area to 431 species (Table 41), representing 79% of the national list.

Figure 15A.Wine-throated Hummingbird (*Atthis ellioti*), Laguna de Las Ranas. October 2007. By: Carlos Funes.

Figure 15B. Emerald-chinned Hummingbird (*Abeillia abeillei*), Laguna de Las Ranas. October 2007. By: Carlos Funes.

Figure 15C. Great Horned Owl (*Bubo virginianus*), Plan de Amayo. October 2007. By: Carlos Funes.

Figure 15D. Emerald Toucanet (*Aulacorhynchus prasinus*), Laguna de Las Ranas, October 2007. By: Carlos Funes.

Figure 15E. Eggs of the White-collared Swift (*Streptoprocne zonaris*), found in Santo Domingo de Guzmán. July 2007. By: Carlos Funes.

Figure 15F. Scaled Antpitta (*Grallaria guatimalensis*), Laguna de las Ninfas. July 2007. By: Karla Lara.

Figure 15G. Rock Wren (*Salpinctes obsoletus*), an individual captured in the lava field of Volcán de Izalco. August 2007. By: Carlos Funes.

Figure 15H. Tricolored Munia (*Lonchura malacca*), Santa Rita Protected Natural Area. September 2007. By: Carlos Funes.

Figure 15l. Boat-billed Heron (*Cochlearius cochlearius*), Santa Rita Protected Natural Area, September 2007. By: Carlos Funes.

Figure 15J. American Pygmy Kingfisher (*Chloroceryle aenea*) female, Santa Rita Protected Natural Area, September 2007. By: Carlos Funes.

Figure 15K. Rose-throated Becard (*Pachyramphus aglaiae*) female, Santa Rita Protected Natural Area, November 2007. By: Jorge Jiménez.

Figure 15L. Yellow-winged Cacique (*Cacicus melanicterus*), Los Cóbanos, August 2007. By: Carlos Funes.

Figure 15M. Wandering Tattler (*Tringa incana*), Los Cóbanos Protected Natural Area. December 2007. By: Karla Lara.

Figure 15N. Pomarine Jaeger (*Stercorarius pomarinus*), Los Cóbanos Protected Natural Area. December 2007. By: Karla Lara.

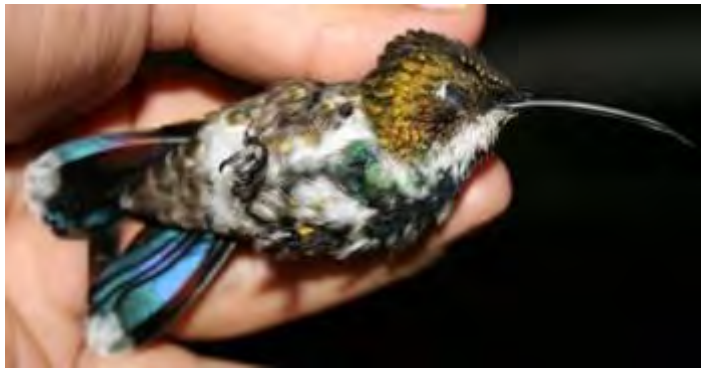

Figure 15O. Green-breasted Mango (*Anthracothorax prevostii*), Los Cóbanos. August 2007. By: Carlos Funes.

Figure 15P. Purple Gallinule (*Porphyrio martinica*), Playa El Zope, Los Cóbanos Protected Natural Area. August 2007. By: Carlos Funes.

FIGURE 15. SELECTED PHOTOGRAPHS OF BIRDS TAKEN DURING THE FIELD STUDY.

TABLE 41. LIST OF 431 BIRD SPECIES RECORDED IN THE PROJECT AREA (order follows AOU Checklist, www.aou.org).

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Crypturellus cinnamomeus	Tinamú Canelo	Thicket Tinamou	Resident	Forest Generalist	Lowlands
Dendrocygna autumnalis	Pijiji Aliblanco (Pishishe)	Black-bellied Whistling-Duck	Resident	Wetlands Specialist	Lowlands
Cairina moschata	Pato Real	Muscovy Duck	Resident	Wetlands Specialist	Lowlands
Anas americana	Pato Chalcuan	American Wigeon	Visitor	Wetlands Specialist	Lowlands
Anas platyrhynchos	Cerceta Cuello Negro	Mallard	Migratory Vagrant	Wetlands Specialist	Lowlands
Anas discors	Cerceta Aliazul, Pajarilla	Blue-winged Teal	Visitor	Wetlands Specialist	Lowlands
Anas clypeata	Pato Cucharón Norteño	Northern Shoveler	Visitor	Wetlands Specialist	Lowlands
Oxyura jamaicensis	Pato Tepalcate	Ruddy Duck	Status Uncertain	Wetlands Specialist	Lowlands
Ortalis leucogastra	Chachalaca Vientre-blanco	White-bellied Chachalaca	Resident	Forest Generalist	Lowlands
Penelope purpurascens	Pavo Cojolito	Crested Guan	Resident	Forest Specialist	Lowlands
Penelopina nigra	Pajuil (Pava Negra)	Highland Guan	Resident	Forest Specialist	Highlands
Crax rubra	Hocofaisán (Pajuil)	Great Curassow	Resident	Forest Specialist	Lowlands
Dendrortyx leucophrys	Gallina-de-monte Centroamericana	Buffy-crowned Wood-Partridge	Resident	Forest Generalist	Highlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Colinus cristatus	Codorniz-cotui Centroamericana	Crested Bobwhite	Resident	Open Area Generalist	Lowlands
Dactylortyx thoracicus	Codorniz Silbadora	Singing Quail	Resident	Forest Generalist	Highlands
Tachybaptus dominicus	Zambullidor Menor	Least Grebe	Resident	Wetlands Specialist	Lowlands
Podilymbus podiceps	Zambullidor Piquipinto	Pied-billed Grebe	Resident and migratory	Wetlands Specialist	Lowlands
Spheniscus magellanicus	Pingüino de Magellanes	Magellanic Penguin	Migratory Vagrant	Marine Waters	Lowlands
Puffinus pacificus	Pardela Colicuña	Wedge-tailed Shearwater	Visitor	Marine Waters	Lowlands
Puffinus opisthomelas	Pardela Mexicana	Black-vented Shearwater	Visitor	Marine Waters	Lowlands
Puffinus lherminieri	Pardela de Audubón	Audubon's Shearwater	Visitor	Marine Waters	Lowlands
Phaethon aethereus	Rabijunco Piquirrojo	Red-billed Tropicbird	Non-migratory Vagrant	Marine Waters	Lowlands
Sula granti	Bobo Enmascarado de Grant	Nazca Booby	Visitor	Marine Waters	Lowlands
Sula nebouxii	Bobo Patiazul	Blue-footed Booby	Visitor	Marine Waters	Lowlands
Sula leucogaster	Bobo Vientre-blanco	Brown Booby	Visitor	Marine Waters	Lowlands
Pelecanus erythrorhynchos	Pelicano Blanco Americano	American White Pelican	Visitor	Wetlands Specialist	Lowlands
Pelecanus occidentalis	Pelicano Café	Brown Pelican	Visitor	Wetlands Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Phalacrocorax brasilianus	Cormorán Neotropical	Neotropic Cormorant	Resident	Wetlands Specialist	Lowlands
Anhinga anhinga	Pato Aguja	Anhinga	Resident	Wetlands Specialist	Lowlands
Fregata magnificens	Fragata	Magnificent Frigatebird	Visitor	Wetlands Specialist	Lowlands
Ixobrychus exilis	Avetorito Americano	Least Bittern	Resident	Wetlands Specialist	Lowlands
Tigrisoma mexicanum	Garza Tigre Gorjinuda	Bare-throated Tiger-Heron	Resident	Wetlands Specialist	Lowlands
Ardea herodias	Garzon Cenizo	Great Blue Heron	Visitor	Wetlands Specialist	Lowlands
Ardea alba	Garza Grande	Great Egret	Resident and migratory	Wetlands Specialist	Lowlands
Egretta thula	Garza Nivea	Snowy Egret	Resident and migratory	Wetlands Specialist	Lowlands
Egretta caerulea	Garza Azul	Little Blue Heron	Visitor	Wetlands Specialist	Lowlands
Egretta tricolor	Garza Tricolor	Tricolored Heron	Resident and migratory	Wetlands Specialist	Lowlands
Egretta rufescens	Garza Rojiza	Reddish Egret	Visitor	Wetlands Specialist	Lowlands
Bubulcus ibis	Garza Ganadera (Garrapatera)	Cattle Egret	Resident	Wetlands Specialist	Lowlands
Butorides virescens	Garza Verde	Green Heron	Resident and migratory	Wetlands Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Nycticorax nycticorax	Garza-nocturna Coroninegra	Black-crowned Night-Heron	Resident	Wetlands Specialist	Lowlands
Nyctanassa violacea	Garza-nocturna Coroniclara	Yellow-crowned Night-Heron	Visitor	Wetlands Specialist	Lowlands
Cochlearius cochlearius	Garza Cucharón	Boat-billed Heron	Resident	Wetlands Specialist	Lowlands
Eudocimus albus	Ibis Blanco	White Ibis	Resident	Wetlands Specialist	Lowlands
Platalea ajaja	Espátula Rosada	Roseate Spoonbill	Resident	Wetlands Specialist	Lowlands
Mycteria americana	Cigueña Americana (Pulido)	Wood Stork	Resident and migratory	Wetlands Specialist	Lowlands
Coragyps atratus	Zopilote Negro	Black Vulture	Resident and migratory	Open Area Generalist	Altitude Generalist
Cathartes aura	Aura Cabecirroja	Turkey Vulture	Resident and migratory	Open Area Generalist	Altitude Generalist
Cathartes burrovianus	Aura Sabanera	Lesser Yellow-headed Vulture	Non-migratory Vagrant	Open Area Specialist	Lowlands
Sarcoramphus papa	Zopilote Rey (Rey Zope)	King Vulture	Resident	Forest Generalist	Altitude Generalist
Pandion haliaetus	Gavilán Pescador	Osprey	Visitor	Wetlands Specialist	Lowlands
Leptodon cayanensis	Milano Cabecigris	Gray-headed Kite	Resident	Forest Specialist	Lowlands
Chondrohierax uncinatus	Milano Piquiganchudo	Hook-billed Kite	Visitor	Forest Generalist	Altitude Generalist

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Elanoides forficatus	Milano Tijereta	Swallow-tailed Kite	Transient	Forest Generalist	Altitude Generalist
Elanus leucurus	Milano Coliblanco	White-tailed Kite	Resident	Open Area Generalist	Lowlands
Rostrhamus sociabilis	Milano Caracolero	Snail Kite	Status Uncertain	Wetlands Specialist	Lowlands
Harpagus bidentatus	Milano Bidentado	Double-toothed Kite	Non-migratory Vagrant	Forest Generalist	Altitude Generalist
Ictinia mississippiensis	Milano de Misisipi	Mississippi Kite	Transient	Forest Generalist	Altitude Generalist
Ictinia plumbea	Milano Plomizo	Plumbeous Kite	Breeding Visitor	Forest Specialist	Lowlands
Busarellus nigricollis	Aguililla Canela	Black-collared Hawk	Extinct (Locally)	Forest Specialist	Lowlands
Circus cyaneus	Gavilán Rastrero	Northern Harrier	Visitor	Open Area Generalist	Lowlands
Accipiter striatus	Gavilán Pajarero	Sharp-shinned Hawk	Visitor	Forest Generalist	Altitude Generalist
Accipiter cooperi	Gavilán de Cooper	Cooper's Hawk	Visitor	Forest Generalist	Altitude Generalist
Geranospiza caerulescens	Gavilán Zancudo	Crane Hawk	Resident	Forest Generalist	Lowlands
Leucopternis albicollis	Aguililla Blanca	White Hawk	Resident	Forest Specialist	Lowlands
Buteogallus anthracinus	Aguililla Negra Menor	Common Black-Hawk	Resident	Forest Generalist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Buteogallus urubitinga	Aguililla Negra Mayor	Great Black-Hawk	Resident	Forest Generalist	Lowlands
Parabuteo unicinctus	Aguililla de Harris	Harris's Hawk	Resident	Open Area Specialist	Lowlands
Buteo magnirostris	Aguililla Caminera	Roadside Hawk	Resident	Open Area Generalist	Lowlands
Buteo platypterus	Aguililla Aluda	Broad-winged Hawk	Visitor	Forest Generalist	Highlands
Buteo nitidus	Aguililla Gris	Gray Hawk	Resident	Forest Generalist	Lowlands
Buteo brachyurus	Aguililla Colicorta	Short-tailed Hawk	Resident and migratory	Forest Generalist	Altitude Generalist
Buteo swainsoni	Aguililla de Swainson	Swainson's Hawk	Transient	Open Area Generalist	Lowlands
Buteo albicaudatus	Aguililla Coliblanca	White-tailed Hawk	Resident	Open Area Generalist	Lowlands
Buteo albonotatus	Aguililla Aura	Zone-tailed Hawk	Resident and migratory	Open Area Generalist	Lowlands
Buteo jamaicensis	Aguililla Colirroja	Red-tailed Hawk	Resident and migratory	Forest Generalist	Highlands
Spizaetus tyrannus	Águila Tirana (Águila Crestada Negra)	Black Hawk-Eagle	Resident	Forest Generalist	Altitude Generalist
Spizaetus ornatus	Águila Elegante	Ornate Hawk-Eagle	Extinct (Locally)	Forest Specialist	Lowlands
Micrastur ruficollis	Halcón-selvático Barrado	Barred Forest-Falcon	Resident	Forest Generalist	Altitude Generalist
Micrastur semitorquatus	Halcón-selvático Barrado	Collared Forest-Falcon	Resident	Forest Generalist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Caracara cheriway	Caracara Común (Querque)	Crested Caracara	Resident	Open Area Generalist	Lowlands
Herpetotheres cachinnans	Halcón Guaco (Guas)	Laughing Falcon	Resident	Forest Generalist	Lowlands
Falco sparverius	Cernícalo Américano	American Kestrel	Resident and migratory	Open Area Specialist	Altitude Generalist
Falco columbarius	Esmerejón	Merlin	Visitor	Open Area Generalist	Lowlands
Falco rufigularis	Halcón Murcielaguero	Bat Falcon	Resident	Open Area Generalist	Lowlands
Falco peregrinus	Halcón Peregrino	Peregrine Falcon	Visitor	Open Area Generalist	Lowlands
Aramides axillaris	Rascón Cuellirrufo	Rufous-necked Wood-Rail	Resident	Forest Specialist	Altitude Generalist
Aramides cajanea	Rascón Cuelligris	Gray-necked Wood-Rail	Resident	Wetlands Specialist	Altitude Generalist
Porzana carolina	Polluela Sora	Sora	Visitor	Wetlands Specialist	Lowlands
Porphyrio martinica	Gallineta Morada	Purple Gallinule	Resident	Wetlands Specialist	Lowlands
Gallinula chloropus	Gallineta Común	Common Moorhen	Resident and migratory	Wetlands Specialist	Lowlands
Fulica americana	Gallareta Americana	American Coot	Resident and migratory	Wetlands Specialist	Altitude Generalist

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Heliornis fulica	Pájaro-cantil	Sungrebe	Non-migratory Vagrant	Wetlands Specialist	Lowlands
Aramus guarauna	Carao (Garza Caracolera)	Limpkin	Resident	Wetlands Specialist	Lowlands
Burhinus bistriatus	Alcaraván Americana	Double-striped Thick-knee	Resident	Open Area Specialist	Lowlands
Pluvialis squatarola	Chorlo Gris	Black-bellied Plover	Visitor	Wetlands Specialist	Lowlands
Pluvialis dominica	Chorlo Dorado Americano	American Golden-Plover	Transient	Wetlands Specialist	Lowlands
Charadrius collaris	Chorlito Collarejo	Collared Plover	Visitor	Wetlands Specialist	Lowlands
Charadrius alexandrinus	Chorlito Niveo	Snowy Plover	Visitor	Wetlands Specialist	Lowlands
Charadrius wilsonia	Chorlito Piquigrueso	Wilson's Plover	Resident and migratory	Wetlands Specialist	Lowlands
Charadrius semipalmatus	Chorlo Semipalmado	Semipalmated Plover	Visitor	Wetlands Specialist	Lowlands
Charadrius vociferus	Chorlito Tildío	Killdeer	Visitor	Wetlands Specialist	Lowlands
Haematopus palliatus	Ostrero Americano	American Oystercatcher	Resident	Wetlands Specialist	Lowlands
Himantopus mexicanus	Cadelero Americano (Policía)	Black-necked Stilt	Resident	Wetlands Specialist	Lowlands
Jacana spinosa	Jacana Mesoamericana	Northern Jacana	Resident	Wetlands Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Actitis macularius	Playero Alzacolita (Alzaculito)	Spotted Sandpiper	Visitor	Wetlands Specialist	Lowlands
Tringa solitaria	Playero Solitario	Solitary Sandpiper	Visitor	Wetlands Specialist	Lowlands
Tringa incana	Playero Vagabundo	Wandering Tattler	Visitor	Wetlands Specialist	Lowlands
Tringa melanoleuca	Patamarilla Mayor	Greater Yellowlegs	Visitor	Wetlands Specialist	Lowlands
Tringa semipalmata	Playero Pihuihui	Willet	Visitor	Wetlands Specialist	Lowlands
Tringa flavipes	Patamarilla Menor	Lesser Yellowlegs	Visitor	Wetlands Specialist	Lowlands
Bartramia longicauda	Zarapito Ganga	Upland Sandpiper	Transient	Open Area Specialist	Lowlands
Numenius phaeopus	Zarapito Trinador	Whimbrel	Visitor	Wetlands Specialist	Lowlands
Numenius americanus	Zarapito Piquilargo	Long-billed Curlew	Visitor	Wetlands Specialist	Lowlands
Limosa fedoa	Picopando Canelo	Marbled Godwit	Visitor	Wetlands Specialist	Lowlands
Arenaria interpres	Vuelvepiedras Rojizo	Ruddy Turnstone	Visitor	Wetlands Specialist	Lowlands
Aphriza virgata	Playero de Marejada	Surfbird	Transient	Wetlands Specialist	Lowlands
Calidris canutus	Playero Gordo	Red Knot	Visitor	Wetlands Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Calidris alba	Playero Blanco	Sanderling	Visitor	Wetlands Specialist	Lowlands
Calidris pusilla	Playerito Semipalmado	Semipalmated Sandpiper	Visitor	Wetlands Specialist	Lowlands
Calidris mauri	Playerito Occidental	Western Sandpiper	Visitor	Wetlands Specialist	Lowlands
Calidris minutilla	Playerito Mínimo	Least Sandpiper	Visitor	Wetlands Specialist	Lowlands
Calidris melanotos	Playero Pectoral	Pectoral Sandpiper	Transient	Wetlands Specialist	Lowlands
Calidris himantopus	Playero Zancudo	Stilt Sandpiper	Transient	Wetlands Specialist	Lowlands
Limnodromus griseus	Costurero Piquicorto	Short-billed Dowitcher	Visitor	Wetlands Specialist	Lowlands
Gallinago delicata	Agachona de Wilson	Wilson's Snipe	Visitor	Wetlands Specialist	Lowlands
Phalaropus lobatus	Falarapo Cuellirojo	Red-necked Phalarope	Visitor	Marine Waters	Lowlands
Phalaropus fulicarius	Falarapo Piquigrueso	Red Phalarope	Migratory Vagrant	Marine Waters	Lowlands
Leucophaeus atricilla	Gaviota Reidora	Laughing Gull	Visitor	Wetlands Specialist	Lowlands
Leucophaeus pipixcan	Gaviota de Franklin	Franklin's Gull	Transient	Wetlands Specialist	Lowlands
Larus delawarensis	Gaviota Piquianillada	Ring-billed Gull	Migratory Vagrant	Wetlands Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Chlidonias niger	Golondrina-marina Negra	Black Tern	Transient	Wetlands Specialist	Lowlands
Sterna dougallii	Golondrina-marina Rosada	Roseate Tern	Migratory Vagrant	Marine Waters	Lowlands
Sterna hirundo	Golondrina-marina Común	Common Tern	Visitor	Wetlands Specialist	Lowlands
Thalasseus maximus	Golondrina-marina Real	Royal Tern	Visitor	Wetlands Specialist	Lowlands
Thalasseus sandvicensis	Golondrina-marina de Sandwich	Sandwich Tern	Visitor	Marine Waters	Lowlands
Thalasseus elegans	Golondrina-marina Elegante	Elegant Tern	Transient	Marine Waters	Lowlands
Rynchops niger	Rayador Americano	Black Skimmer	Resident and migratory	Wetlands Specialist	Lowlands
Stercorarius pomarinus	Salteador Pomarino	Pomarine Jaeger	Transient	Marine Waters	Lowlands
Columba livia	Paloma Doméstica (Paloma de Castillo)	Rock Pigeon	Resident	Open Area Generalist	Altitude Generalist
Patagioenas flavirostris	Paloma Morada	Red-billed Pigeon	Resident	Forest Generalist	Altitude Generalist
Patagioenas fasciata	Paloma Encinera	Band-tailed Pigeon	Resident	Forest Specialist	Highlands
Zenaida asiatica	Paloma Aliblanca	White-winged Dove	Resident and migratory	Open Area Generalist	Altitude Generalist
Zenaida macroura	Paloma Huilota	Mourning Dove	Visitor	Open Area Generalist	Lowlands
Columbina inca	Tórtola Colilarga	Inca Dove	Resident	Open Area Generalist	Lowlands
Columbina passerina	Tórtola Común	Common Ground-Dove	Resident	Open Area Specialist	Lowlands
Columbina minuta	Tórtola Pechilisa	Plain-breasted Ground-Dove	Resident	Open Area Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Columbina talpacoti	Tortolita Rojiza	Ruddy Ground-Dove	Resident	Open Area Generalist	Lowlands
Claravis pretiosa	Tórtola Azul	Blue Ground-Dove	Resident	Forest Specialist	Lowlands
Leptotila verreauxi	Paloma Arroyera (Rodadora)	White-tipped Dove	Resident	Forest Generalist	Lowlands
Geotrygon albifacies	Paloma-perdiz Cariblanca	White-faced Quail-Dove	Resident	Forest Generalist	Highlands
Geotrygon montana	Paloma-perdiz Rojiza	Ruddy Quail-Dove	Resident	Forest Generalist	Lowlands
Aratinga holochlora	Perico Gorjirrojo	Green Parakeet	Status Uncertain	Forest Specialist	Altitude Generalist
Aratinga strenua	Perico Verde Centroamericano	Pacific Parakeet	Resident	Forest Generalist	Altitude Generalist
Aratinga canicularis	Perico Frentinaranja	Orange-fronted Parakeet	Resident	Forest Generalist	Altitude Generalist
Brotogeris jugularis	Periquito Barbinaranja	Orange-chinned Parakeet	Resident	Forest Generalist	Lowlands
Amazona albifrons	Loro Frentiblanco	White-fronted Parrot	Resident	Forest Generalist	Lowlands
Amazona auropalliata	Loro Nuquiamarillo	Yellow-naped Parrot	Resident	Forest Generalist	Lowlands
Piaya cayana	Chocolatero, Piscoy	Squirrel Cuckoo	Resident	Forest Generalist	Lowlands
Coccyzus americanus	Cuco Piquiamarillo	Yellow-billed Cuckoo	Transient	Forest Generalist	Lowlands
Coccyzus minor	Cuco Manglero	Mangrove Cuckoo	Resident and migratory	Forest Generalist	Altitude Generalist
Tapera naevia	Cuco Rayado	Striped Cuckoo	Resident	Forest Generalist	Lowlands
Morococcyx erythropygus	Cuco-terrestre Menor	Lesser Ground-Cuckoo	Resident	Forest Generalist	Lowlands
Geococcyx velox	Correcaminos Menor	Lesser Roadrunner	Resident	Open Area Generalist	Highlands
Crotophaga sulcirostris	Pijuyo	Groove-billed Ani	Resident	Open Area Generalist	Altitude Generalist
Tyto alba	Lechuza de Campanario	Barn Owl	Resident	Open Area Generalist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Megascops cooperi	Tecolote de Cooper	Pacific Screech-Owl	Resident	Forest Generalist	Lowlands
Megascops trichopsis	Tecolote Bigotudo	Whiskered Screech-Owl	Resident	Forest Specialist	Highlands
Pulsatrix perspicillata	Búho de Anteojos	Spectacled Owl	Resident	Forest Specialist	Lowlands
Bubo virginianus	Búho Cornudo	Great Horned Owl	Resident	Forest Generalist	Altitude Generalist
Glaucidium brasilianum	Tecolotito Común (Aurorita)	Ferruginous Pygmy-Owl	Resident	Forest Generalist	Lowlands
Ciccaba virgata	Búho Café	Mottled Owl	Resident	Forest Generalist	Altitude Generalist
Ciccaba nigrolineata	Búho Blanquinegro	Black-and-white Owl	Resident	Forest Specialist	Lowlands
Pseudoscops clamator	Búho-cornudo Cariblanco	Striped Owl	Resident	Open Area Specialist	Lowlands
Chordeiles acutipennis	Chotacabras Menor	Lesser Nighthawk	Resident and migratory	Open Area Specialist	Lowlands
Nyctidromus albicollis	Tapacaminos Pucuyo (Caballero)	Common Pauraque	Resident	Open Area Generalist	Lowlands
Caprimulgus carolinensis	Tapacaminos Carolinense	Chuck-will's-widow	Transient	Forest Generalist	Lowlands
Caprimulgus vociferus	Tapacaminos Cuerprihuio	Whip-poor-will	Resident and migratory	Forest Generalist	Altitude Generalist
Nyctibius jamaicensis	Bienparado Norteño	Northern Potoo	Resident	Forest Generalist	Lowlands
Cypseloides niger	Vencejo Negro	Black Swift	Status Uncertain	Open Area Generalist	Highlands
Streptoprocne rutila	Vencejo Cuellicastaño	Chestnut-collared Swift	Resident	Open Area Generalist	Altitude Generalist
Streptoprocne zonaris	Vencejo Cuelliblanco	White-collared Swift	Resident	Open Area Generalist	Lowlands
Chaetura vauxi	Vencejo de Vaux	Vaux's Swift	Resident	Open Area Generalist	Altitude Generalist

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Aeronautes saxatalis	Vencejo Gorjiblanco	White-throated Swift	Visitor	Open Area Generalist	Highlands
Panyptila cayennensis	Vencejo-tijereta Menor	Lesser Swallow-tailed Swift	Resident	Open Area Generalist	Lowlands
Panyptila sanctihieronymi	Vencejo-tijereta Mayor	Great Swallow-tailed Swift	Resident	Open Area Generalist	Highlands
Campylopterus rufus	Fandanguero Rufo	Rufous Sabrewing	Resident	Forest Specialist	Highlands
Campylopterus hemileucurus	Fandanguero Morado	Violet Sabrewing	Resident	Forest Generalist	Altitude Generalist
Florisuga mellivora	Jacobino Nuquiblanco	White-necked Jacobin	Non-migratory Vagrant	Forest Generalist	Lowlands
Colibri thalassinus	Orejavioleta Verde	Green Violetear	Resident	Open Area Specialist	Highlands
Anthracothorax prevostii	Mango Pechiverde	Green-breasted Mango	Resident and migratory	Forest Generalist	Lowlands
Abeillia abeillei	Colibrí Barbiesmeralda	Emerald-chinned Hummingbird	Resident	Forest Specialist	Highlands
Chlorostilbon canivetii	Esmeralda de Canivet	Canivet's Emerald	Resident	Forest Generalist	Lowlands
Hylocharis eliciae	Zafiro Gorjiazul	Blue-throated Goldentail	Resident	Forest Specialist	Lowlands
Amazilia beryllina	Colibrí de Berilo	Berylline Hummingbird	Resident	Forest Generalist	Lowlands
Amazilia rutila	Colibrí Canelo	Cinnamon Hummingbird	Resident	Open Area Generalist	Lowlands
Lampornis viridipallens	Colibrí-serrano Gorjiverde	Green-throated Mountain-gem	Resident	Forest Generalist	Highlands
Lampornis amethystinus	Colibrí-serrano Gorjiamatisto	Amethyst-throated Hummingbird	Resident	Forest Generalist	Highlands
Eugenes fulgens	Colibrí Magnífico	Magnificent Hummingbird	Resident	Open Area Specialist	Highlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Heliomaster longirostris	Picolargo Coroniazul	Long-billed Starthroat	Resident	Forest Generalist	Lowlands
Heliomaster constantii	Picolargo Coronioscuro	Plain-capped Starthroat	Resident	Open Area Generalist	Lowlands
Doricha enicura	Tijereta Centroamericana	Slender Sheartail	Status Uncertain	Open Area Specialist	Highlands
Tilmatura dupontii	Colibrí Colipinto	Sparkling-tailed Hummingbird	Status Uncertain	Open Area Specialist	Highlands
Archilochus colubris	Colibrí Gorjirrubi	Ruby-throated Hummingbird	Visitor	Forest Generalist	Altitude Generalist
Atthis ellioti	Zumbador Centroamericano	Wine-throated Hummingbird	Resident	Open Area Specialist	Highlands
Selasphorus platycercus	Zumbador Coliancho	Broad-tailed Hummingbird	Non-migratory Vagrant	Open Area Generalist	Highlands
Trogon melanocephalus	Trogón Cabecinegro	Black-headed Trogon	Resident	Forest Generalist	Lowlands
Trogon violaceus	Trogón Violaceo (Coa Pechiamarilla)	Violaceous Trogon	Resident	Forest Generalist	Lowlands
Trogon elegans	Trogón Elegante (Coa Pechiroja)	Elegant Trogon	Resident	Forest Generalist	Lowlands
Hylomanes momotula	Momoto Enano	Tody Motmot	Resident	Forest Specialist	Lowlands
Momotus momota	Momoto Coroniazul (Talapo)	Blue-crowned Motmot	Resident	Forest Generalist	Altitude Generalist
Eumomota superciliosa	Momoto Cejiturqueza (Torogoz)	Turquoise-browed Motmot	Resident	Open Area Generalist	Lowlands
Megaceryle torquata	Martín-pescador Collarejo	Ringed Kingfisher	Resident	Wetlands Specialist	Lowlands
Megaceryle alcyon	Martín-pescador Norteño	Belted Kingfisher	Visitor	Wetlands Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Chloroceryle amazona	Martín-pescador Amazona	Amazon Kingfisher	Resident	Wetlands Specialist	Lowlands
Chloroceryle americana	Martín-pescador Verde	Green Kingfisher	Resident	Wetlands Specialist	Lowlands
Chloroceryle aenea	Martín-pescador Enano	American Pygmy Kingfisher	Resident	Forest Generalist	Lowlands
Notharchus macrorhynchos	Buco Collarejo	White-necked Puffbird	Status Uncertain	Forest Specialist	Lowlands
Aulacorhynchus prasinus	Tucaneta Verde (Tucán Verde)	Emerald Toucanet	Resident	Forest Generalist	Highlands
Pteroglossus torquatus	Tucancillo Collarejo (Pico de Navaja)	Collared Aracari	Resident	Forest Generalist	Lowlands
Melanerpes formicivorus	Carpintero Arlequín	Acorn Woodpecker	Resident	Forest Specialist	Highlands
Melanerpes aurifrons	Carpintero Frentidorado	Golden-fronted Woodpecker	Resident	Forest Generalist	Altitude Generalist
Sphyrapicus varius	Chupasavia Vientre-amarillo	Yellow-bellied Sapsucker	Visitor	Forest Generalist	Altitude Generalist
Veniliornis fumigatus	Carpintero Café	Smoky-brown Woodpecker	Resident	Forest Specialist	Lowlands
Colaptes rubiginosus	Carpintero Olivaceo	Golden-olive Woodpecker	Resident	Forest Generalist	Altitude Generalist
Dryocopus lineatus	Carpintero Lineado	Lineated Woodpecker	Resident	Forest Generalist	Altitude Generalist
Campephilus guatemalensis	Carpintero Piquiclaro	Pale-billed Woodpecker	Resident	Forest Specialist	Lowlands
Synallaxis erythrothorax	Guitío Pechirrufo	Rufous-breasted Spinetail	Resident	Open Area Specialist	Lowlands
Dendrocincla homochroa	Trepatroncos Rojizo	Ruddy Woodcreeper	Resident	Forest Specialist	Lowlands
Sittasomus griseicapillus	Trepatroncos Olivaceo	Olivaceous Woodcreeper	Resident	Forest Generalist	Lowlands
Glyphorynchus spirurus	Trepatroncos Piquicuna	Wedge-billed Woodcreeper	Non-migratory Vagrant	Forest Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Xiphocolaptes promeropirhynchus	Trepatroncos Gigante	Strong-billed Woodcreeper	Resident	Forest Specialist	Highlands
Dendrocolaptes sanctithomae	Trepatroncos Barrado	Northern Barred-Woodcreeper	Resident	Forest Specialist	Lowlands
Xiphorhynchus flavigaster	Trepatroncos Piquiclaro	Ivory-billed Woodcreeper	Resident	Forest Generalist	Lowlands
Lepidocolaptes souleyetii	Trepatroncos Corona-rayada	Streak-headed Woodcreeper	Resident	Forest Generalist	Lowlands
Lepidocolaptes affinis	Trepatroncos Corona-punteada	Spot-crowned Woodcreeper	Resident	Forest Generalist	Highlands
Thamnophilus doliatus	Batará Barrada	Barred Antshrike	Resident	Forest Generalist	Altitude Generalist
Grallaria guatimalensis	Hormiguero-cholino Escamoso	Scaled Antpitta	Resident	Forest Generalist	Highlands
Camptostoma imberbe	Mosquerito Lampiño Norteño	Northern Beardless-Tyrannulet	Resident	Forest Specialist	Lowlands
Myiopagis viridicata	Elenia Verdosa	Greenish Elaenia	Resident	Forest Generalist	Lowlands
Elaenia flavogaster	Mosquero Elenia Ventriamarillo	Yellow-bellied Elaenia	Resident	Open Area Generalist	Lowlands
Elaenia frantzii	Elenia Serrana	Mountain Elaenia	Resident	Forest Generalist	Highlands
Mionectes oleagineus	Mosquero Vientre-ocre	Ochre-bellied Flycatcher	Resident	Forest Generalist	Lowlands
Zimmerius vilissimus	Mosquerito Cejiblanco	Paltry Tyrannulet	Resident	Forest Generalist	Altitude Generalist
Oncostoma cinereigulare	Picocurvo Norteño	Northern Bentbill	Resident	Forest Specialist	Lowlands
Todirostrum cinereum	Espatulilla Común	Common Tody-Flycatcher	Resident	Forest Specialist	Lowlands
Rhynchocyclus brevirostris	Picoplano de Anteojos	Eye-ringed Flatbill	Resident	Forest Specialist	Altitude Generalist
Tolmomyias sulphurescens	Picoplano Ojiblanco	Yellow-olive Flycatcher	Resident	Forest Generalist	Lowlands
Platyrinchus cancrominus	Picochato Rabón	Stub-tailed Spadebill	Resident	Forest Specialist	Lowlands
Onychorhynchus coronatus	Mosquero Real	Royal Flycatcher	Status Uncertain	Forest Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Contopus cooperi	Pibí Boreal	Olive-sided Flycatcher	Transient	Forest Generalist	Altitude Generalist
Contopus sordidulus	Pibí Occidental	Western Wood-Pewee	Transient	Forest Generalist	Altitude Generalist
Contopus virens	Pibí Oriental	Eastern Wood-Pewee	Transient	Forest Generalist	Lowlands
Contopus cinereus	Pibí Tropical	Tropical Pewee	Resident and migratory	Forest Generalist	Lowlands
Empidonax flaviventris	Mosquero Vientre-amarillo	Yellow-bellied Flycatcher	Visitor	Forest Generalist	Lowlands
Empidonax alnorum	Mosquero Ailero	Alder Flycatcher	Transient	Forest Generalist	Altitude Generalist
Empidonax traillii	Mosquero Saucero	Willow Flycatcher	Visitor	Open Area Generalist	Lowlands
Empidonax albigularis	Mosquero Gorjiblanco	White-throated Flycatcher	Status Uncertain	Open Area Specialist	Highlands
Empidonax minimus	Mosquero Mínimo	Least Flycatcher	Visitor	Forest Generalist	Lowlands
Empidonax hammondii	Mosquero de Hammond	Hammond's Flycatcher	Visitor	Forest Specialist	Highlands
Empidonax flavescens	Mosquero Amarillento	Yellowish Flycatcher	Resident	Forest Generalist	Highlands
Empidonax fulvifrons	Mosquero Pechicanelo	Buff-breasted Flycatcher	Resident	Forest Specialist	Highlands
Sayornis nigricans	Mosquero Negro	Black Phoebe	Resident	Especialista ríos	Lowlands
Attila spadiceus	Atila Rabadilla-brillante	Bright-rumped Attila	Resident	Forest Generalist	Lowlands
Myiarchus tuberculifer	Copetón Triste	Dusky-capped Flycatcher	Resident	Forest Generalist	Altitude Generalist
Myiarchus nuttingi	Copetón de Nutting	Nutting's Flycatcher	Resident	Open Area Generalist	Lowlands
Myiarchus crinitus	Copetón Viajero	Great Crested Flycatcher	Visitor	Forest Generalist	Lowlands
Myiarchus tyrannulus	Copetón Tirano	Brown-crested Flycatcher	Resident and migratory	Forest Specialist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Pitangus sulphuratus	Luis Grande (Cristo Fue)	Great Kiskadee	Resident	Open Area Generalist	Lowlands
Megarynchus pitangua	Luis Piquigrueso	Boat-billed Flycatcher	Resident	Forest Generalist	Altitude Generalist
Myiozetetes similis	Luis Gregario (Chio)	Social Flycatcher	Resident	Forest Generalist	Lowlands
Myiodynastes luteiventris	Papamoscas Vientre-amarillo	Sulphur-bellied Flycatcher	Breeding Visitor	Forest Generalist	Lowlands
Tyrannus melancholicus	Tirano Tropical	Tropical Kingbird	Resident	Open Area Generalist	Lowlands
Tyrannus verticalis	Tirano Occidental	Western Kingbird	Visitor	Open Area Generalist	Lowlands
Tyrannus tyrannus	Tirano Viajero	Eastern Kingbird	Transient	Open Area Generalist	Altitude Generalist
Tyrannus forficatus	Tirano-tijereta Rosado	Scissor-tailed Flycatcher	Visitor	Open Area Generalist	Lowlands
Pachyramphus major	Cabezón Cuelligris	Gray-collared Becard	Resident	Forest Specialist	Highlands
Pachyramphus aglaiae	Cabezón Degollado	Rose-throated Becard	Resident	Forest Generalist	Lowlands
Tityra semifasciata	Titira Enmascarada (Torreja)	Masked Tityra	Resident	Forest Generalist	Altitude Generalist
Chiroxiphia linearis	Saltarín Colilargo (Toledo)	Long-tailed Manakin	Resident	Forest Specialist	Lowlands
Pipra mentalis	Saltarín Cabecirrojo	Red-capped Manakin	Non-migratory Vagrant	Forest Generalist	Lowlands
Vireo griseus	Vireo Ojoblanco	White-eyed Vireo	Migratory Vagrant	Forest Generalist	Lowlands
Vireo pallens	Vireo Manglero	Mangrove Vireo	Resident	Forest Specialist	Lowlands
Vireo bellii	Vireo de Bell	Bell's Vireo	Visitor	Open Area Generalist	Lowlands
Vireo flavifrons	Vireo Gorgiamarillo	Yellow-throated Vireo	Visitor	Forest Generalist	Lowlands
Vireo plumbeus	Vireo Plomizo	Plumbeous Vireo	Status Uncertain	Forest Specialist	Highlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Vireo solitarius	Vireo Solitario	Blue-headed Vireo	Visitor	Forest Generalist	Altitude Generalist
Vireo gilvus	Vireo Gorjeador	Warbling Vireo	Visitor	Forest Generalist	Altitude Generalist
Vireo leucophrys	Vireo Gorripardo	Brown-capped Vireo	Resident	Forest Specialist	Highlands
Vireo philadelphicus	Vireo Filadelfia	Philadelphia Vireo	Visitor	Forest Generalist	Highlands
Vireo olivaceus	Vireo Ojirrojo	Red-eyed Vireo	Transient	Forest Generalist	Altitude Generalist
Vireo flavoviridis	Vireo Amarillo-verdoso	Yellow-green Vireo	Breeding Visitor	Forest Generalist	Lowlands
Hylophilus decurtatus	Verdillo Menor	Lesser Greenlet	Resident	Forest Generalist	Lowlands
Vireolanius pulchellus	Vireón Esmeraldo	Green Shrike-Vireo	Resident	Forest Specialist	Lowlands
Cyclarhis gujanensis	Vireón Cejirrufo	Rufous-browed Peppershrike	Resident	Forest Generalist	Altitude Generalist
Calocitta formosa	Urraca-hermosa Cariblanca (Urraca)	White-throated Magpie-Jay	Resident	Open Area Generalist	Altitude Generalist
Cyanocorax melanocyaneus	Chara Centroamericana	Bushy-crested Jay	Resident	Forest Generalist	Highlands
Cyanolyca pumilo	Chara de Niebla	Black-throated Jay	Resident	Forest Specialist	Highlands
Progne chalybea	Martín Pechigris	Gray-breasted Martin	Resident	Open Area Generalist	Altitude Generalist
Tachycineta bicolor	Golondrina Arbolera	Tree Swallow	Visitor	Open Area Generalist	Lowlands
Tachycineta albilinea	Golondrina Manglera	Mangrove Swallow	Resident	Wetlands Specialist	Lowlands
Tachycineta thalassina	Golondrina Cariblanca	Violet-green Swallow	Visitor	Open Area Generalist	Altitude Generalist
Stelgidopteryx serripennis	Golondrina-aliserrada Norteña	Northern Rough-winged Swallow	Resident	Open Area Generalist	Altitude Generalist

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Riparia riparia	Golondrina Riverena	Bank Swallow	Transient	Open Area Generalist	Lowlands
Petrochelidon pyrrhonota	Golondrina Risquera	Cliff Swallow	Transient	Open Area Generalist	Lowlands
Petrochelidon fulva	Golondrina Pueblera	Cave Swallow	Visitor	Open Area Generalist	Lowlands
Hirundo rustica	Golondrina Ranchera	Barn Swallow	Visitor	Open Area Generalist	Altitude Generalist
Campylorhynchus rufinucha	Guacalchía (Matraquita Nuquirrufa)	Rufous-naped Wren	Resident	Open Area Generalist	Lowlands
Salpinctes obsoletus	Saltapared Roquero	Rock Wren	Resident	Open Area Specialist	Altitude Generalist
Thryothorus maculipectus	Saltapared Pechimanchado	Spot-breasted Wren	Resident	Forest Specialist	Lowlands
Thryothorus rufalbus	Saltapared Rufiblanco	Rufous-and-white Wren	Resident	Forest Generalist	Altitude Generalist
Thryothorus pleurostictus	Saltapared Vientre-barrado	Banded Wren	Resident	Forest Specialist	Lowlands
Thryothorus modestus	Saltapared Sencillo	Plain Wren	Resident	Open Area Generalist	Altitude Generalist
Troglodytes aedon	Saltapared Continental Norteño	House Wren	Resident	Forest Generalist	Altitude Generalist
Troglodytes rufociliatus	Saltapared Cejirrufo	Rufous-browed Wren	Resident	Forest Specialist	Highlands
Henicorhina leucophrys	Saltapared-selvático Pechigris	Gray-breasted Wood-Wren	Resident	Forest Specialist	Highlands
Ramphocaenus melanurus	Soterillo Picudo	Long-billed Gnatwren	Resident	Forest Specialist	Lowlands
Polioptila caerulea	Perlita Grisilla	Blue-gray Gnatcatcher	Visitor	Forest Generalist	Lowlands
Polioptila albiloris	Perlita Cejiblanca	White-lored Gnatcatcher	Resident	Forest Generalist	Lowlands
Sialia sialis	Azulejo Gorjicanelo	Eastern Bluebird	Resident	Forest Specialist	Highlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Myadestes occidentalis	Clarín Jilguero (Guardabarranco)	Brown-backed Solitaire	Resident	Forest Generalist	Highlands
Catharus aurantiirostris	Zorzalito Piquinaranja	Orange-billed Nightingale-Thrush	Resident	Forest Generalist	Highlands
Catharus frantzii	Zorzalito de Frantzius	Ruddy-capped Nightingale-Thrush	Resident	Forest Specialist	Highlands
Catharus ustulatus	Zorzalito de Swainson	Swainson's Thrush	Visitor	Forest Generalist	Altitude Generalist
Catharus guttatus	Zorzalito Colirrufo	Hermit Thrush	Migratory Vagrant	Forest Generalist	Highlands
Hylocichla mustelina	Zorzalito Maculado	Wood Thrush	Visitor	Forest Generalist	Altitude Generalist
Turdus infuscatus	Zorzal Negro	Black Thrush	Resident	Forest Specialist	Highlands
Turdus grayi	Zorzal Pardo	Clay-colored Thrush	Resident	Forest Generalist	Altitude Generalist
Turdus assimilis	Zorzal Gorjiblanco	White-throated Thrush	Resident	Forest Specialist	Highlands
Turdus rufitorques	Zorzal Cuellirufo	Rufous-collared Robin	Resident	Open Area Specialist	Highlands
Dumetella carolinensis	Pájaro-gato Gris	Gray Catbird	Migratory Vagrant	Forest Generalist	Altitude Generalist
Mimus gilvus	Cenzontle Sureño	Tropical Mockingbird	Resident	Open Area Generalist	Lowlands
Melanotis hypoleucus	Mulato Pechiblanco	Blue-and-white Mockingbird	Resident	Forest Specialist	Highlands
Anthus rubescens	Bisbita Americana	American Pipit	Migratory Vagrant	Open Area Generalist	Altitude Generalist
Bombycilla cedrorum	Ampelis Americano	Cedar Waxwing	Visitor	Forest Generalist	Altitude Generalist
Vermivora pinus	Chipe Aliazul	Blue-winged Warbler	Visitor	Forest Generalist	Highlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Vermivora chrysoptera	Chipe Alidorado	Golden-winged Warbler	Visitor	Forest Generalist	Highlands
Vermivora peregrina	Chipe Peregrino	Tennessee Warbler	Visitor	Forest Generalist	Altitude Generalist
Vermivora celata	Chipe Corona-naranja	Orange-crowned Warbler	Migratory Vagrant	Open Area Generalist	Highlands
Vermivora ruficapilla	Chipe de Nashville	Nashville Warbler	Visitor	Open Area Generalist	Highlands
Parula superciliosa	Chipe Cejiblanco	Crescent-chested Warbler	Resident	Forest Specialist	Highlands
Parula americana	Parula Norteña	Northern Parula	Migratory Vagrant	Forest Generalist	Lowlands
Parula pitiayumi	Parula Tropical	Tropical Parula	Non-migratory Vagrant	Forest Generalist	Altitude Generalist
Dendroica petechia	Chipe Amarillo	Yellow Warbler	Visitor	Forest Generalist	Lowlands
Dendroica petechia xantholora	Chipe de Manglar	Mangrove Warbler	Resident	Forest Specialist	Lowlands
Dendroica pensylvanica	Chipe Flanquicastaño	Chestnut-sided Warbler	Migratory Vagrant	Forest Generalist	Altitude Generalist
Dendroica magnolia	Chipe de Magnolia	Magnolia Warbler	Visitor	Forest Generalist	Lowlands
Dendroica tigrina	Chipe Atigrado	Cape May Warbler	Migratory Vagrant	Forest Generalist	Altitude Generalist
Dendroica caerulescens	Chipe Azuloso	Black-throated Blue Warbler	Migratory Vagrant	Open Area Generalist	Altitude Generalist
Dendroica chrysoparia	Chipe Caridorado	Golden-cheeked Warbler	Visitor	Forest Specialist	Highlands
Dendroica virens	Chipe Dorsiverde	Black-throated Green Warbler	Visitor	Forest Generalist	Altitude Generalist
Dendroica townsendi	Chipe de Townsend	Townsend's Warbler	Visitor	Forest Generalist	Highlands
Dendroica occidentalis	Chipe Cabeciamarillo	Hermit Warbler	Visitor	Forest Specialist	Highlands
Dendroica fusca	Chipe Gorjinaranja	Blackburnian Warbler	Transient	Forest Generalist	Altitude Generalist

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Dendroica graciae	Chipe de Grace	Grace's Warbler	Resident	Forest Specialist	Highlands
Dendroica discolor	Chipe Pradeño	Prairie Warbler	Migratory Vagrant	Forest Generalist	Lowlands
Mniotilta varia	Chipe Trepador	Black-and-white Warbler	Visitor	Forest Generalist	Altitude Generalist
Setophaga ruticilla	Pavito Migratorio	American Redstart	Visitor	Forest Specialist	Lowlands
Helmitheros vermivorum	Chipe Gusanero	Worm-eating Warbler	Visitor	Forest Generalist	Altitude Generalist
Limnothlypis swainsonii	Chipe de Swainson	Swainson's Warbler	Migratory Vagrant	Forest Generalist	Altitude Generalist
Seiurus aurocapilla	Chipe-suelero Coronado	Ovenbird	Visitor	Forest Generalist	Altitude Generalist
Seiurus noveboracensis	Chipe-suelero Chaquero	Northern Waterthrush	Visitor	Forest Specialist	Lowlands
Seiurus motacilla	Chipe-suelero Arroyero	Louisiana Waterthrush	Visitor	Forest Specialist	Altitude Generalist
Oporornis formosus	Chipe de Kentucky	Kentucky Warbler	Visitor	Forest Generalist	Altitude Generalist
Oporornis philadelphia	Chipe Llorón	Mourning Warbler	Transient	Forest Generalist	Altitude Generalist
Oporornis tolmiei	Chipe de Tolmie	MacGillivray's Warbler	Visitor	Open Area Generalist	Altitude Generalist
Geothlypis trichas	Mascarita Común	Common Yellowthroat	Visitor	Open Area Generalist	Altitude Generalist
Geothlypis poliocephala	Mascarita Piquigruesa	Gray-crowned Yellowthroat	Resident	Open Area Specialist	Altitude Generalist
Wilsonia citrina	Chipe Encapuchado	Hooded Warbler	Visitor	Forest Generalist	Altitude Generalist

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Wilsonia pusilla	Chipe de Wilson	Wilson's Warbler	Visitor	Forest Generalist	Altitude Generalist
Wilsonia canadensis	Chipe Collarejo	Canada Warbler	Transient	Forest Generalist	Altitude Generalist
Cardellina rubrifrons	Chipe Carirrojo	Red-faced Warbler	Visitor	Forest Specialist	Highlands
Myioborus miniatus	Pavito Gorjigris	Slate-throated Redstart	Resident	Forest Generalist	Highlands
Euthlypis lachrymosa	Chipe Roquero	Fan-tailed Warbler	Resident	Forest Generalist	Lowlands
Basileuterus culicivorus	Chipe Corona-dorada	Golden-crowned Warbler	Resident	Forest Specialist	Highlands
Basileuterus rufifrons	Chipe Gorrirrufo	Rufous-capped Warbler	Resident	Forest Generalist	Altitude Generalist
Icteria virens	Gritón Pechiamarillo	Yellow-breasted Chat	Visitor	Open Area Generalist	Lowlands
Habia rubica	Tángara-hormiguera Coronirroja	Red-crowned Ant-Tanager	Resident	Forest Specialist	Altitude Generalist
Habia fuscicauda	Tángara-hormiguera Gorjirroja	Red-throated Ant-Tanager	Resident	Forest Specialist	Lowlands
Piranga rubra	Tángara Roja	Summer Tanager	Visitor	Forest Generalist	Lowlands
Piranga olivacea	Tángara Escarlata	Scarlet Tanager	Transient	Forest Generalist	Lowlands
Piranga ludoviciana	Tángara Occidental	Western Tanager	Visitor	Forest Generalist	Altitude Generalist
Piranga bidentata	Tángara Dorsirrayada	Flame-colored Tanager	Resident	Forest Specialist	Highlands
Piranga leucoptera	Tángara Aliblanca	White-winged Tanager	Resident	Forest Generalist	Highlands
Thraupis episcopus	Tángara Azuligris	Blue-gray Tanager	Resident	Open Area Generalist	Lowlands
Thraupis abbas	Tángara Aliamarilla	Yellow-winged Tanager	Resident	Open Area Generalist	Altitude Generalist
Cyanerpes cyaneus	Mielero Patirrojo	Red-legged Honeycreeper	Resident and migratory	Forest Generalist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Volatinia jacarina	Semillero Brincador	Blue-black Grassquit	Resident	Open Area Generalist	Altitude Generalist
Sporophila torqueola	Semillero Collarejo	White-collared Seedeater	Resident	Open Area Generalist	Lowlands
Sporophila minuta	Semillero Pechicanelo	Ruddy-breasted Seedeater	Resident	Open Area Specialist	Lowlands
Amaurospiza concolor	Semillero Azul	Blue Seedeater	Resident	Forest Specialist	Altitude Generalist
Tiaris olivaceus	Semillero Olivaceo	Yellow-faced Grassquit	Resident	Open Area Generalist	Highlands
Diglossa baritula	Picaflor Vientre-canelo	Cinnamon-bellied Flowerpiercer	Resident	Open Area Specialist	Highlands
Atlapetes albinucha	Saltón Nuquiblanco	White-naped Brush-Finch	Resident	Forest Generalist	Highlands
Melozone biarcuata	Rascador Patilludo	Prevost's Ground-Sparrow	Resident	Forest Generalist	Highlands
Melozone leucotis	Rascador Orejiblanco	White-eared Ground-Sparrow	Resident	Forest Specialist	Highlands
Aimophila ruficauda	Zacatonero Cabecirrayado	Stripe-headed Sparrow	Resident	Open Area Generalist	Lowlands
Aimophila rufescens	Zacatonero Rojizo	Rusty Sparrow	Resident	Open Area Generalist	Highlands
Ammodramus savannarum	Gorrión Chapulín	Grasshopper Sparrow	Visitor	Open Area Specialist	Altitude Generalist
Melospiza lincolnii	Gorrión de Lincoln	Lincoln's Sparrow	Visitor	Open Area Generalist	Highlands
Zonotrichia capensis	Gorrión Chingolo	Rufous-collared Sparrow	Resident	Open Area Generalist	Highlands
Saltator coerulescens	Saltator Grisáceo (Dichoso-fuí)	Grayish Saltator	Resident	Open Area Generalist	Altitude Generalist

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Saltator atriceps	Saltator Cabecinegro (Chepito)	Black-headed Saltator	Resident	Forest Generalist	Altitude Generalist
Pheucticus ludovicianus	Picogrueso Pechirrosado (Puñalada)	Rose-breasted Grosbeak	Visitor	Forest Generalist	Altitude Generalist
Cyanocompsa parellina	Colorín Azulinegro	Blue Bunting	Resident	Forest Specialist	Lowlands
Passerina caerulea	Picogrueso Azul	Blue Grosbeak	Resident and migratory	Open Area Generalist	Lowlands
Passerina cyanea	Colorín Azul	Indigo Bunting	Visitor	Open Area Generalist	Lowlands
Passerina ciris	Colorín Sietecolores (Sietecolores)	Painted Bunting	Visitor	Open Area Generalist	Lowlands
Spiza americana	Arrocero Americano	Dickcissel	Visitor	Open Area Generalist	Lowlands
Agelaius phoeniceus	Tordo Sargento	Red-winged Blackbird	Resident	Open Area Specialist	Lowlands
Sturnella magna	Pradero Común	Eastern Meadowlark	Resident	Open Area Specialist	Altitude Generalist
Dives dives	Tordo Cantor	Melodious Blackbird	Resident	Forest Generalist	Altitude Generalist
Quiscalus mexicanus	Zanate Mayor (Zanate♀, Clarinero♂)	Great-tailed Grackle	Resident	Open Area Generalist	Altitude Generalist
Molothrus aeneus	Vaquero Ojirrojo	Bronzed Cowbird	Resident	Open Area Generalist	Lowlands
Icterus wagleri	Bolsero de Wagler	Black-vented Oriole	Resident	Forest Generalist	Highlands
Icterus maculialatus	Bolsero Guatemalteco	Bar-winged Oriole	Resident	Forest Generalist	Highlands
Icterus spurius	Bolsero Castaño	Orchard Oriole	Visitor	Open Area Generalist	Lowlands

Species	Spanish name	English name	Seasonality	Habitat	Elevation
Icterus pustulatus	Bolsero Dorsirrayado	Streak-backed Oriole	Resident	Open Area Generalist	Altitude Generalist
Icterus pectoralis	Bolsero Pechimanchado	Spot-breasted Oriole	Resident	Open Area Generalist	Altitude Generalist
Icterus gularis	Bolsero de Altamira	Altamira Oriole	Resident	Open Area Generalist	Altitude Generalist
Icterus galbula	Bolsero de Baltimore	Baltimore Oriole	Visitor	Open Area Generalist	Altitude Generalist
Amblycercus holosericeus	Cacique Piquiclaro	Yellow-billed Cacique	Resident	Forest Generalist	Lowlands
Cacicus melanicterus	Cacique Mexicano	Yellow-winged Cacique	Resident	Open Area Generalist	Lowlands
Euphonia affinis	Eufonia Gorjinegro	Scrub Euphonia	Resident	Forest Generalist	Lowlands
Euphonia hirundinacea	Eufonia Gorjiamarillo	Yellow-throated Euphonia	Resident	Forest Specialist	Altitude Generalist
Euphonia elegantissima	Eufonia Capucha-azul	Elegant Euphonia	Resident	Forest Generalist	Highlands
Chlorophonia occipitalis	Clorofonia Coroniazul	Blue-crowned Chlorophonia	Resident	Forest Generalist	Highlands
Carduelis notata	Dominico Cabecinegro	Black-headed Siskin	Resident	Forest Specialist	Highlands
Carduelis psaltria	Dominico Dorsioscuro	Lesser Goldfinch	Resident	Open Area Generalist	Altitude Generalist
Passer domesticus	Gorrión Doméstico	House Sparrow	Resident	Open Area Generalist	Lowlands
Lonchura malacca	Capuchino de Cabeza Negra	Tricolored Munia	Non-migratory Vagrant	Open Area Generalist	Lowlands

3.2. INVENTORY COMPLETENESS

It is important to evaluate completeness of the inventories before comparing the sites, because species richness is influenced by inventory effort (Komar 2002, 2007). Before the field study began, the baseline bird inventory of the watersheds within the IMCW Project area was substantially incomplete, with only 5 of the 11 watersheds above 80% completeness (based on the presence of 74 test species). After field work, 10 of the 11 watersheds now have reasonably complete inventories, averaging 86% complete, and can be compared for conservation importance (Fig. 16, Table 42). The only watershed that will be not be analyzed, for lack of data, is the Bocana San Juan Watershed. In seven watersheds, more than 85% of the test species have been recorded. In the three watersheds with 57% to 74% of test species recorded, the watersheds lack middle and higher elevations, such that some of the test species may actually be absent, thus these areas may have more complete inventories than indicated here.

Prior to field work, the level of inventory completeness (or effort) was a reasonably good predictor of the number of threatened bird species recorded from each watershed (linear regression R-squared=0.466, P=0.021, statistically signficant), indicating that lists of threatened species were not comparable among watersheds. But after completing the field work and eliminating the one watershed with a very poor inventory, the level of inventory completeness is no longer a good predictor of the number of threatened bird species present (R^2=0.281, P=0.115, not statistically significant). Now we can assume that the number of threatened birds present is relatively accurate and can be used as an index of relative conservation importance to prioritize the 10 watersheds for conservation action.

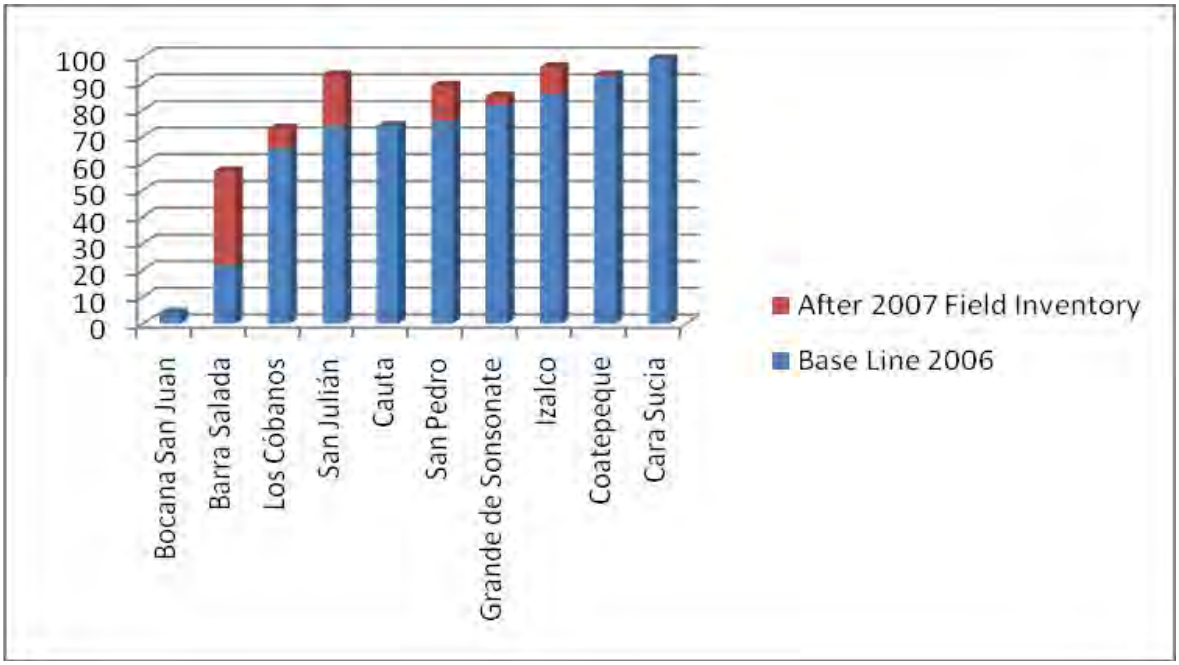

FIGURE 16. INCREMENT IN INVENTORY COMPLETENESS INDEX FOR BIRDS IN WATERSHEDS OF SOUTHWESTERN EL SALVADOR, RESULTING FROM FIELD STUDY.

TABLE 42. INVENTORY COMPLETENESS FOR BIRDS AND RELATIVE IMPORTANCE OF WATERSHEDS.

Watershed	Inventory test species recorded through 2006 (%)	Inventory test species recorded through 2007 (%)	Conservation important species recorded through 2006 (%)	Conservation important species recorded through 2007 (%)
Bocana San Juan	4	4	5	5
Barra Salada	22	57	15	26
Los Cóbanos	66	73	25	30
San Julián	74	93	15	17
Cauta	74	74	21	21
San Pedro	76	89	12	22
Grande de Sonsonate	82	85	24	27
Izalco	86	96	26	31
Coatepeque	93	93	39	39
Cara Sucia	99	99	72	72
Barra de Santiago	100	100	71	74
Full Project Area	**100**		**100**	

The 25 municipalities have widely varying levels of inventory effort, and in fact nine municipalities still present no data on bird presence. After completing the inventory field work, eight municipalities now have inventories with more than 75% of test species recorded (i.e., inventory completeness), including six with more than 90%. Prior to field work, only five municipalities had inventory completeness above 75% (Table 43). The inventory completeness level for all municipalities combined is a very good predictor for the proportion of threatened bird species present (R^2=0.632, F=39.44, P<0.001), which demonstrates that the varying levels of effort significantly biases the apparent relative importance of the municipalities for threatened bird species. If we eliminate municipalities with <60% inventory completeness, inventory effort is still a good predictor (R^2=0.369, F=6.44, P=0.028). But if we consider only municipalities with >75% inventory completeness, the relative completeness is a very poor predictor of threatened bird species present (R^2=0.046, F=0.29, P=0.609), such that this group of municipalities can be compared. The mean completeness score for this group is 92%.

TABLE 43. INVENTORY COMPLETENESS FOR BIRDS AND RELATIVE IMPORTANCE OF MUNICIPALITIES.

Municipality	Inventory test species recorded through 2006 (%)	Inventory test species recorded through 2007 (%)	Conservation important species recorded through 2006 (%)	Conservation important species recorded through 2007 (%)
Acajutla	66	69	30	33
Apaneca	45	61	13	18
Armenia	0	0	0	0
Caluco	74	92	14	15
Chalchuapa	0	0	0	0
Concepción de Ataco	62	62	9	9
Cuisnahuat	0	0	0	0
Guaymango	0	0	0	0
Izalco	93	97	26	28
Juayúa	61	97	15	18
Jujutla	95	95	57	57
Nahulingo	27	27	0	0
Nahuizalco	41	41	1	1
Salcoatitán	0	0	0	0
San Antonio del Monte	0	0	0	0
San Francisco Menéndez	100	100	66	68
San Julián	8	8	3	3
San Pedro Puxtla	68	68	13	13
Santa Ana	77	77	32	32
Sta. Catarina Masahuat	0	0	0	0
Santo Domingo de Guzmán	0	61	0	2
Sonsonate	66	82	18	39
Sonzacate	0	0	0	0
Tacuba	93	93	30	30
Tepecoyo	0	0	0	0
Full Project Area	**100**		**100**	

Inventory effort for the eight ecosystems varies widely, according to the proportion of test species that have been recorded in each ecosystem (Table 44). The differing levels of effort appear to bias the relative importance scores for the ecosystems, although the linear regression (threatened bird species richness regressed against proportion of test species recorded) is not quite statistically significant (R^2=0.442, F=4.751, P=0.072). Removing the two poorly-studied ecosystems (savanna and coral reef) removes most of the bias. The remaining six ecosystems all have inventory completeness scores above 80%. For this group of reasonably completely studied ecosystems, the conservation importance score (threatened species richness) is not at all predicted by the level of inventory effort (regression results: R^2=0.013, F=0.0054, P=0.828), suggesting that the numbers of threatened bird species recorded can be compared among sites and used as an indicator of conservation importance.

TABLE 44. INVENTORY COMPLETENESS FOR BIRDS AND RELATIVE IMPORTANCE OF ECOSYSTEMS.

Ecosystem	Inventory test species recorded through 2007 (%)	Conservation important species recorded through 2007 (%)
Humid Forest	98	33
Dry Forest	97	26
Cloud Forest	98	17
Estuaries (and Mangroves)	83	39
Beaches	81	13
Freshwater Wetlands (and swamp forests)	84	20
Savanna	35	5
Coral Reef	64	2

3.3. EVALUATION OF CONSERVATION IMPORTANCE AMONG AREAS AND ECOSYSTEMS.

The Cara Sucia and the Barra de Santiago watersheds (both include parts of El Imposible National Park and parts of Barra de Santiago estuary) have the highest conservation importance, with more than 70% of the area's nationally threatened bird species present. They are distantly followed by the Coatepeque and Izalco watersheds (which combined include Los Volcanes National Park and the San Marcelino Protected Natural Area complex, each a part of the Apaneca-Ilamatepec Biosphere Reserve), which have 39% and 31% of the threatened bird species present, respectively. The greater importance for birds of the El Imposible area with respect to the San Marcelino area was previously noted by Komar & Herrera (1995). Other watersheds have fewer threatened birds present (Table 42).

Among municipalities, San Francisco Menéndez (El Imposible National Park and Santa Rita Protected Natural Area) and Jujutla (Barra de Santiago estuary and Protected Natural Area) have considerably more conservation importance than Sonsonate (Los Cóbanos and Barra Salada Protected Natural Areas), which in turn is more important for birds than Tacuba, Izalco and Santa Ana (the latter two municipalities include Los Volcanes National Park and San Marcelino Complex of Protected Natural Areas). The lowest importance scores were for Juayúa (Laguna de las Ranas) and Caluco (Plan de Amayo Protected Natural Area) (Table 43).

Estuaries (Mangroves), such as at Barra de Santiago, are the most important ecosystem for bird conservation, with 39% of the area's threatened bird species, more than humid forest (33%) and dry forest (26%; Table 44). These ecosystems are followed in importance by freshwater wetlands, cloud forest, and beaches.

4. RECOMMENDATIONS

I present below two types of recommendations: those that relate to bird conservation strategies, resulting from the results reported herein, and those that relate to filling gaps in the existing bird inventory. Although field surveys carried out during 2007 were intensive, and the study area has been extensively studied for birds previously (Komar 2007), there are still noteworthy gaps in the ornithological inventory.

The field surveys reconfimed what was generally already known about the Study Area. The natural habitats are highly fragmented and of very reduced size. Most birds found in these habitats are generalist species adapted to rapidly changing landscapes and disturbance. Conserving the few habitat specialist species that persist in southwestern El Salvador will require great efforts to increase natural vegetation cover, especially forest cover but also natural savanna vegetation. Ideally, reforestation or habitat recuperation can be organized so as to create natural habitat corridors connecting patches of habitat, such as the mangrove estuaries to the humid forests that still remain in the upper watersheds.

The small fragments of natural habitat are subject to numerous threats (Komar & Girón 2007), one of which is global climate change which is probably already causing ecosystem adjustments that will stress the remaining wildlife populations. Such large scale landscape processes stress the need for a major effort to invest in re-greening the landscape. The best way to allow the ecosystems to adapt to climate change is to provide space across an altitudinal gradient for natural ecosystems to migrate as temperature regimes change.

Where are the priority sites for implementing habitat conservation? While the mangrove ecosystems are home to the most threatened bird species, many of those species are waterbirds and migratory shorebirds, neither of which will benefit greatly from reforestation or expanding habitat corridors. Waterbirds and shorebirds are indeed highly threatened, because of their habitat specializations. Many shorebirds migrate to El Salvador from Arctic breeding grounds which are themselves threatened by climate change and by anthropogenic activities such as oil drilling. The recommended conservation strategy for these birds in El Salvador is to increase education for local

fishermen and tourists. As users of the estuaries learn about the special challenges these birds face, they may increase their appreciation for the birds and take more care to protect them.

The next highest priorities are in the humid forest and dry forests ecosystems. These are the areas that most require efforts to expand natural areas and connect them via corridors. Especially useful would be to reforest the riparian areas, connecting the remnant transition forests behind the mangroves to small patches of dry forest and further upstream, to humid forest.

Also important for the long-term conservation of birds in southwestern El Salvador is to expand bird monitoring efforts. Long-term monitoring of bird populations is needed to determine if birds are able to withstand the various stresses, and can indicate to conservation managers if efforts are not enough. Current monitoring efforts carried out by SalvaNATURA at the two national parks in the Study Area are not sufficient, and additional monitoring stations are needed both as study replicates, and also to monitor birds in additional habitats, such as in mangrove forests and on mudflats (where shorebirds feed).

The 2007 field inventories failed to ~~c~~omplete" the local bird inventories, in part, because of the seasonality of the field work. Sites were visited twice (two different seasons) during the second semester of the year, but bird communities vary across the entire year, and a third visit (at least) would be required to cover all seasons important for documenting bird communities. For example, none of the sites were visited during spring (April and early May), when spring migration is in full swing and when most local resident birds are beginning their breeding season. The results indicate that only one of the watersheds and only one municipality have complete inventories (100% of test species registered), therefore considerable work across the study area is still needed to complete the inventories. More complete inventories could reveal different or additional conservation priorities within the study area. They could also provide more information useful for valuing the area's natural resources, such as by identifying localities where species attractive for ecotourism can be found reliably by tourists.

Given that southwestern El Salvador is arguably the best inventoried area in the country (for birds), I recommend using this area to initiate a pilot project to take the bird inventory to a new level. In many countries, ornithologists have used an inventory method known as atlas mapping, in particular for documenting the local breeding ranges of resident bird species. This method consists of dividing the study area into a series of grid squares, and then mobilizing many observers (ornithologists and bird enthusiasts) to visit each grid to determine the bird species that breed within the grid. A reasonable grid size would be 5 x 5 km, or 25 km^2. Biologists documenting breeding birds could also document other types of flora and fauna during their visits to each grid. The atlas would determine much more accurately the actual distribution and range size for each species in the study area. It would also be useful for collecting data on elevational ranges for species, which are needed to determine long-term adaptability to projected climate change for each species.

CHAPTER 6:

INVENTORY OF TERRESTRIAL MAMMALS IN SOUTHWESTERN EL SALVADOR

Luis Girón, Melissa Rodríguez, and James G. Owen
Conservation Science Department
*Salva*NATURA, San Salvador, El Salvador
legiron@salvanatura.org

1. INTRODUCTION

El Salvador's natural areas are highly fragmented and anthropogenically disturbed, which complicates the study of wild mammals. Mammalian inventories have not been completed in any of the country's natural areas. The first terrestrial mammal collection efforts in southwestern El Salvador were carried out in 1927 and 1942 (Burt and Stirton 1961). The second phase of collections was carried out by Heinz Felten, between 1952 and 1954 (Felten 1956). Then, during a third collection phase between 1988 and 2005, James G. Owen invested the largest effort so far to document mammals of El Salvador. The most recent efforts documenting mammals in the southwestern region of the country, mainly bats, began in 2003 with the Neobats–El Salvador program carried out by Luis Girón of *Salva*NATURA. Neobats–El Salvador provided data up to 2006 (unpublished data).

The information from mammal studies carried out previously in southwestern El Salvador was systematized prior to field work, generating a list of 97 mammal species recorded in the study area (Girón & Owen 2007). The purpose of this study was to complement these inventories with field work and make an evaluation of mammals in selected watersheds, municipalities, ecosystems, and Protected Natural Areas.

2. METHODOLOGY

2.1. STUDY AREA

The study was conducted in eight Protected Natural Areas, in seven of the 11 watersheds of southwestern El Salvador (Fig. 17). These sites correspond to eight of the 25 municipalities located within the IMCW project area, within the Departments of

Ahuachapán, Sonsonate, and Santa Ana (Tabla 5-1). The ecosystems included Dry Forest, Humid Forest, Cloud Forest, and a Savanna dominated by *Crescentia alata*.

2.2. FIELD METHODOLOGY

During June–December 2007, traps were placed at each site, usually two harp traps to capture bats, 50 Sherman live traps for small rodents, five Tomahawk traps for medium-sized mammals, and 12 camera traps. We also established observation transects at each site (except for Laguna de las Ninfas). Sampling efforts per site are given in Table 45.

In order to calculate the relative frequency and relative abundance, each day was used as a sampling unit. The relative frequency was obtained by multiplying the number of samples (days) by 100, in which each one of the species appeared, divided by the total number of samples. The relative abundance was obtained by dividing the number of each individual species observed between the total numbers of individuals observed of all of the species multiplying the result by 100.

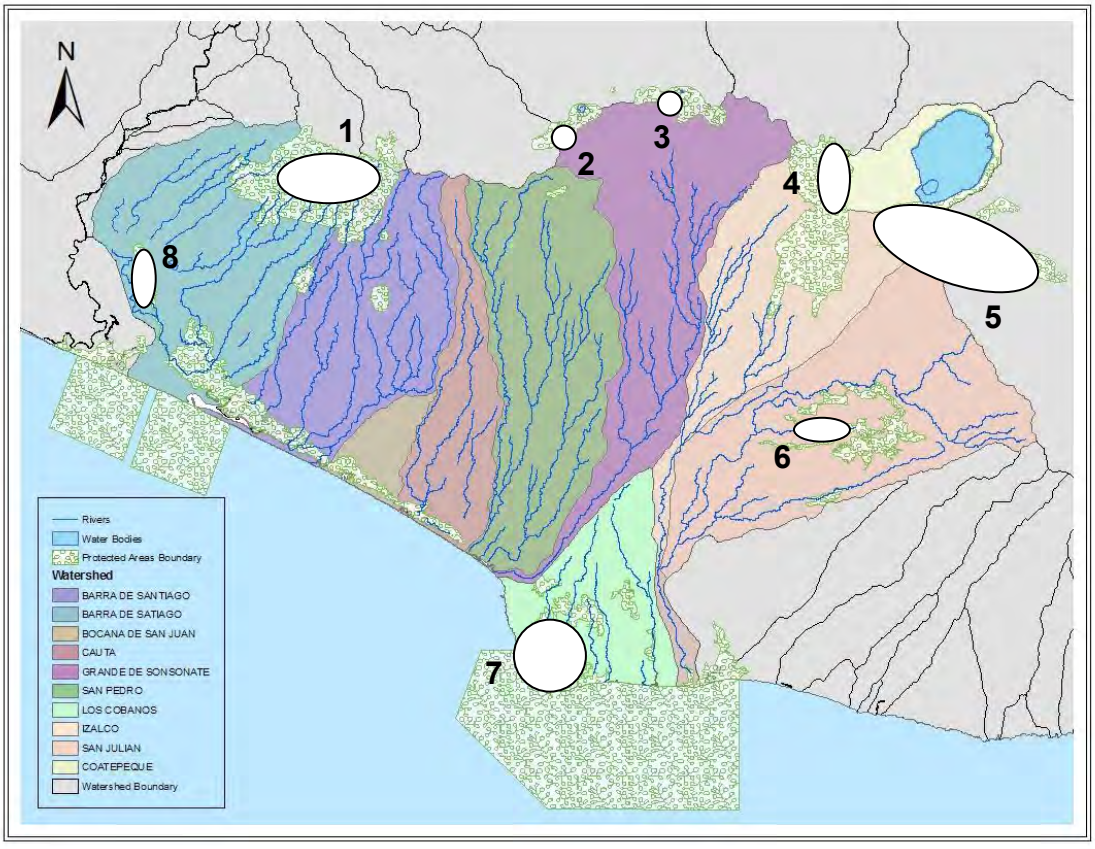

FIGURE 17. MAP OF SITES SAMPLED FOR MAMMALS IN 2007: (1) EL IMPOSIBLE NATIONAL PARK, (2) SIERRA DE APANECA WEST (LAGUNA DE LAS NINFAS), (3) SIERRA DE APANECA EAST (LAGUNA DE LAS RANAS), (4) LOS VOLCANES NATIONAL PARK, (5) SAN MARCELINO COMPLEX, (6) PLAN DE AMAYO, (7) LOS CÓBANOS, (8) BOSQUE SANTA RITA.

TABLE 45. SITES AND SAMPLING EFFORTS FOR MAMMALS.

Site	Specific Site	Municipality	Departament	Latitude and Longitude	Elevation	Days	TH	RTN	TTN	HTN	CTN
Sierra de Apeneca West	Laguna de las Ninfas	Apaneca	Ahuachapán	13.8733º -89.80557º	1500	5	0	320	20	12	40
Sierra de Apaneca East	Laguna de las Ranas	Chalchuapa	Santa Ana	13.90391º -89.72281º	1750	10	10	320	20	8	88
Plan de Amayo		Caluco	Sonsonate	13.69088º -89.64741º	335	5	10	220	15	5	64
Los Cóbanos		Acajutla	Sonsonate	13.52764º -89.80955º	3	10	10	480	40	16	80
Santa Rita		San Francisco Menéndez	Ahuachapán	13.80º -90.06º	33	10	10	162	20	6	81
San Marcelino		Izalco	Sonsonate	13.81040º -89.57049º	917	5	10	240	16	8	64
Los Volcanes	Los Andes	Santa Ana	Santa Ana	13.86848º -89.62009º	1735	20	20	550	55	22	184
	Cerro Verde	Santa Ana	Santa Ana	13.82611º -89.62389º	2000						
El Imposible	La Fincona	San Francisco Menéndez	Ahuachapán	13.84320º -89.97761º	738	40	36	850	80	36	352
	San Benito	San Francisco Menéndez	Ahuachapán	13.82712º -89.94712º	730						
	Cerro Campana	Tacuba	Ahuachapán	13.85675º -89.91398º	1350						
	Guayapa	San Francisco Menéndez	Ahuachapán	13.82778º -89.93663º	478						
TOTAL						**105**	**106**	**3,142**	**266**	**113**	**953**

TH: Transect hours; RTN: Rodent trap nights; TTN: Tomahawk trap nights; HTN: Harp trap nights; CTN: Camera trap days & nights.

2.3. LEVEL OF INVENTORY COMPLETENESS

A list of 48 generalist species expected in the area was created, to determine the degree of inventory completeness in the study area's municipalities and watersheds (Table 46), modifying a method proposed by Gómez de Silva and Medellín (2001). In ecological terms, the generalist species are those that exist in a variety of habitats and eat varied foods that are found in both disturbed and pristine habitats. These species are expected to be present in every site in the departments of Ahuachapán, Santa Ana, and Sonsonate. We compared the generalist species recorded with the list of expected generalist species for each municipality, watershed, ecosystem, and protected natural area, to calculate the percentage level of inventory completeness.

As a complement, we used species accumulation curves and to estimate the inventory completeness. From the curves, we generated various estimates of species richness, using ACE (Abundance-based Coverage Estimator), ICE (Incidence-based Coverage Estimator), Chao 1, Chao 2, Jack-Knife 1 and Jack-Knife 2 methods, all calculated with the EstimateS version 7.51 program (Colwell 2006). The accumulation curves were obtained taking each day as a sampling unit, using data from all of the combined techniques, to achieve a similar sampling effort for each sampling day.

2.4. EVALUATION OF THE RELATIVE IMPORTANCE OF SITES

We prepared a list of 34 species of conservation importance that can be found in southwestern El Salvador (Table 47). For each municipality, watershed, ecosystem, and Protected Natural Area, we determined the percentage of these species that have been recorded. This percentage represents the relative importance of a site for mammal conservation. Since the level of inventory completeness can influence the proportion of conservation-important species reported (Komar 2007), we only evalutated the importance of the sites when these showed an inventory completeness of more than 70%.

3. RESULTS AND DISCUSSION

3.1. RECORDED SPECIES

We recorded 1296 individuals representing 72 species, of which 49 were captured, 17 were photographed by camera traps, 21 were observed in transects, and five were recorded only outside of standardized sampling. We recorded 16 species at Sierra de Apaneca West, 27 at Plan de Amayo, 16 at Los Cóbanos, 13 at Santa Rita, 21 at Sierra de Apaneca East, 22 at Los Volcanes, 21 at San Marcelino, and 54 at El Imposible. Regarding ecosystems, 44 species were recorded in Dry Forest, 44 in Humid Forest, 30 in Cloud Forest, and 17 in Savanna. The species that showed the greatest relative frequency were the Central American Agouti (*Dasyprocta punctata*) which appeared in 46% of the samples followed by the Nine-banded Armadillo (*Dasypus novemcinctus*) and Common Opposum (*Didelphis marsupialis*), which appeared in 40% and 31% of the samples, respectively. The species with greatest relative abundance, both bats, were the Jamaican Fruit-eating Bat (*Artibeus jamaicensis*), with 17% of all records, followed by the Hairy-legged Myotis (*Myotis keaysi*) with 13% of all records (Table 48).

TABLE 46. INDICATOR SPECIES (MAMMALS) OF INVENTORY COMPLETENESS.

Family	Species	Spanish Name
Didelphidae	*Didelphis marsupialis*	Tacuazín Negro
Didelphidae	*Didelphis virginianus*	Tacuazín Blanco
Didelphidae	*Marmosa mexicana*	Tacuazín Ratón
Didelphidae	*Phylander opossum*	Hurón o Cuatro Ojos
Dasypodidae	*Dasypus novemcinctus*	Cuzuco
Emballonuridae	*Saccopteryx bilineata*	Murciélago Grande de Líneas Blancas
Mormoopidae	*Pteronotus davyi*	Murciélago de Espalda Desnuda
Phyllostomidae	*Phyllostomus discolor*	Murciélago Hoja de Lanza Menor
Phyllostomidae	*Glossophaga soricina*	Murciélago Longi Rostro Común
Phyllostomidae	*Glossophaga leachii*	Murciélago Longirostro Gris
Phyllostomidae	*Glossophaga commissarisi*	Murciélago Longorostro de Commissaris
Phyllostomidae	*Carollia subrufa*	Murciélago de Cola Corta Gris
Phyllostomidae	*Carollia perspicillata*	Murciélago Frutero Común de Cola Corta
Phyllostomidae	*Sturnira lilium*	Murciélago Frutero Común de Hombros Amarillos
Phyllostomidae	*Artibeus intermedius*	Murciélago Frutero Intermedio
Phyllostomidae	*Artibeus jamaicensis*	Murciélago Frutero de Jamaica
Phyllostomidae	*Artibeus toltecus*	Murciélago Frutero Tolteca
Phyllostomidae	*Artibeus phaeotis*	Murciélago Peludo de Ojos Grandes
Phyllostomidae	*Uroderma bilobatum*	Murciélago Constructor de Tiendas Común
Phyllostomidae	*Artibeus helleri*	Murciélago de Heller
Phyllostomidae	*Chiroderma villosum*	Murciélago Frutero de Velvety
Phyllostomidae	*Desmodus rotundus*	Vampiro Común

Family	Species	Spanish Name
Vespertilionidae	*Myotis nigricans*	Murciélago Negruzco Común
Vespertilionidae	*Myotis keaysi*	Murciélago de Patas Peludas
Vespertilionidae	*Rhogeessa tumida*	Murciélago Enano de Alas Negras
Molossidae	*Molossus ater*	Murciélago Mastín Negro
Molossidae	*Molossus molossus*	Murciélago Mastín Común
Sciuridae	*Sciurus variegatoides*	Ardilla Gris
Geomyidae	*Orthogeomys grandis*	Taltuza
Heteromyidae	*Liomys salvini*	Ratón Bolsero
Cricetidae	*Sigmodon hispidus*	Rata Algodonera
Cricetidae	*Reithrodontomys gracilis*	Ratón Cosechador
Cricetidae	*Peromyscus mexicanus*	Ratón Venado Mexicano
Cricetidae	*Baiomys musculus*	Ratón Bolsero del sur
Cricetidae	*Ototylomys phyllotis*	Rata Escaladora de Orejas Grandes
Cricetidae	*Nyctomys sumichrasti*	Ratón
Cricetidae	*Rattus rattus*	Rata Negra
Cricetidae	*Mus musculus*	Ratón Casero
Erethizontidae	*Sphiggurus mexicanus*	Puerco Espín o Zorro Espín
Dasyproctidae	*Dasyprocta punctata*	Cotuza
Leporidae	*Sylvilagus floridanus*	Conejo Silvestre
Canidae	*Urocyon cinereoargenteus*	Zorra Gris
Procyonidae	*Procyon lotor*	Mapache
Mustelidae	*Mustela frenata*	Comadreja
Mephitidae	*Mephitis macroura*	Zorrillo Listado
Mephitidae	*Spilogale angustifrons*	Zorrillo Manchado
Felidae	*Puma yagouaroundi*	Gato Zonto
Cervidae	*Odocoileus virginianus*	Venado Cola Blanca

TABLE 47. MAMMALS THAT ARE INDICATORS OF IMPORTANT SITES FOR CONSERVATION.[1]

Species	Spanish Name	National Status (MARN 2004)	Red List (IUCN 2008)
Chironectes minimus	Tacuazín de Agua	Endangered	
Tamandua mexicana	Oso Hormiguero	Threatened	
Rhynchonycteris naso	Murciélago	Threatened	
Saccopteryx leptura	Murciélago Pequeño de Líneas Blancas	Threatened	
Peropteryx macrotis	Murciélago	Threatened	
Balantiopteryx plicata	Murciélago de Alas de Saco Gris	Threatened	
Noctilio albiventris	Murciélago Pescador Pequeño	Threatened	
Mormoops megalophylla	Murciélago Rostro de Fantasma	Threatened	
Pteronotus personatus	Murciélago Bigotudo Pequeño	Threatened	
Pteronotus gymnonotus	Murciélago de Espalda Desnuda Grande	Threatened	
Micronycteris microtis	Murciélago Orejón Común	Threatened	
Lonchorhina aurita	Murciélago Orejón Nariz de Espada	Threatened	
Macrophyllum macrophyllum	Murciélago de Patas Largas	Threatened	
Trachops cirrhosus	Murciélago con Verrugas en el Labio	Threatened	
Chrotopterus auritus	Murciélago Falso Vampiro	Threatened	
Leptonycteris yerbabuenae	Murciélago Magueyero	Endangered	Vulnerable

Species	Spanish Name	National Status (MARN 2004)	Red List (IUCN 2008)
Artibeus hartii	Murciélago Frutero Pigmeo	Threatened	
Uroderma magnirostrum	Murciélago Constructor de Tiendas Café		
Diaemus youngi	Vampiro de Ala Blanca	Endangered	
Bauerus dubiaquercus[2]	Murciélago de Van Gelder		
Lasiurus blossevilli	Murciélago Rojo		
Eumops auripendulus	Murciélago	Threatened	
Eumops underwoodi	Murciélago de Underwood	Endangered	
Neotoma mexicana	Rata de Bosque Mexicana	Threatened	
Cuniculus paca	Tepezcuintle	Threatened	
Eira barbara	Tayra o Perico Ligero	Endangered	
Lontra longicaudis	Nutria	Endangered	
Puma concolor	Puma	Endangered	
Leopardus pardalis	Ocelote	Endangered	
Leopardus wiedii	Tigrillo	Endangered	
Tapirus bairdi	Tapir o Danta		Endangered
Tayassu tajacu	Cuche de Monte	Endangered	

[1] Threatened or endangered at the national level (MARN 2004, modified by the authors).
[2] Species recently reported for the country that has not been evaluated for the national level threatened species list.

TABLE 48. INDIVIDUAL MAMMALS COUNTED DURING THE STUDY.

Scientific Name	RF (%)	RA (%)	Ecosystem				Sampled Sites								Total
			DF	HF	CF	S	WA	PA	LV	LC	SR	EA	SM	EI	
Didelphis marsupialis	31	3	11	24	6	3	1	5	2	3	1	3	5	24	44
Didelphis virginiana	16	2	1	9	9	6	1		8	6	1		2	7	25
Philander opossum	6	1	9			3				3	9				12
Marmosa mexicana[1]			1					1							1
Dasypus novemcinctus (Fig. 18A)	40	4	12	25	18	2	2	1	14	2	3	2	1	32	57
Tamandua mexicana (Fig. 18B)	1	0		1										1	1
Saccopteryx bilineata	1	0		1										1	1
Balantiopteryx plicata	4	1	3	15				3						15	18
Pteronotus parnellii (Fig. 18C)	1	0		2									2		2
Pteronotus davyi	4	1	2	5	1				1		1		5	1	8
Pteronotus personatus	1	0				1				1					1
Trachops cirrhosus (Fig. 18D)	1	0	1								1				1
Micronycteris microtis (Fig. 18E)	2	1	1	6				1						6	7
Phyllostomus discolor	1	0	1					1							1

Scientific Name	RF (%)	RA (%)	Ecosystem				Sampled Sites								Total
			DF	HF	CF	S	WA	PA	LV	LC	SR	EA	SM	EI	
Anoura geoffroyi	1	0		1										1	1
Glossophaga leachii	13	2	10	6	4			1	2			2	5	10	20
Glossophaga commissarisi	12	2	12	10	2		2	2			1		5	14	24
Glossophaga soricina	5	1	2		3	2	3			2				2	7
Choeroniscus godmani	1	0		1										1	1
Carollia subrufa	6	1	9	6				1			7		5	2	15
Artibeus intermedius[2]				1										1	1
Artibeus jamaicensis	23	17	147	43		32		117		32	7		14	52	222
Artibeus lituratus	9	1	11		5	2	5			2			2	5	18
Artibeus toltecus	10	2	14	7	4		3					1	2	19	25
Artibeus aztecus	2	0			3							3			3
Artibeus phaeotis	1	0	1											1	1
Artibeus hartii	1	0	1											1	1
Artibeus helleri	1	0		1										1	1
Uroderma bilobatum	1	0				1				1					1

Scientific Name	RF (%)	RA (%)	Ecosystem				Sampled Sites								Total
			DF	HF	CF	S	WA	PA	LV	LC	SR	EA	SM	EI	
Chiroderma salvini	2	0		1	2		2							1	3
Centurio senex (Fig. 18F)	3	1	8											8	8
Sturnira lilium	11	1	3	8	4	2	1	2	1	2		2		9	17
Sturnira ludovici	8	2		9	16		2		14					9	25
Diphylla ecaudata	1	0	1											1	1
Desmodus rotundus	6	2	15	2	4			3			8	4	2	4	21
Natalus stramineus	4	0	1	2	2				2					3	5
Eptesicus furinalis	1	0	1											1	1
Eptesicus fuscus	1	0			1		1								1
Bauerus dubiaquercus (Fig. 5-1G)	1	0		3										3	3
Myotis elegans	2	0	5								2			3	5
Myotis keaysi	26	13	8	62	100		31		34		2	35	1	67	170
Myotis nigricans	2	1			7				1			6			7
Rhogeessa tumida	4	0	2	1		1		1		1				2	4

Scientific Name	RF (%)	RA (%)	Ecosystem				Sampled Sites								Total
			DF	HF	CF	S	WA	PA	LV	LC	SR	EA	SM	EI	
Sciurus deppei	12	1		1	16		1		12			3		1	17
Sciurus variegatoides	9	1	6	2	3		1	2	1			1	2	4	11
Orthogeomys grandis	4	0	1	1	3				2			1	1	1	5
Liomys salvini	11	1	9	6		1		4		1			7	4	16
Oryzomys couesi	1	0				1				1					1
Ototylomys phyllotis (Fig. 18H)	4	0	2	4				1					4	1	6
Tylomys nudicaudatus	2	0		3										3	3
Neotoma mexicana (Fig. 18I)	1	0			1				1						1
Nyctomys sumichrasti	7	1	1	1	5			1	4			1		1	7
Peromyscus mexicanus (Fig. 18J)	18	8		14	84		8		62			14		14	98
Reithrodontomys mexicanus	1	0			1				1						1
Sigmodon hispidus	5	0	1	2		3				3	1			2	6
Coendou mexicanus[1]				1										1	1
Dasyprocta punctata (Fig. 18K)	46	8	15	63	20		4	3	9			7	1	74	98

Scientific Name	RF (%)	RA (%)	Ecosystem				Sampled Sites								Total
			DF	HF	CF	S	WA	PA	LV	LC	SR	EA	SM	EI	
Cuniculus paca (Fig. 18L)	21	4	5	50										55	55
Urocyon cinereoargenteus (Fig. 18M)	18	2	3		23	3	1	2	21	3		1	1		29
Puma yaguarondi (Fig. 18N)	2	0	1	1				1						1	2
Leopardus wiedii (Fig. 18Ñ)	1	0	1					1							1
Mephitis macroura[1]			1					1							1
Spilogale angustifrons[1]			1					1							1
Mustela frenata[1]			1										1		1
Eira barbara	1	0		1										1	1
Potos flavus (Fig. 18O)	13	1	6	5	8				5			3		11	19
Bassariscus sumichrasti	8	1	2	7				1						8	9
Nasua narica (Fig. 18P)	13	3		45										45	45
Procyon lotor (Fig. 18Q)	17	2	18	2		4		7		4	9			4	24
Sylvilagus floridanus	6	1	1		2	4	1		1	4	1				7
Odocoileus virginianus (Fig. 18R)	19	2	1	13	18				16			2		14	32

Scientific Name	RF (%)	RA (%)	Ecosystem				Sampled Sites								Total
			DF	HF	CF	S	WA	PA	LV	LC	SR	EA	SM	EI	
Tayassu tajacu (Fig. 18S)	4	1	1	6										7	7
Total records	**-**	**-**	**370**	**480**	**376**	**71**	**70**	**168**	**214**	**71**	**54**	**91**	**68**	**575**	**1296**
Species recorded during the study	**-**	**-**	**44**	**44**	**31**	**17**	**16**	**27**	**22**	**16**	**13**	**21**	**21**	**53**	**72**
Total species[3]	**-**	**-**	**78**	**70**	**56**	**25**	**18**	**31**	**47**	**25**	**40**	**21**	**43**	**72**	**101**

RF (%) = Relative Frequency, RA (%) = Relative Abundance, DF = Dry Forest, HF = Humid Forest, CF= Cloud Forest, S= Savanna, WA=West Apaneca, PA = Plan de Amayo, LV = Los Volcanes (only in cloud forest), LC = Los Cóbanos, SR = Santa Rita, EA=East Apaneca, SM = San Marcelino, EI = El Imposible.

[1]Reported outside of sampling.

[2]*A. intermedius* may be a subspecies of *A. lituratus* (Reid 1997).

[3]Species totals take into account prior investigations.

Figure 18A. Nine-banded Armadillo (*Dasypus novemcinctus*), El Imposible National Park, taken with camera traps, November 2007.

Figure 18B. Northern Tamandua (*Tamandua mexicana*), El Imposible National Park, taken with camera traps, December 2007.

Figure 18C. Common Moustached Bat (*Pteronotus parnellii*), San Marcelino Complex Protected Natural Area, October 2007, by Melissa Rodríguez.

Figure 18D. Fringe-lipped Bat (*Trachops cirrhosus*), Santa Rita Protected Natural Area, Sepember 2007, by Melissa Rodríguez.

Figure 18E. Common Big-eared Bat (*Micronycteris microtis*), El Imposible National Park, October 2007, by Stefany Henríquez.

Figure 18F. Wrinkle-faced bat (*Centurio senex*), El Imposible National Park, December 2007, by Melissa Rodríguez.

Figure 18G. Van Gelder´s Bat (*Bauerus dubiaquercus*), Imposible National Park, Cerro Campana sector, December 2007, by Luis Girón.

Figure 18H. Big-eared Climbing Rat (*Ototylomys phyllotis*), San Marcelino Complex Protected Natural Area, October 2007, by Luis Girón.

Figure 18I. Mexican Wood Rat (*Neotoma mexicana*), Cerro Verde, Los Volcanes National Park, September 2007, by Luis Giròn.

Figure 18J. Mexican Deer Mouse (*Peromyscus mexicanus*), Laguna Las Ranas Protected Natural Area, October 2007, by Melissa Rodríguez.

Figure 18K. Central American Agouti (*Dasyprocta punctata*), Laguna Las Ranas Protected Natural Area, taken with camera traps, October 2007.

Figure 18L. Paca (*Cuniculus paca*), El Imposible National Park, taken with camera traps, December 2007.

Figure 18M. Gray Fox (*Urocyon cinereoargenteus*), Los Volcanes National Park, Los Andes sector, taken with camera traps, August 2007.

Figure 18N. Jaguarundi (*Puma yagouaroundi*), Plan de Amayo Protected Natural Area, taken with camera traps, July 2007.

Figure 18Ñ. Margay (*Leopardus wiedii*), Plan de Amayo Protected Natural Area, taken with camera traps, July 2007.

Figure 18O. Kinkajou (*Potos flavus*), El Imposible National Park, November 2007, by Luis Girón.

Figure 18P. Coati (*Nasua narica*), El Imposible National Park, taken with camera traps, December 2007.

Figure 18Q. Northern Raccoon (*Procyon lotor*), El Imposible National Park, taken with camera traps, October 2007.

Figure 18R. White-tailed Deer (*Odocoileus virginianus*), Los Volcanes National Park, Cerro Verde, taken with camera traps, September 2007.

Figure 18S. Collared Peccary (*Tayassu tajacu*), El Imposible National Park, taken with camera traps, November 2007.

FIGURE 18. SELECTED MAMMAL PHOTOGRAPHS TAKEN DURING THE STUDY.

3.2. STATUS OF INVENTORY COMPLETION

Four new species, all bats, were recorded in the study area for the first time (*Micronycteris microtis, Pteronotus parnelli, Pteronotus personatus,* and *Bauerus dubiaquercus*), increasing the list of mammals for the study area to 101 species (Table 49). *Bauerus dubiaquercus* was new for El Salvador (Girón, Owen & Rodríguez in press). Considering the list of 48 indicator species used to evaluate inventory completion, we estimated that the level of inventory completeness for the study area increased from 92% to 100%. The Protected Natural Areas with the most complete inventories are: El Imposible (81%), Santa Rita (63%), and Los Volcanes (52%) (Table 50).

Inventory completeness indices have been calculated for nine watersheds. The watersheds with the highest level of inventory completeness are: Cara Sucia (83%), Barra de Santiago (79%), Grande de Sonsonate (67%), and Coatepeque (67%) (Tabla 51). Indices of completeness were calculated for 16 municipalities. Those with the highest indices are San Francisco Menéndez (85%), Santa Ana (60%), Tacuba (46%), Acajutla (46%), and Caluco (46%) (Table 52). Among ecosystems, the habitats with the highest inventory completeness indices are: Dry Forest (90%), Humid Forest (79%), and Cloud Forest (67%) (Table 53).

TABLE 49. LIST OF TERRESTRIAL MAMMAL SPECIES RECORDED IN SOUTHWESTERN EL SALVADOR THROUGH 2007.

Order	Family	Scientific Name	Spanish Common Name	English Common Name	Source
DIDELPHIMORPHA					
	DIDELPHIDAE				
		Didelphis marsupialis	Tacuazín Negro	Common Opossum	Present Study
		Didelphis virginiana	Tacuazín Blanco	Virginia Opossum	Present Study
		Philander opossum	Tacuazín Cuatro Ojos o Hurón	Gray Four-eyed Opossum	Present Study
		Marmosa mexicana	Tacuazín Ratón	Mexican Mouse Opossum	Present Study
		Chironectes minimus	Tacuazín de Agua	Water Opossum	SalvaNATURA Database
XENARTHRA					
	DASYPODIDAE				
		Dasypus novemcinctus	Cusuco	Nine-banded Armadillo	Present Study
	MYRMECOPHAGIDAE				
		Tamandua mexicana	Oso Hormiguero	Northern Tamandua	Present Study
INSECTIVORA					
	SORICIDAE				
		Cryptotis parva	Musaraña Listada	Least Shrew	SalvaNATURA Database
		Cryptotis merriami	Musaraña de Orejas Cortas	Merriam´s Short-eared Shrew	Néstor Herrera, unpublished data
CHIROPTERA					
	EMBALLONURIDAE				
		Saccopteryx bilineata	Murciélago Grande de Líneas Blancas	Greater White-lined Bat	Present Study
		Balantiopteryx plicata	Murciélago Gris de Alas de Saco	Gray Sac-winged Bat	Present Study
		Peropteryx macrotis	Murciélago	Lesser Doglike Bat	SalvaNATURA Database
	MORMOOPIDAE				
		Pteronotus parnellii	Murciélago Bigotudo Común	Common Mustached Bat	Present Study

Order	Family	Scientific Name	Spanish Common Name	English Common Name	Source
		Pteronotus davyi	Murciélaguito de Espalda Desnuda	Davy's Naked-backed Bat	Present Study
		Pteronotus personatus	Murciélago Bigotudo	Lesser Mustached Bat	Present Study
	NOCTILIONIDAE				
		Noctilio leporinus	Murciélago Pescador	Fishing Bat	SalvaNATURA Database
		Noctilio albiventris	Murciélago Pescador Pequeño	Lesser Fishing Bat	SalvaNATURA Database
	PHYLLOSTOMIDAE				
		Trachops cirrhosus	Murciélago con Verrugas en el Labio	Fringe-lipped Bat	Present Study
		Micronycteris microtis	Murciélago Orejudo Común	Common Big-eared Bat	Present Study
		Chrotopterus auritus	Murciélago Falso Vampiro	Woolly False Vampire Bat	SalvaNATURA Database
		Phyllostomus discolor	Murciélago Hoja de Lanza Menor	Pale Spear-nosed Bat	Present Study
		Anoura geoffroyi	Murciélago Longirostro Común de Piernas Peludas	Geoffroy's Tailless Bat	Present Study
		Glossophaga leachii	Murciélago Longirostro gris	Gray Long-tounged Bat	Present Study
		Glossophaga commissarisi	Murciélago Longirostro de Commissari	Commissaris's Long-tounged Bat	Present Study
		Glossophaga soricina	Murciélago Longirostro Común	Pallas's Long-tounged Bat	Present Study
		Choeroniscus godmani	Murciélago de Godman	Godman’s Whiskered Bat	Present Study
		Carollia perspicillata	Murciélago Frutero Común de Cola Corta	Seba's Short-tailed Bat	SalvaNATURA Database
		Carollia subrufa	Murciélago de Cola Corta Común	Gray Short-tailed Bat	Present Study
		Artibeus intermedius	Murciélago Frutero Intermedio	Intermediate Fruit-eating Bat	Present Study
		Artibeus jamaicensis	Murciélago Frutero de Jamaica	Jamaican Fruit-eating Bat	Present Study
		Artibeus lituratus	Murciélago Frutero Mayor	Great Fruit-eating Bat	Present Study
		Artibeus toltecus	Murciélago Frutero Tolteca	Toltec Fruit-eating Bat	Present Study
		Artibeus aztecus	Murciélago Frutero Azteca	Aztec Fruit-eating Bat	Present Study

Order	Family	Scientific Name	Spanish Common Name	English Common Name	Source
		Artibeus phaeotis	Murciélago Peludo de Ojos Grandes	Hairy Big-eyed Bat	Present Study
		Artibeus hartii	Murciélago Frutero Pigmeo	Pygmy Fruit-eating Bat	Present Study
		Artibeus helleri	Murciélago de Heller	Heller's Broad-nosed Bat	Present Study
		Uroderma bilobatum	Murciélago Constructor de Tiendas Común	Common Tent-making Bat	Present Study
		Chiroderma salvini	Murciélago de Ojos Grandes de Salvin	Salvin's Big-eyed Bat	Present Study
		Chiroderma villosum	Murciélago Frutero de Velvety	Velvety Fruit-eating Bat	SalvaNATURA Database
		Centurio senex	Murciélago de Cara Arrugada	Wrinkle-faced Bat	Present Study
		Sturnira lilium	Murciélago Frutero Común de Hombros Amarillos	Little Yellow Shouldered Bat	Present Study
		Sturnira ludovici	Murciélago Frutero de Occidente	Highland Yellow-shouldered Bat	Present Study
		Diphylla ecaudata	Vampiro de Patas Peludas	Hairy-legged Vampire Bat	Present Study
		Desmodus rotundus	Vampiro Común	Common Vampire Bat	Present Study
	NATALIDAE				
		Natalus stramineus	Murciélago de Orejas de Embudo	Mexican Funnel-eared Bat	Present Study
	VESPERTILIONIDAE				
		Eptesicus furinalis	Murciélago Vespertino Menor	Argentine Brown Bat	Present Study
		Eptesicus fuscus	Murciélago Café Gande	Big Brown Bat	Present Study
		Bauerus dubiaquercus	Murciélago de Van Gelder	Van Gelder´s Bat	Present Study
		Lasiurus ega	Murciélago Amarillo del sur	Southern Yellow Bat	Girón 2005
		Lasiurus intermedius	Murciélago Amarillo Centroamericano	Central American Yellow Bat	SalvaNATURA Database
		Myotis elegans	Murciélago Elegante	Elegant Myotis	Present Study
		Myotis keaysi	Murciélago de patas peludas	Hairy-legged Myotis	Present Study
		Myotis nigricans	Murciélago Negruzco Común	Black Myotis	Present Study
		Rhogeessa tumida	Murciélago Enano de Alas Negras	Black-winged Little Yellow Bat	Present Study
	MOLOSSIDAE				
		*Molossops greenhalli**	Murciélago Cara de Perro de	Greenhall's Dog-faced Bat	Girón 2005

Order	Family	Scientific Name	Spanish Common Name	English Common Name	Source
			Greenhall		
		Molossus molossus	Murciélago Mastín Común	Pallas's Mastiff Bat	SalvaNATURA Database
		Molossus ater	Murciélago Mastín Negro	Black Mastiff Bat	SalvaNATURA Database
		Eumops underwoodi	Murciélago de Underwood	Underwood's Bonneted Bat	SalvaNATURA Database
		*Nyctinomops laticaudatus**	Moloso Cola de Ratón Mediano	Broad-eared Bat	Girón 2005
RODENTIA					
	SCIURIDAE				
		Sciurus deppei	Ardilla Cuzca o Ardilla Café	Deppe's Squirrel	Present Study
		Sciurus variegatoides	Ardilla Gris	Variegated Squirrel	Present Study
	GEOMYIDAE				
		Orthogeomys grandis	Taltuza	Giant Pocket Gopher	Present Study
	HETEROMYIDAE				
		Liomys salvini	Ratón Bolsero	Salvin's Spiny Pocket Mouse	Present Study
	CRICETIDAE				
		Mus musculus	Ratón Casero	House Mouse	SalvaNATURA Database
		Rattus rattus	Rata Negra	House Rat, Black Rat	SalvaNATURA Database
		Baiomys musculus	Ratón Bolsero del Sur	Southern Pygmy Mouse	SalvaNATURA Database
		Oryzomys couesi	Ratón Arrocero de Coues	Coues' Rice Rat	Present Study
		Oryzomys rostratus	Ratón Arrocero	Rusty Rice Rat	SalvaNATURA Database
		Ototylomys phyllotis	Rata Escaladora de Orejas Grandes	Big-eared Climbing Rat	Present Study
		Olygoryzomys fulvescens	Ratón Arrocera Pigmea del Norte	Northern Pygmy Rice Rat	Ibarra 2005

Order	Family	Scientific Name	Spanish Common Name	English Common Name	Source
		Tylomys nudicaudus	Rata Escaladora del norte	Northern Climbing Rat	Present Study
		Neotoma mexicana	Rata Mexicana de Bosque	Mexican Wood Rat	Present Study
		Nyctomys sumichrasti	Ratón Jocotero	Vesper Rat	Present Study
		Peromyscus mexicanus	Ratón Venado Mexicano	Mexican Deer Mouse	Present Study
		Reithrodontomys gracilis	Ratón Cosechador	Slender Harvest Mouse	SalvaNATURA Database
		Reithrodontomys mexicanus	Ratón Cosechador Mexicano	Mexican Harvest Mouse	Present Study
		Rheomys thomasi	Ratón de Agua	Thomas's Water Mouse	SalvaNATURA Database
		Sigmodon hispidus	Rata Algodonera	Hispid Cotton Rat	Present Study
	ERETHIZONTIDAE				
		Sphiggurus mexicanus	Puerco Espín o Zorro Espín	Mexican Porcupine	Present Study
	DASYPROCTIDAE				
		Dasyprocta punctata	Cotuza	Central American Agouti	Present Study
	CUNICULIDAE				
		Cuniculus paca	Tepezcuintle	Paca	Present Study
CARNIVORA					
	CANIDAE				
		Canis latrans	Coyote	Coyote	Nestor Herrera, unpublished data
		Urocyon cinereoargenteus	Zorra Gris o gato de monte	Gray Fox	Present Study
	FELIDAE				
		Puma yagouaroundi	Yaguarundi o Gato Zonto	Jaguarundi	Present Study
		Puma concolor	Puma	Puma	Néstor Herrera, unpublished data
		Leopardus pardalis	Ocelote	Ocelot	SalvaNATURA Database

Order	Family	Scientific Name	Spanish Common Name	English Common Name	Source
		Leopardus wiedii	Tigrillo	Margay, Tree Ocelot	Present Study
	MEPHITIDAE				
		Mephitis macroura	Zorrillo Listado	Common Hog-nosed Skunk	Present Study
		Conepatus leuconotus	Zorrillo Lomo Blanco	Hooded Skunk	Néstor Herrera, Data not published
		Spilogale angustifrons	Zorrilo Manchado	Spotted Skunk	Present Study
	MUSTELIDAE				
		Mustela frenata	Comadreja Andina (Comadreja)	Long-tailed Weasel	Rivera Muñoz 2000
		Eira barbara	Tayra	Tayra	Present Study
		Lontra longicaudis	Nutria	Neotropical River Otter	SalvaNATURA Database
	PROCYONIDAE				
		Potos flavus	Micoleón	Kinkajou	Present Study
		Bassariscus sumichrasti	Cacomistle, Guayanoche	Central American Cacomistle	Present Study
		Nasua narica	Pezote	Coatimundi	Present Study
		Procyon lotor	Mapache	Northern Raccoon	Present Study
LAGOMORPHA					
	LEPORIDAE				
		Sylvilagus floridanus	Conejo Silvestre	Eastern Cottontail	Present Study
ARTIODACTYLA					
	CERVIDAE				
		Odocoileus virginianus	Venado Cola Blanca	White-tailed Deer	Present Study
	TAYASSUIDAE				
		Tayassu tajacu	Cuche de monte	Collared Peccary	Present Study
PERISODACTYLA					
	TAPIRIDAE				
		Tapirus bairdi	Tapir o Danta	Baird´s Tapir	SalvaNATURA Database
9	**27**	**101**			

The records deposited in the SalvaNATURA database for this study come from specimens found in the following museums: American Museum of Natural History (AMNH), Carnegie Museum of Natural History (CM), Museo de Historia Natural de El Salvador (MUHNES), Harrison Museum (HM), Royal Ontario Museum of Natural History, Texas Cooperative Wildlife Collection (TCWC), Museum of Vertebrate Zoology (MVZ) y The Museum of Natural History of the University of Kansas (KU). Furthermore, data has been taken from the *Salva*NATURA/WCS Neobats-El Salvador project.

* = Ultrasound record. Never collected in the country.

TABLE 50. LEVEL OF MAMMAL INVENTORY COMPLETENESS IN THE PROTECTED NATURAL AREAS.

Protected Natural Area	Species Recorded in the Study	Species Recorded in the Site	Inventory Completeness		Conservation Important Species	
			% Previous	% Current	% Previous	% Current
El Imposible	53	72	63	81	32	41
Los Cóbanos	16	25	2	40	3	6
Los Volcanes	23	47	33	52	15	21
Plan de Amayo	27	31	23	52	0	12
San Marcelino	21	43	42	63	12	12
Santa Rita	13	40	52	63	3	9
Sierra de Apaneca East	21	21	2	35	0	0
Sierra de Apaneca West	16	18	0	29	0	3
TOTAL[7]	**73**	**103**	**92**	**100**	**47**	**65**

[7]The entire study area.

TABLE 51. INVENTORY COMPLETENESS FOR MAMMALS AND RELATIVE IMPORTANCE OF WATERSHEDS.

Watershed	Inventory Completeness		Conservation Important Species	
	% Previous	% Current	% Previous	% Current
Barra de Santiago	54	79	18	24
Barra Salada	0	0	0	0
Bocana San Juan	15	15	0	0
Cara Sucia	58	83	35	41
Cauta	0	0	0	0
Coatepeque	46	67	18	21
Grande de Sonsonate	42	67	3	6
Izalco	21	31	0	0
Los Cóbanos	2	40	3	6
San Julián	19	46	0	18
San Pedro	13	17	3	3

TABLE 52. INVENTORY COMPLETENESS FOR MAMMALS AND RELATIVE IMPORTANCE OF MUNICIPALITIES.

Municipality	Inventory Completeness		Conservation Important Species	
	% Previous	% Current	% Previous	% Current
Acajutla	17	46	6	9
Apaneca	0	29	0	3
Armenia	0	19	0	3
Atiquizaya	0	27	0	0
Caluco	19	46	0	12
Chalchuapa	4	31	0	0
Concepción de Ataco	0	0	0	0
Cuisnahuat	0	0	0	0
El Congo	0	19	0	6
Guaymango	0	0	0	0
Izalco	2	23	0	0
Juayua	17	21	0	0
Jujutla	23	42	3	9
Nahuizalco	21	21	0	0
Nahulingo	0	0	0	0
Salcoatitán	0	0	0	0
San Antonio del Monte	0	0	0	0
San Francisco Menéndez	56	85	18	44
San Julián	0	0	0	0
San Pedro Puxtla	13	13	0	0
Santa Ana	52	60	12	12
Santa Catarina Masahuat	0	0	0	0
Sto. Domingo de Guzmán	0	0	0	0
Sonsonate	2	10	3	3
Sonzacate	0	0	0	0
Tacuba	21	46	0	26
Tepecoyo	0	0	0	0

TABLE 53. INVENTORY COMPLETENESS FOR MAMMALS AND RELATIVE IMPORTANCE OF ECOSYSTEMS.

Ecosystem	Inventory Completeness		Conservation Important Species	
	% Previous	% Current	% Previous	% Current
Humid forest	**48**	**79**	**15**	**32**
Cloud forest	**50**	**67**	**9**	**21**
Dry forest	**69**	**90**	**24**	**47**
Freshwater	**33**	**33**	**6**	**6**
Intertidal	**0**	**0**	**0**	**0**
Mangrove	**33**	**42**	**6**	**9**
Savanna	**2**	**40**	**3**	**6**

Another way of calculating inventory completeness is by using species accumulation curves. For this study the accumulation curve is still not stabilized after 98 days of standardized sampling efforts (Fig.19). Based on this curve, different estimators project from 91 up to 138 species of land mammals in the southwestern region of El Salvador (Table 54). On the other hand, taking into account that we have already recorded 101 species and we are still missing 12 species of conservation importance that are potentially present in the area, we can estimate the existence of at least 113 terrestrial mammal species in the study area. In any case, we expect additional species, particularly bats and rodents, even though 100% of the expected generalists have already been detected.

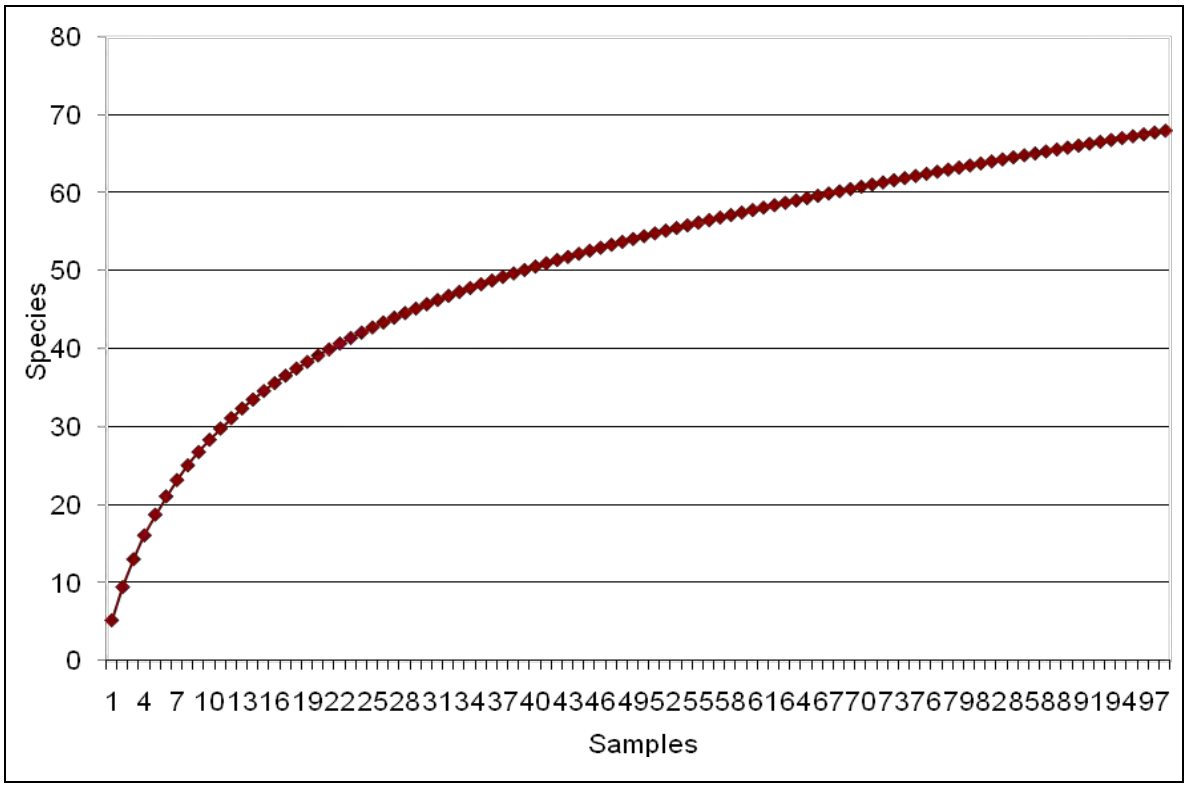

FIGURE 19. SPECIES ACCUMULATION CURVE OF TERRESTRIAL MAMMALS IN SOUTHWESTERN EL SALVADOR.

For ecosystems, the accumulation curves also do not become stabilized (Fig. 20). For Dry Forest, the richness calculators estimate there could be up to 69 species, for the Humid Forest up to 75, for the Cloud Forest up to 43 and for Savanna up to 26 (Table 54). In the case of Dry Forest, 78 species have been recorded including previous studies (greater than the estimated richness) and very few expected species are still missing to complete the inventory; it is a similar case with the Humid Forest and the Cloud Forest, reporting 70 and 57 species, respectively. Savanna reports 25 species whereas a maximum of 26 are estimated.

TABLE 54. ESTIMATORS OF TERRESTRIAL MAMMAL SPECIES RICHNESS IN THE STUDY AREA AND IN EACH ECOSYSTEM.

Richness Estimator	Estimated Richness (Colwell 2006)				
	Total Area	Dry Forest	Humid Forest	Cloud Forest	Savanna
ACE	92	67	54	34	20
ICE	95	63	67	40	23
Chao 1	138	67	53	33	19
Chao 2	99	59	68	36	21
Jack-Knife 1	91	60	62	40	23
Jack-Knife 2	107	69	75	43	26
Average	**104**	**64**	**63**	**38**	**22**

The fact that both the Dry Forest and Cloud Forest present lists with more species than were estimated from the species accumulation curve, suggests that some of the species reported in the past are already locally extinct. Some examples of possibly extinct species are: *Chrotopterus auritus* collected only once in 1927 at the Barra de Santiago, *Reithrodontomys gracilis* collected for the last time in 1958 at Lake Coatepeque and *Tapirus bairdi* for which there is a report of a skull found in 1987 near El Imposible National Park although it is unknown when the specimen was alive. Although there are no formal records, elderly persons living in the area still remember when the jaguar (*Pantera onca*) existed (Karla Lara, pers. comm.) and it is also possible that the Spider Monkey *Ateles geoffroyi* lived in the area many years ago.

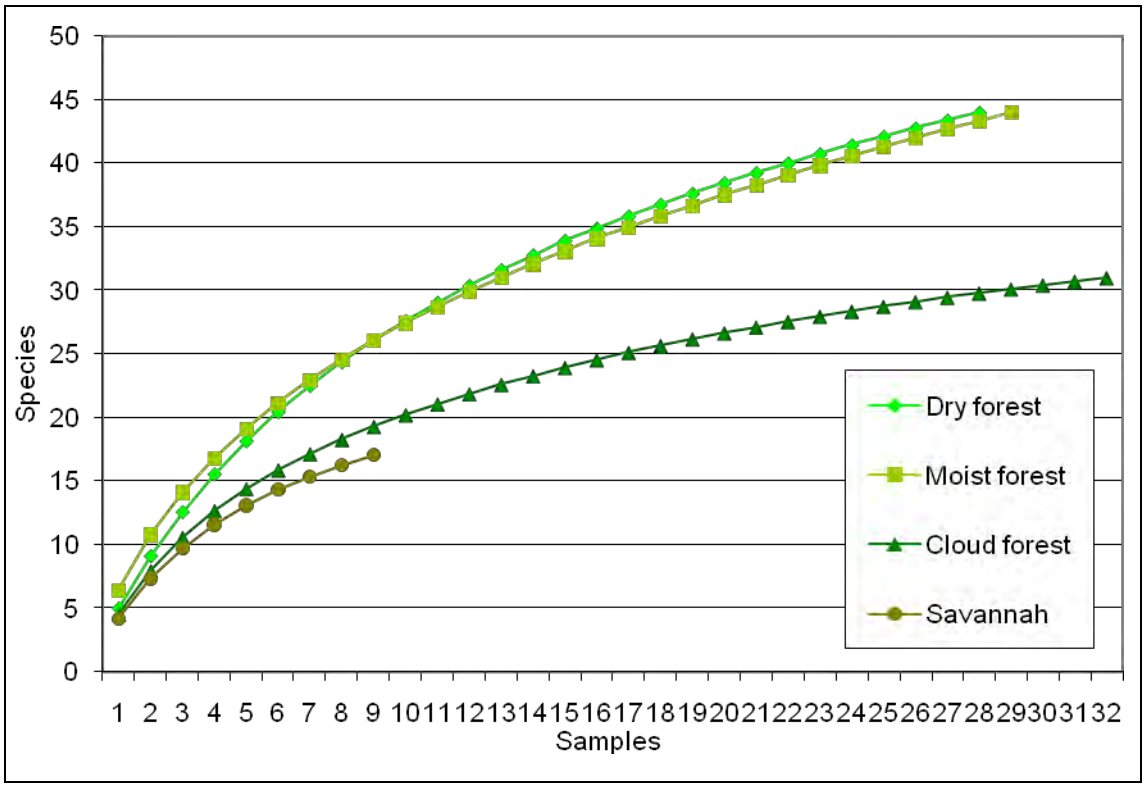

FIGURE 20. ACCUMULATION CURVES OF TERRESTRIAL MAMMAL SPECIES BY ECOSYSTEM.

3.3. SPECIES OF CONSERVATION IMPORTANCE

Twenty-two threatened species, indicators of conservation importance, have been recorded in the study area. Examples include the Margay Cat (*Leopardus wiedii*), Ocelot (*Leopardus pardalis*), Central American River Otter (*Lontra longicaudis*), and the Baird's Tapir (*Tapirus bairdi*). There are 11 threatened species and seven endangered species at the national level (MARN 2004), and also one globally endangered species (IUCN 2008) (See Table 47).

Below is a description of some important species:

Trachops cirrhosus (Fig. 18D). Up until 2004 this species was only known in El Salvador from three sites in the departments of La Libertad and San Miguel. On 19 September 2007, we found the second record for Santa Rita and the second record since 1953 in the country. The first record from Santa Rita was in June 2005 during the Neobats-El Salvador project. The species is considered nationally threatened (MARN 2004).

Micronycteris microtis (Fig. 18E). This species had not been captured in El Salvador since 1978 and was only known in El Salvador from four sites in the departments of San Miguel and La Libertad. We recorded the species at Plan de Amayo on 21 July 2007 and at El Imposible National Park on 31 October 2007. These are the first records for the project area and for the departments of Sonsonate and Ahuachapán, respectively. This species is considered nationally threatened (MARN 2004).

Bauerus dubiaquercus (Fig. 18G). On 15 December 2007, this species was recorded for the first time in El Salvador at El Imposible National Park (Girón et al. in press). Previously, its known distribution range was highly fragmented, with populations known from Jalisco, Guerrero and the Island of Tres Marías in Mexico, and on the Caribbean slopes of Honduras and Costa Rica. It has a globally Near-Threatened status (IUCN 2008).

Neotoma mexicana (Fig. 18I). This species had only been collected in Montecristo and at the Santa Ana Volcano. On 9 September 2007, we found an individual at Cerro Verde, the first collection of the species since 1979. This rodent is considered nationally endangered (MARN 2004).

Leopardus wiedii (Fig. 18Ñ). This species was only documented from five sities around the country: Cerro Cacahuatique, Montecristo, Jucuarán, La Montañona, and El Imposible. We provide the first record for Plan de Amayo, from a camera trap on 22 July 2007.

3.4. EVALUATION OF CONSERVATION IMPORTANCE FOR THE SITES AND ECOSYSTEMS UNDER STUDY.

Of the list of 34 threatened species identified as indicators of site importance, the proportion actually recorded in the project area increased from 47% to 65%. At the watershed level, only two have reasonably complete inventories, permitting comparisons of site importance. The Cara Sucia watershed has 41% indicators for site importance,

while the Barra de Santiago has only 24% (Table 51). Only one municipality has a reasonably complete inventory, therefore the relative importance of the municipalities cannot be analyzed. Regarding ecosystems, only two relatively complete inventories can be compared. The Dry Forest (47%) is more important than the Humid Forest (32%) (Table 53). Only one Protected Natural Area has a nearly complete inventory, therefore the Protected Natural Areas cannot be analyzed for relative importance.

4. RECOMMENDATIONS

To complement the efforts made and complete the inventories, we recommend working at the following sites: San Marcelino, Plan de Amayo and in the coffee plantations of the Apaneca mountain range to see if mammal species may be using the scattered remnants of natural forest and shaded plantations as a biological corridor. For example, the Large Brown Bat (*Eptesicus fuscus*) has been recorded at the eastern extreme of the mountain range (Santa Ana Volcano) and at west side of the range, at Laguna de Las Ninfas. San Marcelino and Plan de Amayo are important sites for mammal conservation but have not been studied in depth and their inventories are incomplete.

Permanent monitoring stations with camera traps should be established in the natural areas where felines have been detected; little is known about their populations and all of the members of the cat family are nationally threatened, which makes it important to study these species.

The Anabat acoustic sampling technique should be carried out to detect high flying bats as these are captured only on very rare occasions, such as the Greenhall Dog-faced Bat (*Molossops greenhalli*), which has only been recorded in El Salvador by that technique.

It is very important to monitor and carry out ecological studies of some mammal species that enter into conflict with humans due to their interference with agricultural crops. This situation is mentioned constantly in communities adjoining the natural areas and we recommend studying this problem. If it is documented that some species may cause more harm to the crops and therefore generate economic losses, then a strategy could be established to minimize the problem without harming the mammal populations involved. Some mammal population controls may be warranted, because of the demise of natural predators, such as the jaguar (*Panthera onca*) and the puma (*Puma concolor*).

REFERENCES

Amaya, J.A., S.M. García & T.A. Valladares. 2003. Estudio de la composición florística del estrato arbustivo en el Cerro –El Águila" Municipio de Chalchuapa, Santa Ana.Tésis de Licenciatura. El Salvador: Universidad de El Salvador. 49 p.

Barahona, D. E. & A. V. Henríquez. 2007. Captura incidental de tortugas marinas en la pesca de palangre de fondo con anzuelos –J" y anzuelos circulares 13 y 14, y su efectividad en la pesca de peces demersales de la costa salvadoreña. Trabajo de Graduación para optar al grado de Licenciatura en Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 98 pp.

Baum, J.K., Myers, R.A., Kehler, D.G., Worm, B., Harley, S.J., & Doherty, P.A. 2003. Collapse and conservation of shark populations in the Northwest Atlantic. Science 299:389-392.

Bishop S.D.H, Francis M.P, Duffy C. &, Montgomery J.C. 2006. Age, growth, maturity, longevity and natural mortality of the shortfin mako (*Isurus oxyrinchus*) in New Zealand waters. Marine and Freshwater Research 57: 143–154.

Bjork, R. D. 2009. Reintroduction of the Scarlet Macaw to El Salvador. Parrots International Magazine 1, on-line (3 pp.).

Boeseman, M. 1956. Sobre una colección de peces de la República de El Salvador. Comunicaciones, Instituto Tropical de Investigaciones Científicas, Universidad de El Salvador, El Salvador. 4: (2/3). 75–88 pp.

Burt, W. H. & R. A. Stirton. 1961. The mammals of El Salvador. Miscellaneous Publications Museum of Zoology, University of Michigan 117: 1–69.

Bussing, W. A. 1976. Geographic distribution of the San Juan Ichthyofauna of Central America with remarks on its origin and ecology, pp. 157–175 In T.B. Thorson (eds). Investigations of Nicaraguan Lakes. School of Life Sciences, Univ. Nebraska.

Bussing, W. A. 1987. Los peces de las aguas continentales de Costa Rica. Editorial Universidad de Costa Rica. 287 pp.

Bussing, W. A. 1998. Peces de las aguas continentales de Costa Rica/Freshwater fishes of Costa Rica. Editorial Universidad de Costa Rica. 448 pp.

Bussing, W. A. & M. I. López. 1993. Peces demersales y pelágicos costeros del Pacífico de Centroamérica Meridional. Rev. Biol. Trop. Publicación Especial: 1–164 pp.

Cabrera Martínez, G. I. & D. I. Mejía Marroquín. 1998. Vegetación del bosque las Lajas, Refugio de Vida Silvestre del Complejo San Marcelino, Santa Ana - Sonsonate, El Salvador. Tesis de Licenciatura. El Salvador: Universidad de El Salvador. 86 p.

Calderón, M. G. & R. A. Hernández. 1974. Estudio biológico pesquero de la Bahía de Jiquilisco. Dirección General de Recursos Naturales Renovables, MAG, El Salvador. 207–218 pp.

Candray, M. A. & C. W. Ríos. 2005. Composición y abundancia de la ictiofauna con importancia comercial en el Estero de Jaltepeque, San Luís La Herradura, Departamento de La Paz, El Salvador. Trabajo de Graduación para optar al grado de Licenciatura en Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 55 pp.

Castro, R. A. 1976. Ictiofauna y algunas determinaciones físico-químicas en el Río Lempa. Tesis para optar al grado de Licenciatura en Biología, Departamento de Biología, Facultad de Ciencias y Humanidades, Universidad de El Salvador. 79 pp.

Castro, R. A. 1983. Los métodos y aperos de pesca más importantes utilizados en los lagos, lagunas y embalses de El Salvador, su eficiencia en lo económico y en la captura por especie. Dirección General de Recursos Naturales Renovables, MAG, El Salvador. 20 pp.

Castro R. A. & J. P. Robinson. 1976. Estudio Preliminar Biológico Pesquero del Río Lempa. Dirección General de Recursos Naturales Renovables, MAG, Volumen III, El Salvador. 188 pp.

Castro R. A. & F. Godínez. 1978. Evaluación pesquera en el Lago de Ilopango y Laguna de Olomega. Dirección General de Recursos Naturales Renovables, MAG, El Salvador. 36 pp.

Centro de Desarrollo de la Pesca y la Acuicultura. 2006. Estadísticas Pesqueras y Acuícola, Vol. 33. MAG, El Salvador. 70 pp.

Cerén, J.G.; G.N. López & D. Delcid. 2003. Estudio de la composición florística del estrato herbáceo en el área natural del Cerro –El Águila".Tesis de Licenciatura. El Salvador: Universidad de El Salvador. 86 p.

Chicas, F. A., J. A. González, & W. E. Ramírez. Ecología y manejo de las comunidades de peces del Golfo de Fonseca, Departamento de La Unión, El Salvador. Centro de Investigaciones Científicas, Universidad de El Salvador, (en Prensa).

Colwell, R. K. 2006. Statistical estimation of species richness and shared species from samples. University of Connecticut, United States. www.viceroy.eeb.uconn.edu/estimate

Concheiro Pérez, G. A., L. Oldlich, G. Ortí, G. E. Bermingham, I. Doadrio, & R. Zardoya. 2005. Phylogeny and biogeography of 91 species of heroine cichlids (Teleostei: Cichlidae) based on sequences of the cytochrome *b* gene. Molecular Phylogenetics and Evolution 43 (2007) 91–110.

Cortes, J. 1997. Biology and ecology of eastern Pacific coral reefs. Coral Reefs 16: S39–S46.

Cruz, G. A. 1987. Reproductive biology and feeding habits of Cuyamel, *Joturus pichardi* and Tepemechín, *Agonostomus monticola* (Pisces: Mugilidae) from Rio Plátano, Mosquitia, Honduras. Bull. Mar. Sci. 40: 63–72.

Day, J. W., C. A. Hall, W. M. Kemp & A. Yáñez-Arancibia. 1989. Estuarine Ecology. John Willey & Sons, Inc. 557 pp.

Felten, H. 1956. Quirópteros en El Salvador. Revista Comunicaciones. Instituto Tropical de Investigaciones Científicas. pp. 153–170.

Fischer, W., F. Krupp, W. Shneider, C. Sommer, K.E. Carpenter, & V.H. Niem. 1995. Guía FAO para la identificación de especies para los fines de la pesca. Pacifico Centro-Oriental. Volumen II. Vertebrados. Parte I. Roma FAO, 647–1200 pp.

Francis, M. P., & Duffy, C. 2005. Length at maturity in three pelagic sharks (*Lamna nasus*, *Isurus oxyrinchus*, and *Prionace glauca*) from New Zealand. Fishery Bulletin 103: 489–500.

Froese, R. & D. Pauly (Eds). 2007. Fishbase. World Wide Web electronic publication. www.fishbase.org, versión (04/2008).

Fuentes, R., C. I. & N. R. Hernández R. 2004. Distribución y abundancia de la ictiofauna con importancia comercial asociada a la pesca de arrastre de camarones Peneidos (*Penaeus stylirrostris*, *P. vannamei*, *P. occidentalis*, *P. californiensis* y *P. brevirostris*) en la Costa Salvadoreña. Trabajo de Graduación para optar al grado de Licenciatura en Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 85 pp.

Galdámez, A. 2002. Composición de los peces capturados y la madurez sexual de las especies de ~~p~~argo" (Lutjanidae) en Los Cóbanos, Sonsonate. Trabajo de graduación para optar al grado de Licenciatura en Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 97 pp.

García, R. C. 1974. Inventario y esfuerzo de pesca en el Río Grande de San Miguel. Servicio Piscícola, Ministerio de Agricultura y Ganadería. 28 pp.

García, R. C. & J. P. Robinson. 1974. Estudio Biológico Pesquero del Río Paz. Dirección General de Recursos Naturales Renovables. MAG, El Salvador. 42 pp.

García Rivas, J. R. 1997. Vegetación Arbórea de Las Lajas, Refugio de Vida Silvestre, Complejo San Marcelino, Sonsonate, El Salvador. Tesis de Licenciatura. El Salvador: Universidad de El Salvador. 117 p.

Garrison, G. 2005. Peces de la Isla del Coco/ Isla del Coco Fishes. 2da edición, Santo Domingo de Heredia, Costa Rica: Instituto Nacional de Biodiversidad, INBIO, 430 pp.

Gierloff-Emden, H. G. 1958. Los ríos de El Salvador y sus subcuencas tributarias. Comunicaciones, Instituto Tropical de Investigaciones Científicas. 7, 3/4: 23–35 pp.

Girón, L. 2005. Identificación y distribución de los murciélagos del sector Los Andes del volcán de Santa Ana, Complejo Los Volcanes, Santa Ana, El Salvador. Tesis de licenciatura. Universidad de El Salvador. 76 pp.

Girón, L. E. & J.G. Owen. 2007. Status of the inventory of terrestrial mammalian fauna. Pages 74–84 *in* Komar, O., editor, Preliminary inventory in eleven hydrographic watersheds of southwest El Salvador. USAID IMCW Project /Education for Conservation Colection No. 3.

Girón, L. E., Owen, J. G., & Rodríguez, M. E. In press. Van Gelder´s Bat: first record of *Bauerus dubiaquercus* (Chiroptera: Vespertilionidae) from El Salvador, Central America. Southwest Naturalist.

Godínez, J. F. & R. Castro. 1977. Estudio sobre selección de redes agalleras, su introducción en el Lago de Ilopango y Laguna de Metapán. 71 pp.

Gómez de Silva, H. & R. A. Medellín. 2001. Evaluating completeness of species lists for conservation and macroecology: a case study of Mexican land birds. Conservation Biology 15: 1384–1395.

González, J. C. 1977. La vegetación arbórea del pedregal de San Isidro: un análisis florístico y cuantitativo. Tesis de Licenciatura, Universidad de El Salvador, San Salvador. 39 p.

González, R. G. 1995. Los peces nativos en vías de extinción en las aguas continentales de El Salvador, Proyecto Fortalecimiento a la Acuicultura, Programa Regional de Apoyo al Desarrollo de la Pesca en el Istmo Centroamericano (PRADEPESCA), El Salvador. 69 pp.

González, J. A. & W. E. Ramírez. 2007. Ictiofauna del Estero Jaltepeque, con Énfasis en Doce Especies de Importancia Comercial, El Salvador. Trabajo de Graduación para optar al grado de Licenciatura en Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 78 pp.

Greenbaum E. & O. Komar. 2005. Threat assessment and conservation prioritization of the herpetofauna of El Salvador. Biodiversity and Conservation 14: 2377–2395.

Harvey, C. A., Komar, O., Chazdon, R., Ferguson, B. G., Finegan, B., Griffith, D. M., Martínez-Ramos, M., Morales, H., Nigh, R., Soto-Pinto, L., van Breugel, M., & Wishnie, M. H. 2008. Integrating agricultural landscapes with biodiversity conservation in the Mesoamerican hotspot. Conservation Biology 22: 8–15.

Henríquez, V. 2004. Sistema de monitoreo de indicadores biológicos del Área Natural Protegida Complejo Los Volcanes. Estudio de anfibios y reptiles del Complejo Los Volcanes. Informe de consultoría para CATIE. 72 pp.

Henríquez, V. 2009. Las KBAs de El Salvador: Establecimiento de una Línea Base de Áreas Claves para la Biodiversidad. SalvaNATURA, San Salvador, El Salvador 29 pp. Available at www.salvanatura.org.

Henríquez, V. & O. Komar. 2006. Los anfibios y reptiles del Parque Nacional Los Volcanes, El Salvador: Sus valores para la conservación y el ecoturismo. Forma parte de: Komar, O., J. P. Arce, J. R. Smith & I. Varley, 2006. Evaluación de la biodiversidad del Parque Nacional Los Volcanes, El Salvador. Informe de consultoría para el Banco Interamericano de Desarrollo. SalvaNATURA Programa de Ciencias para la Conservación, San Salvador, El Salvador y NatureServe, Washington, D.C., USA. 18 pp.

Henríquez, V. & R. Vaquerano. 2008. *Sphaerodactylus glaucus* (Cope, 1865) (Sauria, Gekkonidae) nuevo registro para la herpetofauna de El Salvador. Acta Zoológica Mexicana 24 (1): 237– 238.

Hernández, R. R. 2006. Diversidad biológica en Chiapas. Capitulo 5, Diversidad de peces continentales en Chiapas. Colegio de la Frontera Sur (ECOSUR).195–221 pp.

Herrera, N., V. Henríquez, and E. Greenbaum**.** 2007. New department and country records for amphibians and reptiles from El Salvador. Herpetological Review 38:222–226.

Herrera, N. & N. Valle Andrade. 2003. Estudio de Flora y Fauna Vertebrada del Área Natural Protegida Plan de Amayo, Caluco, departamento de Sonsonate, El Salvador. Para Asociación AGAPE de El Salvador.

Hildebrand, S. F. 1925. Fishes of the Republic of El Salvador, Central America. Bull. of Bureau of Fisheries, Dept. of Commerce. U.S.A., Document N. 985. 41: 237–287 pp.

Howell, S. N. G. & S. Webb. 1995. A guide to the birds of Mexico and Central America. Oxford Univ. Press, New York.

Hrbek T.; J. Seckinger & A. Meyer 2007. A phylogenetic and biogeographic perspective on the evolution of poeciliid fishes. Molecular Phylogenetics and Evolution 43 (2007) 986–998.

Huezo Chinchilla, H. L*. &* T. *A.* Rosales Menéndez*.* 2001. Evaluación de la selectividad de redes agalleras y determinación de la madurez sexual de los *cíclicos* comerciales del Lago de Ilopango, El Salvador*.* Trabajo de Graduación para optar al grado de Licenciatura en Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 65 p.

Ibarra, R. 2005. Flora y Fauna Vertebrada del Área Natural Protegida ~~–~~Santa Águeda-El Zope" (Complejo Los Cóbanos), Sonsonate, El Salvador. Ministerio de Medio Ambiente y Recursos Naturales. 44 pp.

ICMARES/UES. 2006. Diagnostico de la línea base de las condiciones Biofísicas, Socioeconómicas e Institucionales del Sistema Arrecifal de Los Cóbanos. Instituto de Ciencias del Mar y limnología, Universidad de El Salvador, El Salvador, C.A. 2/3: 77–83 pp.

ICMARES/UES. 2007. Evaluación del área de dragado en la playa Las Veraneras, Sistema Arrecifal Los Cóbanos, Departamento de Sonsonate, El Salvador. Universidad de El Salvador. 54 pp.

IUCN. 2003. Guidelines for Application of IUCN Red List Criteria at Regional Levels: Version 3.0. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii + 26 pp.

IUCN. 2007. 2007 IUCN Red List of Threatened Species. <www.redlist.org> IUCN, Gland, Switzerland and Cambridge, UK. Accessed 23 June 2008.

IUCN. 2009. 2009 IUCN Red List of Threatened Species. <www.redlist.org> IUCN, Gland, Switzerland and Cambridge, UK. Accessed 10 July 2009.

Jiménez, D. J. 1986. Efecto de la luz en la pesca de dos especies de sardinas en el estero de la Barra de Santiago. Tesis para optar al grado de Licenciatura en Biología, Facultad de Ciencias y Humanidades, Universidad de El Salvador 78 pp.

Jiménez-Ramón, J. A. 1994. Los Manglares del Pacífico Centroamericano. Editorial Heredia, Editorial Fundación UNA, Organización para Los Estudios Tropicales (OTS) Costa Rica, 352 pp.

Johnson, K. 1971a. Reporte preliminar sobre la pesca del Lago de Güija, El Salvador. Dirección General de Recursos Naturales Renovables, MAG, El Salvador. 45 pp.

Johnson, K. 1971b. A preliminary report on the fishery of Olomega Lagoon, El Salvador. Report presented to the Ministerio de Agricultura of El Salvador. 20 pp.

Johnson, K. & A. Argumedo. 1971a. Lago de Ilopango, 1971, un estudio preliminar de la pesca del Lago. Dirección General de Recursos Naturales Renovables, MAG, El Salvador. 22 pp.

Johnson, K. & A. Argumedo. 1971b. La pesca en el Lago de Coatepeque. Dirección General de Recursos Naturales Renovables, MAG, El Salvador. 15 pp.

Johnson, K. & M. Ramírez. 1975. Estudio de la pesca en la Laguna de Apastepeque. Dirección General de Recursos Naturales Renovables, MAG. El Salvador. 40 pp.

Jones, H. L. & O. Komar. 2008. Central America (in The Regional Reports: The Nesting Season, June and July 2007). North American Birds 61: 648–651.

Köhler, G., M. Veselý, & E. Greenbaum. 2006. The amphibians and reptiles of El Salvador. Krieger Press, Melbourne, Florida. 238 pp.

Komar, O. 2002. Priority conservation areas for birds in El Salvador. Animal Conservation 5: 173–183.

Komar, O. 2003. En las listas faunísticas, no todas las especies son iguales: las aves de El Salvador como un ejemplo. Pp. 57–61 En H Gómez de Silva & A. Oliveras de Ita (eds.). Conservación de aves: experiencias en México. Cipamex. México, D.F.

Komar, O., editor. 2007. Preliminary inventory in eleven hydrographic watersheds in southwest El Salvador. Status of the flora and fauna inventory through 2006. USAID El Salvador IMCW Project Conservation Education Collection No. 3. 130 pp.

Komar, O. 2007b. Status of the inventory of birds. Pp. 85–130 *en* Komar, O. (ed.) Preliminary inventory in eleven hydrographic watersheds in southwest El Salvador: Status of the flora and fauna inventory through 2006. USAID El Salvador IMCW Project Conservation Education Collection No. 3.

Komar, O., Borjas, G., Cruz, G. A., Eisermann, K., Herrera, N., Linares, J. L., Escobar, C. E., & Girón, L. 2006. Evaluación ecológica rápida en la propuesta área protegida trinacional Montecristo en territorio guatemalteco y hondureño. SalvaNATURA Informe de Consultoría, para el Banco Interamericano de Desarrollo y la Comisión Trinacional Plan Trifinio. 170 pp.

Komar, O. & L. E. Girón. 2007. Prioridades para la conservación de la biodiversidad en el suroccidente de El Salvador. USAID Proyecto MMCC/Colección Educación para la Conservación 2. 109 pp.

Komar, O. & N. Herrera. 1995. Diversidad de Avifauna en el Parque Nacional El Imposible y el Refugio de Vida Silvestre del Complejo San Marcelino. El Salvador. Working Series (Wildlife Conservation Society, Bronx, NY) No. 4. 76 pp.

Komar, O., N. Herrera, R. Ibarra Portillo & L. Girón. In prep. Lista Roja de aves de El Salvador. SalvaNATURA Biodiversity Series No. 3, San Salvador.

Komar, O., & Ibarra-Portillo, R. 2009. El Salvador. Pp. 197–204 in C. Devenish, D. F. Díaz Fernández, R. P. Clay, I. Davidson & I. Yépez Zabala, Eds. Important Bird Areas Americas - Priority sites for biodiversity conservation. Quito, Ecuador: BirdLife International (BirdLife Conservation Series No. 16).

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, et al. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Washington, D.C., U.S.A.

Leenders, T. 2003. Los Anfibios y Reptiles. Pp. 158–161. En: Alvarez, J. M. y Komar, O. (Eds): El Parque Nacional El Imposible y su Vida Silvestre. Biodiversity Series No. 2. San Salvador.

Lin, S. Y. 1957. Estudio general de los recursos de la pesquería regional de El Salvador, MAG, El Salvador. 57 pp.

Linares, J. L. 2003 [2005]. Listado comentado de los árboles nativos y cultivados en la república de El Salvador. *Ceiba* 44(2):105–268.

Linares, J. L. 2007. Status of the inventory of flora (tres and orchids). Pp. 24–55 in Komar, O. (editor.). Preliminary inventory in eleven hydrographic watersheds of southweset El Salvador: Status of the flora and fauna inventory through 2006. USAID El Salvador IMCW Project Conservation Education Collection No. 3.

Linares, J. L. & M. Sousa. 2008. Nuevas especies de *Dalbergia* (Leguminosae: Papilionoideae: Dalbergieae) en México y Centroamérica. *Ceiba* 48(1-2):61–82

López, T. N. 1995. Estudio del desarrollo gonadal y análisis del contenido estomacal de la ~~"m~~ojara" (*Cichlasoma guija*) en el Lago de Ilopango. Tesis para optar al grado de Licenciatura en Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 50 pp.

Martínez, C. E., Henríquez Cisneros, V. E., & Komar, O. 2009. Conozcamos la Biodiversidad. Manuales del Programa de Capacitaciones Comunidades y Biodiversidad (SalvaNATURA, El Salvador) Componente 2, 41 pp.

Mejía, L. A. & F. A. Chicas. 2007. La pesca de sardinas y otros peces juveniles en la Bahía de Jiquilisco, El Salvador. Rev. Quehacer Científico. Vol. 6, Año 4. Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 19–26 pp,

Méndez, M. F. 2006. Inventario de Ictiofauna de Salamar, Cuenca Sur de la Sierra de Jucuarán, Departamento de Usulután, El Salvador. Programa de Ciencias para la Conservación. SalvaNATURA, San Salvador, El Salvador. Informe de consultoría Anexo 3. 12 pp.

MARN (Ministerio de Medio Ambiente y Recursos Naturales). 2000a. Estrategia Nacional de Diversidad Biológica. Ministerio de Medio Ambiente y Recursos Naturales, San Salvador, El Salvador.

MARN (Ministerio de Medio Ambiente y Recursos Naturales). 2000b. Colección de CD's Medio Ambiente: CD 2 Sistema de Información Ambiental del Ministerio y Atlas de Índices de Sensibilidad de Toda la Zona Costera El Salvador C.A.

MARN (Ministerio de Medio Ambiente y Recursos Naturales). 2004. Listado Oficial de Especies de Fauna Silvestre Amenazada o en Peligro de Extinción en El Salvador. Diario Oficial (San Salvador, El Salvador) Tomo No. 363, Número 78. Acuerdo No. 10. pp. 5–27.

MARN (Ministerio de Medio Ambiente y Recursos Naturales). 2005. Estado del conocimiento de la Biodiversidad en El Salvador, Documento Final. Informe técnico preparado por Melibea Gallo, 154 pp.

MARN (Ministerio de Medio Ambiente y Recursos Naturales). 2006. Ley del Medio Ambiente y sus Reglamentos. Ministerio de Medio Ambiente y Recursos Naturales, 282 pp.

Monterrosa, E. 1960. Observaciones sobre la pesca con redes agalleras en el Lago de Güija. Dirección General de Recursos Naturales Renovables, MAG, El Salvador. 3 pp.

Mora, M., J. Cabrera & G. Galeano. 1997. Reproducción y alimentación del gaspar *Atractosteus tropicus* (Pisces: Lepisosteidae) en el Refugio Nacional de Vida Silvestre Caño Negro, Costa Rica. Rev. Biol. Trop. 45: 861–866 pp.

Morrone, J. J. 2007. Hacia una biogeografía Evolutiva. Rev. Chil. Hist. Nat. Santiago de Chile. Vol. 80. Nº 4.

Orellana, J. J. 1985. Peces Marinos de Los Cóbanos, Peces de El Salvador. FUNDACION SIGMA. New Cork. 126 pp.

Orellana, J. J. 1992. Inventario preliminar de los peces de agua dulce y marinos de El Salvador, América Central. Secretaria Ejecutiva del Medio Ambiente (SEMA), El Salvador. 150 pp.

Pacheco, S. R. & S. N. Cokkom. 2007. Efectividad de anzuelos circulares números 15 y 16 con respecto a anzuelos ┼" en la pesca con palangre de especies altamente migratorias y su incidencia en la captura de especies no objetivo, dentro de la zona económica exclusiva de El Salvador. Trabajo de Graduación para optar al grado de Licenciatura en Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador, 53 pp.

Paz Quevedo, O. W. & N. E. Ventura Centeno. 2004. Protección y Conservación del Área Natural Protegida Santa Rita y Laguna Gamboa. Inventario de Flora y Fauna del Área Natural Protegida Santa Rita. Ahuachapán. Para ADESCONE. 51 pp.

Perdices, A. B., E. A. Birmingham, A. B. Montilla, A. B. & I. B. Doatrio. 2002. Evolutionary history of the genus *Rhamdia* (Teleostei: Pimelodidae) in Central América. Molecular Phylogenetics and Evolution 25 (2002) 172–189 pp.

Phillip, D.A. 1983. Reproduction and feeding of the mountain mullet, *Agonostomus monticola*, in Trinidad, West Indies. Environmental Biology of Fishes 37: 47–55

Phillips, P. & J. B. Ulloa. 1981. Estudio de las Poblaciones de Peces de la Bahía de Jiquilisco. El Salvador. 45 pp.

PNUMA (Programa de las Naciones Unidas para el Medio Ambiente). 2004. Geo Centroamérica: Perspectivas del Medio Ambiente 2004. 68 pp.

PREPAC (Plan Regional de Pesca y Acuicultura Continental, El Salvador). 2005. Inventario de cuerpos de agua continentales de El Salvador, con énfasis en la pesca y la acuicultura. 477 pp.

Ramírez, C. R. 2001. Vegetation of a Subtropical Pre-Montane Moist Forest in Central America. Tesis de grado Doctor of Philosophy. Facultad de Biología, Universidad de New York. Consultada el 22 de marzo de 2002. Disponible en: http://it.stlawu.edu/~cram/El Imposible/Diss.html

Reid, F. A. 1997. Mammals of Central America and Southeast Mexico. Oxford University Press, New York.

Remsen, J. V. Jr. 1994. Use and misuse of bird lists in community ecology and conservation. Auk 111: 225–227.

Reyes Bonilla, H. & J. E. Barraza. 2003. Corals and associated marine communities from El Salvador. En: J. Cortés (ed.). Coral reefs of Latin America. Elsevier (Amsterdam, Holanda), 331–340 pp.

Rich, T. D., Beardmore, C. J., Berlanga, H., Blancher, P. J., Bradstreet, M. S. W., Butcher, G. S., Demarest, D. W., Dunn, E. H., Hunter, W. C., Iñigo-Elias, E. E., Kennedy, J. A., Martell, A. M., Panjabi, A. O., Pashley, D. N., Rosenberg, K. V., Rustay, C. M., Wendt, J. S., & Will, T. C. 2004. Partners in Flight North American landbird conservation plan. Cornell Lab of Ornithology, Ithaca, New York.

Rivera Muñoz, J. R. 2000. Conservación, protección y recuperación de los recursos naturales del Refugio de Vida Silvestre Complejo San Marcelino. Estudio de fauna de las clases Amphibia, Reptilia, Aves y Mammalia en el Complejo San Marcelino. Asociación Salvadoreña de Conservación del Medio Ambiente. Fondo Iniciativas para las América El Salvador – FIAES. 36 pp.

Robertson, D. R. & G. R. Allen, 2002. Peces costeros del Pacífico Oriental Tropical: Un Sistema de Información. Instituto Smithsonian de Investigaciones Tropicales, Balboa, República de Panamá.

Robertson, D. R. & G. R. Allen. 2006. Peces Costeros del Pacífico Oriental Tropical: Un Sistema de Información. Instituto Smithsonian de Investigaciones tropicales, Balboa, República de Panamá.

Robertson, D. R & G. R. Allen. 2008. Shorefishes of the Tropical Eastern Pacific online information system. Version 1.0. Smithsonian Tropical Research Institute, Balboa, Panamá. www.neotropicalfishes.org/sftep, www.stri.org/sftep.

Rojas, M. J., E. Maravilla & F. A. Chicas. 2004. Hábitos alimentarios del ~~p~~argo mancha" *Lutjanus guttatus* (Pisces: Lutjanidae) En los Cóbanos y Puerto de La Libertad, El Salvador *Rev. Biol. Trop.,* Vol. 52, Nº 1, 163–170.

Ruiz, L. J. Torres de J. A. Mendez, E. & A. S. Prieto. 2003. Aspectos biométricos de *Sparisoma aurofrenatum* (Pisces: Scaridae) de un parche arrecifal del Parque Nacional Mochima, Venezuela. Biol., dic. 2003, vol, Nº 3, 161–170.

Salgado-Maldonado, G., F. Moravec, G. Cabañas-Carranza, R. Aguilar-Aguilar, P. Sánchez-Nava, R. Báez-Valé, & T. Scholz. 2004. Helminth parasites of the tropical gar, *Atractosteus tropicus* Gill from Tabasco, Mexico. Journal of Parasitology 90: 260–265.

Schmitter-Soto, J. J. 2007. A systematic revision of the genus *Archocentrus* (Perciformes: Cichlidae), with the description of two new genera and six new species. Zootaxa 1603: 1–78.

Segovia Prado, J. V. Fauna ictiológica del sistema arrecifal Los Cóbanos, El Salvador. (En preparación).

Segovia, J. V. & M. Navarrete. 2007. Biodiversidad en parches de coral hermatípicos (*Porites lobata* y *Pocilopora sp.*) a nivel de Ecosistema en el Sistema Arrecifal Los Cóbanos, Departamento de Sonsonate, El Salvador. Trabajo de Graduación para

optar al grado de Licenciatura en Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 70 pp.

Solís, I. B., 2006. Distribución y abundancia del pez machorra, *Atractosteus tropicus*, en el Zanjon el Chino, Municipio de San Francisco Menéndez, Ahuachapán, El Salvador. Escuela de Biología, Facultad de Ciencias Naturales y Matemática, Universidad de El Salvador. 46 pp.

Soto-Galera, E. 2006. Ictiofauna de los corredores biológicos Sierra Madre Sur y Selva Maya Zoque. Instituto politécnico Nacional. Informe final SNIB-CONABIO proyecto Nº Y026. México D.F., 14 pp.

Stevens, W. D., C. Ulloa U., A. Pool & O. M. Montiel (Eds). 2001. Flora de Nicaragua. Monographs in Systematic Botany from the Missouri Botanical Garden. 85

Ulloa, J. B. & E. A. Melgar. 1983. Estudio preliminar de las poblaciones del ~~p~~ez ejote" (*Melaniris guija*) en el Lago de Ilopango, El Salvador. CENDEPESCA. MAG. El Salvador. 11 pp.

Ulloa, J. B. & R. Castro. 1985a. Situación actual de la pesca en la Laguna de Metapán, algunas relaciones técnicas para su manejo. CENDEPESCA. MAG. El Salvador. 8 pp.

Ulloa, J. B. & R. Castro. 1985b. Diagnóstico de la pesca en el Lago de Güija, relacionada con el empleo de diversos métodos y aperos de pesca. CENDEPESCA. MAG. El Salvador. 23 pp.

Ulloa, J. B., N. Avalos, & T. Sorto. 1988. Informe sobre la producción pesquera del embalse Cerrón Grande 1986-1987. CENDEPESCA. MAG. El Salvador. 23 pp.

Ulloa, J. B., E. A. Hernández, J. A González & W. E. Ramírez. 2003. Evaluación de Algunos Aspectos Biológicos de la Captura de Peces y Camarones Obtenida con Redes de Enmalle Número Nueve en El Estero de Jaltepeque, CENDEPESCA, MAG, El Salvador, 24 pp.

Vásquez, M. J. 1993. Ictiofauna del Estero Barra de Santiago, Publicaciones ocasionales, Museo de Historia Natural de El Salvador. 40 pp.

Villa, J. 1971. Sinopsis de los peces de nicaragua. 3ª edición, Departamento de Biología, Universidad Nacional Autónoma de Nicaragua, Managua, 132 pp.

Villa, J. 1982. Peces nicaragüenses de agua dulce. Colección Cultural Serie Geografía y Naturaleza. 253 pp.

Villacorta, R. 2000. Estudio preliminar de la flora del Complejo de San Marcelino. Asociación Salvadoreña para la Conservación del Medio Ambiente (ASACMA).

Waid, R. M., R.L. Raesly, K.R. McKaye & J.K. McCrary. 1999. Zoogeografía íctica de lagunas cratéricas de Nicaragua. Encuentro (Revista de la Universidad Centroamericana, Nicaragua) 51: 65–80.

Yáñez-Arancibia, A. 1975. Sobre los estudios de peces en lagunas costeras: Nota Científica. An. Inst. Cienc. del Mar y Limnol. Univ. Nal. Autón. México. 8 pp.

Zapata F.A & R.Robertson. 2006. How many species of shore fishes are there in the Tropical Eastern Pacific?. Journal of Biogeography. 14 pp.