Alliance for the Conservation of Mesamerican Pine-Oak Forests

Conservation Plan for the Central American Pine-Oak Forest Ecoregion and the Golden-cheeked Warbler




Fundación Defensores de la Naturaleza

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Alianza para la Conservación de los Bosques de Pino-Encino de Mesoamérica

Fundación Defensores de la Naturaleza

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Alliance for the Conservation of Mesoamerican Pine-Oak Forests

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ACRONYMS AND ABBREVIATIONS

ABC	American Bird Conservancy
AFE-COHDEFOR	State Forest Administration – Honduran Corporation of Forest Development (*Administración Forestal del Estado Corporación Hondureña de Desarrollo Forestal*)
ALAS	Wild Areas Alliance (*Alianza para las Áreas Silvestres*)
ANAM	Guatemala's National Association of Municipalities (*Asociación Nacional de Municipalidades*)
ARNPG	Guatemala's Private Nature Reserves Association (*Asociación de Reservas Naturales Privadas de Guatemala*)
ATRIDEST	Trifinio Association for Sustainable Development (*Asociación del Trifinio para el Desarrollo Sostenible*)
AZE	Alliance for Zero Extinction
CAP	Conservation Area Planning
CCAD	Central American Commission for the Environment and Development (*Comisión Centroamericana de Ambiente y Desarrollo*)
CI	Conservation International
CONABIO	National Commission for the Knowledge and Use of Biodiversity in Mexico (*Comisión Nacional para el Conocimiento y Uso de la Biodiversidad en México*)
CONAP	Guatemala's National Council of Protected Areas (*Consejo Nacional de Áreas Protegidas*)
ECLAC	Economic Commission for Latin America and the Caribbean
ECOSUR	College of the South Border (*El Colegio de la Frontera Sur*)
EDUCA	Educational Foundation for Research and Development, Science and Technology (*Fundación Educación para el Desarrollo de la Investigación, Ciencia y Tecnología*)
FAO	Food and Agriculture Organization of the United Nations
FDN	Defenders of Nature Foundation (*Fundación Defensores de la Naturaleza*)
FUNDAR	Friends of the San Juan River Foundation (*Fundación de Amigos del Río San Juan*)
GIS-DEF	Defenders of Nature Foundation's Geographic Information System (*Sistema de Información Geográfico de Defensores de la Naturaleza*)
IHNE	Institute of Natural History and Ecology (*Instituto de Historia Natural y Ecología*)
INAB	Guatemala's National Forest Institute (*Instituto Nacional de Bosques*)
INAFOR	National Forestry Institute (*Instituto Nacional Forestal*)
IUCN	International Union for Conservation of Nature

MARENA	Nicaragua's Ministry of Environment and Natural Resources (*Ministerio de Ambiente y Recursos Naturales*)
NFWF	National Fish and Wildlife Foundation
NMBCA	Neotropical Migratory Bird Conservation Act
PAHO	Pan American Health Organization
PARPA	Agricultural and Productive Reconversion Program (*Programa de Reconversión Agrícola y Productiva*)
PNR	Private Nature Reserve
PRISMA	Salvadorean Environmental Research and Development Program (*Programa Salvadoreño de Investigación sobre Desarrollo y Medio Ambiente*)
PRODETUR	Pro Tourism Development Association of Perquín (*Asociación Pro Desarrollo Turístico de Perquín*)
REHNAP	Honduran Private Nature Reserves Network (*Red Hondureña de Reservas Naturales Privadas*)
TNC	The Nature Conservancy
TPWD	Texas Parks and Wildlife Department
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
URL	Rafael Landívar University (*Universidad Rafael Landívar*)
USAC	San Carlos University of Guatemala (*Universidad San Carlos de Guatemala*)
USFWS	United States Fish and Wildlife Service
WWF	World Wildlife Fund for Nature

FOREWORD

Since tropical forests in the mountains of Mesoamerica are dominated by pines (*Pinus* spp.) and oaks (*Quercus* spp.), pine-oak forests are a key component of the "Forest Bridge of the Americas", a wooded isthmus that links North America with South America. This region is officially known as the Central American pine-oak forest ecoregion (Harcourt and Sayer 1996)[1], which covers 103,842.71 km^2 and is located in the Mexican state of Chiapas, Guatemala, El Salvador, Honduras, and Nicaragua. These forests were one of the main settings for the "Great American Biotic Interchange"—the migration of plants and animals between North and South America after the formation of the Isthmus of Panama. This interchange, along with climatic and geological forces occurring at the time, are responsible for the extraordinary richness of species, natural communities, and ecosystems that exist in the world today, especially in this ecoregion. However, the continued existence of this ecoregion is threatened not only by unsustainable forestry and agricultural practices like commercial logging, extraction of firewood, forest fires, and cattle grazing, but also global climate change. Therefore, coordinated conservation actions that ensure the survival of this unique ecoregion are urgently needed.

Currently, pine-oak forests cover only 26,728.35 km of the region[2], which is 26% of the total area that they once covered in Mesoamerica. The Central American pine-oak forest ecoregion hosts 305 species of birds; 55 of them are migratory bird species and 21 of them are endemic species that inhabit only these forests. Additionally, this ecoregion is one of the most important centers of evolutionary radiation for pine and oak species in the world. The zone between Chiapas and Guatemala is the center of speciation and evolution of the genus *Pinus* and contains more species of pines than any place on Earth of similar acreage (Iarna 2004). According to recent studies, at least 80 species of the genus *Quercus* diverge in this ecoregion. Since this ecoregion provides habitat for 23 species listed as globally endangered by the International Union for Conservation of Nature, Conservation International considers it a biodiversity "Hotspot".

During the past few years, this ecoregion has received a lot of interest from the international community, especially from people and organizations dedicated to furthering conservation efforts to protect it and the Golden-cheeked Warbler (*Dendroica chrysoparia*). This globally endangered migratory bird species has a limited distribution and overwinters in the ecoregion. Populations of this species have decreased significantly, in part due to the destruction and degradation of its wintering habitat.

Given the heightened interest of and recognized need by the international community to collaborate on research and monitoring activities to further conservation efforts to protect this species and its wintering habitat, the Alliance for the Conservation of Mesoamerican Pine-Oak Forests was established in 2003. This voluntary international cooperative partnership initially included members from many national non-governmental organizations, including Pronatura Sur, Instituto Montebello and Instituto de Historia Natural y Ecología in Mexico; Fundación Defensores de la Naturaleza and Asociación de Reservas Naturales Privadas de Guatemala in Guatemala; SalvaNATURA in El Salvador; Fundación EDUCA in Honduras; and Alianza para las Áreas Silvestres in Nicaragua, as well as international organizations such as the Nature Conservancy, Texas Parks and Wildlife Department, and Zoo Conservation Outreach Program.

[1] Central America is the official term used to describe the pine-oak forest ecoregion. However, since the region contains Chiapas, Mexico in addition to Central American countries, the Alliance uses the more accurate geographical term, Mesoamerica in its title.

In 2005, the Alliance began development of this conservation plan. The plan's main purpose is to provide a framework that directs and guides conservation actions in the Central American pine-oak forest ecoregion. The plan also demonstrates the regional efforts implemented by the Alliance to further conservation of pine-oak forests, presents an analysis of the current situation in the ecoregion, identifies threats to its continued existence, discusses opportunities for sustainable, profitable, economic alternatives for local communities, and proposes conservation and management strategies to protect it. As expected, this voluntary, international, cooperative initiative includes many countries, which are functioning at multiple scales, actively involving various stakeholders, and utilizing a variety of strategies to generate the tools and knowledge needed to inform decision-makers regarding the sustainable management and restoration of the Central American pine-oak forest ecoregion so threatened, yet so rich in species and necessary for human well-being.

Maarten Kappelle
Director, Regional Science Program
Meso-American and Caribbean Region
The Nature Conservancy

1 Executive Summary

The Central American pine-oak forest ecoregion gets its name from forests composed of an association of pines and oaks (*Pinus* spp. and *Quercus* spp.; Harcourt and Sayer 1996). This ecoregion is found at altitudes ranging from 600 to 2,300 meters above sea level (masl). Geographically, it ranges from south and central Chiapas, Mexico to northwestern Nicaragua.

This ecoregion is very important because it contains not only a high diversity of conifers and oaks, but also it provides habitat for many species that are considered globally endangered or endemic (Internet WWF 2007). According to Conservation International, the ecoregion is considered an "Endemic Bird Area" and a High Priority Terrestrial Ecoregion (PTE or *Hotspot*) because of the large number of endemic species that occur there. The region also is considered the most important trans-regional migratory route for Neotropical migratory birds (≥225 species) in the Americas (Rappole *et al.* 1999, Welton *et al.* 2006).

The Golden-cheeked Warbler is one of many migratory birds present in the ecoregion. It is a Neotropical migratory songbird of restricted distribution and is considered globally endangered (Internet IUCN 2007). This species breeds exclusively in central Texas and overwinters in pine-oak forests located between 900 to 2,200 masl from Chiapas, Mexico to northwestern Nicaragua (Pulich 1976, Howell and Webb 1995, Rappole *et al.* 1999).

The ecoregion covers an area consisting of 103,842.71 km^2 but has suffered considerable habitat loss due to forest fragmentation and degradation. Of the total area, only 26,728.35 km^2, approximately 26%, remains forested. The principle threats to the ecoregion are fires, incompatible conservation and management practices, commercial logging, and the extraction of firewood. The average deforestation rate for the ecoregion is 60,000 ha/year which, if continued, will eliminate all forest cover within the next 45 years.

The Alliance for the Conservation of Mesoamerican Pine-oak Forests[2] was created in 2003 due to the richness of biodiversity and endemic species present in the ecoregion. The Alliance consists of eight institutions located in the United States, Mexico, Guatemala, El Salvador, Honduras, and Nicaragua. These institutions are working together to conserve the pine-oak forest ecosystem in order to guarantee the survival of the Golden-cheeked Warbler through joint efforts and involvement of all stakeholders.

Already the Alliance has developed a regional conservation plan entitled "Conservation Plan for the Central American Pine-Oak Forests and the Golden-cheeked Warbler", which is meant to guide conservation efforts for the ecoregion. The plan was developed through a series of workshops, held in each of the member countries, followed by three regional meetings, which were designed to coordinate and integrate the opinions of all the members of the Alliance, stakeholders, and other institutions interested in the conservation of pine-oak forests.

This plan proposes actions and strategies that guarantee the conservation and sustainable development of priority areas within the ecoregion in the medium and long term. The actions described in the plan are aimed at strengthening the Alliance, which will be responsible for coordinating, evaluating, and developing the proposed strategies. The proposed actions of this plan also aim to decrease threats to the ecoregion by promoting sustainable forest management, including integrated fire management. The plan also takes into account the implementation of conservation actions through mechanisms that are already

[2] The 'Alliance' adopted the term Mesoamerica to accurately describe the geographic region within which conservation actions are being directed.

established in the area, such as municipal parks, private reserves, and ecological easements.

This Alliance is one of a few regional conservation initiatives being implemented in the Neotropics. Its goal is to provide support for the conservation of the pine-oak forest ecosystem and all associated biodiversity and ecological processes involved with it, as well as to guarantee the survival of the Golden-cheeked Warbler through joint efforts and involvement of all stakeholders at regional and national levels. Additionally, the Alliance hopes to be viewed as a model for future regional activities in Central America.

Resumen Ejecutivo

La Ecoregión de Bosques de Pino-Encino de Centroamérica toma su nombre por la asociación vegetal dominante de especies de *Pinus* spp. y *Quercus* spp. que ocupa el rango altitudinal de 600 a 2,300 metros sobre el nivel del mar (msnm). En términos geográficos abarca desde el centro y sur de Chiapas (México) hasta el Noroeste de Nicaragua.

Esta ecoregión es de gran importancia debido a la gran diversidad de coníferas y encinos, además de ser hábitat para muchas especies catalogadas como amenazadas a nivel global y varias especies endémicas (Internet WWF 2007). Debido al alto endemismo de fauna, la ecoregión es considerada "Área de endemismos de aves" y una Ecoregión Terrestre Prioritaria (ETP o *Hotspot*, según Conservación Internacional). Además, se considera la más importante zona de reabastecimiento para aves migratorias neotropicales (al menos 225 especies) (Rappole *et al.* 1999, Welton *et al.* 2006).

Entre las aves migratorias presentes en la ecoregión se encuentra el chipe mejillas doradas (*Dendroica chrysoparia*). Esta es una ave migratoria neotropical de distribución restringida y globalmente amenazada (Internet UICN 2007). La especie se reproduce en un área pequeña de Texas y migra durante el invierno hacia el Neotrópico (desde Chiapas hasta el Norte-centro de Nicaragua) donde habita en los bosques de pino-encino desde los 900 a 2,200 msnm (Pulich 1976, Howell and Webb 1995, Rappole *et al.* 1999).

La ecoregión cuenta con una extensión de 103,842.71 km^2 la cual ha sufrido de la pérdida, fragmentación y degradación de los bosques; actualmente cuenta con una cobertura boscosa de 26,728.35 km^2, equivalente al 26% del área total. Entre las principales amenazas identificadas están: los incendios forestales, las prácticas forestales incompatibles con la conservación y la extracción de leña y madera rolliza. A nivel regional el promedio de deforestación es de 60,000 ha/año, a este ritmo la cobertura actual podría desaparecer en los próximos 45 años.

Dada la riqueza de biodiversidad y endemismos existentes en estos ecosistemas, y preocupados por las amenazas que enfrentan los bosques de pino-encino de Centroamérica, en el año 2003 se crea la Alianza para la Conservación de los Bosques de Pino-Encino de Mesoamérica, la cual está conformada actualmente por ocho instituciones nacionales de los Estados Unidos, México, Guatemala, El Salvador, Honduras y Nicaragua, que buscan, a través del esfuerzo multi-institucional, la conservación de este ecosistema y del ave migratoria *Dendroica chrysoparia*.

A partir de esta iniciativa la Alianza desarrolló el "Plan de Conservación de los Bosques de Pino-Encino de Centroamérica y el ave migratoria *Dendroica chrysoparia*", el cual es un esfuerzo para orientar las acciones de conservación en estos ecosistemas. El Plan se realizó a través de talleres de consulta en cada uno de los países y tres reuniones de integración regional, donde participaron los miembros de la Alianza, así como otras instituciones y actores clave, interesados en la conservación de estos bosques.

En este Plan se proponen acciones y estrategias que garantizan en el mediano y largo plazo la

conservación, el desarrollo sostenible y el desarrollo humano de las zonas prioritarias de la ecoregión. Las acciones en este Plan están enfocadas al fortalecimiento de la Alianza, quien fungirá como coordinador, evaluador y principal ejecutor del cumplimiento de las estrategias planteadas. Además, contribuirá a la disminución de las amenazas de la ecoregión, promoviendo el manejo forestal sostenible y el manejo integrado del fuego. También se plantean estrategias de conservación de los bosques mediante mecanismos formales (parques municipales, reservas privadas, servidumbres ecológicas, etc.), especialmente en áreas definidas como prioritarias.

Esta Alianza es una de las pocas iniciativas regionales de conservación que se realizan en Centroamérica la cual, a través del esfuerzo multi-institucional y multi-sectorial a nivel regional y nacional (en cada uno de los países miembros), busca tener un impacto positivo en los bosques de pino-encino, que garanticen su conservación y la supervivencia de la especie bandera (*D. chrysoparia*), la biodiversidad asociada y los procesos que la mantienen. Esta Alianza se espera sirva de modelo para futuras iniciativas que se desarrollen a nivel regional.

2 Introduction

This conservation plan represents the first regional management, conservation, and sustainable development effort for pine-oak forests located in the highlands of the state of Chiapas, Mexico, Guatemala, Honduras, El Salvador, and northern Nicaragua. Its purpose is to promote the actual and potential value of these forests not only in terms of biodiversity, water, timber, recreation, etc., but also as a driving force for sustainable rural development in Mesoamerica.

This document will guide coordinated, regional actions and function as a foundation to initiate and strengthen national alliances or working groups, facilitate planning processes, and provide opportunites to exchange experiences and increase public involvement at a regional scale. Furthermore, it will strengthen the execution, management, and evaluation of the existing pine-oak forest programs and projects and make them more participatory. These regional actions will be achieved because the plan contains clear objectives, a threats analysis, and proposed strategies for achieving these regional actions, although each country will execute them according to its own mechanisms and dynamics.

The plan is the result of the coordinated efforts of the Alliance for the Conservation of Mesoamerican Pine-Oak Forests[3], which was formed in Tuxla Gutiérrez, Chiapas, Mexico in November 2003. The Alliance includes the following institutions: *Alianza para las Áreas Silvestres* (Wild Areas Alliance), *Fundación Defensores de la Naturaleza* (Defenders of Nature), *Fundación Educación para el Desarrollo de la Investigación, Ciencia y Tecnología* (Fundación EDUCA, Foundation for Education, Research and Development, Science and Technology), *Instituto de Historia Natural y Ecología* (Natural History and Ecology Institute), Pronatura Sur, SalvaNATURA, the Nature Conservancy, and Texas Parks and Wildlife Department.

One of the Alliance's principle areas of interest is the conservation of the avifauna that inhabits the Central American pine-oak forest ecoregion, especially those species whose continued existence are at risk like the Golden-Cheeked Warbler. This species is considered globally endangered and serves as an umbrella species for conservation in the ecoregion. For this reason, one of the criteria used in the identification of priority areas was the occurrence of this migratory bird. Given this specific criterion, we designated pine-oak forests ranging from 900 to 2,200 masl as priority areas to protect. However, most of the ecoregion's pine-oak forests are found within this altitudinal range.

The plan's developmental process included conducting regional and national workshops in all five Mesoamerican countries that are members of the Alliance. Ministries or offices in charge of natural resources and conservation and management, non-governmental organizations, universities, protected areas, and other key stakeholders attended and supported each of these workshops. Therefore, this document represents the expert opinion of the attendees and should be viewed as an inclusive working tool designed to improve the extent to which government and civilian institutions and organizations respond to the challenges presented by the Alliance.

[3] The Alliance's original name was "Continental Alliance for the Conservation of the Central American Pine-Oak Forest Ecoregion and its birds" but was changed to better reflect the geographic region it covers.

2.1 Description of the Central American Pine-Oak Forest Ecoregion

The ecoregion is named after the predominant vegetation association that occupies altitudes between 600 to 2,300 masl (Harcourt and Sayer 1996). Some variation in structure and composition exists within the ecoregion when the pine-oak forest mixes with other broadleaf species, such as *Ostrya* spp., *Liquidambar styraciflua*, *Alnus* spp., etc. Montane forests are found at higher altitudes and make up a different ecoregion.

This ecoregion is the result of high volcanic activity, sedimentation, and migration of animal and plant species from North and South America (ca. 3 million years ago), which created a situation that deeply changed the evolution, and likely the extinction, of some species with similar ecological niches, e.g., mammals (Coates *et al.* 2005; Villar Anleu 1997 quoted from Internet WWF 2007). Due to the accelerated pace of deforestation, high poverty indices, and current unsustainable use of resources in this region, World Wildlife Fund considers it "critically endangered" (Internet WWF 2007).

2.1.1 Location and Area

The Central American pine-oak forest ecoregion extends from southern Chiapas, Mexico to northwestern Nicaragua. This ecoregion also includes the Sierra Madre de Chiapas, a mountain range that parallels the Pacific Coast (Stattersfield *et al.* 1998). Geographically, the ecoregion ranges from south-central Chiapas, Mexico through the highlands of Guatemala, a large portion of central Honduras, northern El Salvador, and northwestern Nicaragua. (Figure 1)

According to World Wildlife Fund, the ecoregion covers 111,400 km^2, but a recent analysis conducted by the Alliance produced a georectified estimate of 103,842.71 km^2. This estimate was produced using the database for the Ecoregions Map for the Mesoamerica Ecoregional Planning process, which was developed by *Comisión Centroamericana de Ambiente y Desarrollo* (Central American Commission for the Environment and Development), World Wildlife Fund, and the Nature Conservancy. With this information, the planning team established common criteria and used it to develop a conservation priorities map, which is presented later in this document. Confirmed records of Golden-Cheeked Warblers across the ecoregion were used to verify and georectify the map.

2.1.2 Ecological Characteristics

The ecoregion is considered one of the richest worldwide in terms of the diversity of conifers and oaks (*Quercus* spp). The zone between Chiapas, Mexico and Guatemala is the center of speciation and evolution for the genus *Pinus*. This zone contains more species of conifers than any place on Earth of similar acreage, a consequence of a high level of hybridization.

The Central American pine-oak forest ecoregion provides habitat for many globally endangered and endemic species (Appendix 1) (Internet WWF 2007). About 160 species of mammals are restricted to this and other ecoregions in Central America. Guatemala and Chiapas, Mexico are rich in endemic salamander and amphibian species and are considered a center of origin and dispersion for tropical salamanders (Order Urodela). These areas are also considered the center of evolutionary radiation for lungless salamanders (Order Plethodontidae) and thus, a large number of regional endemic species occur in the ecoregion (Internet AZE 2007, Internet Conservation International 2007).

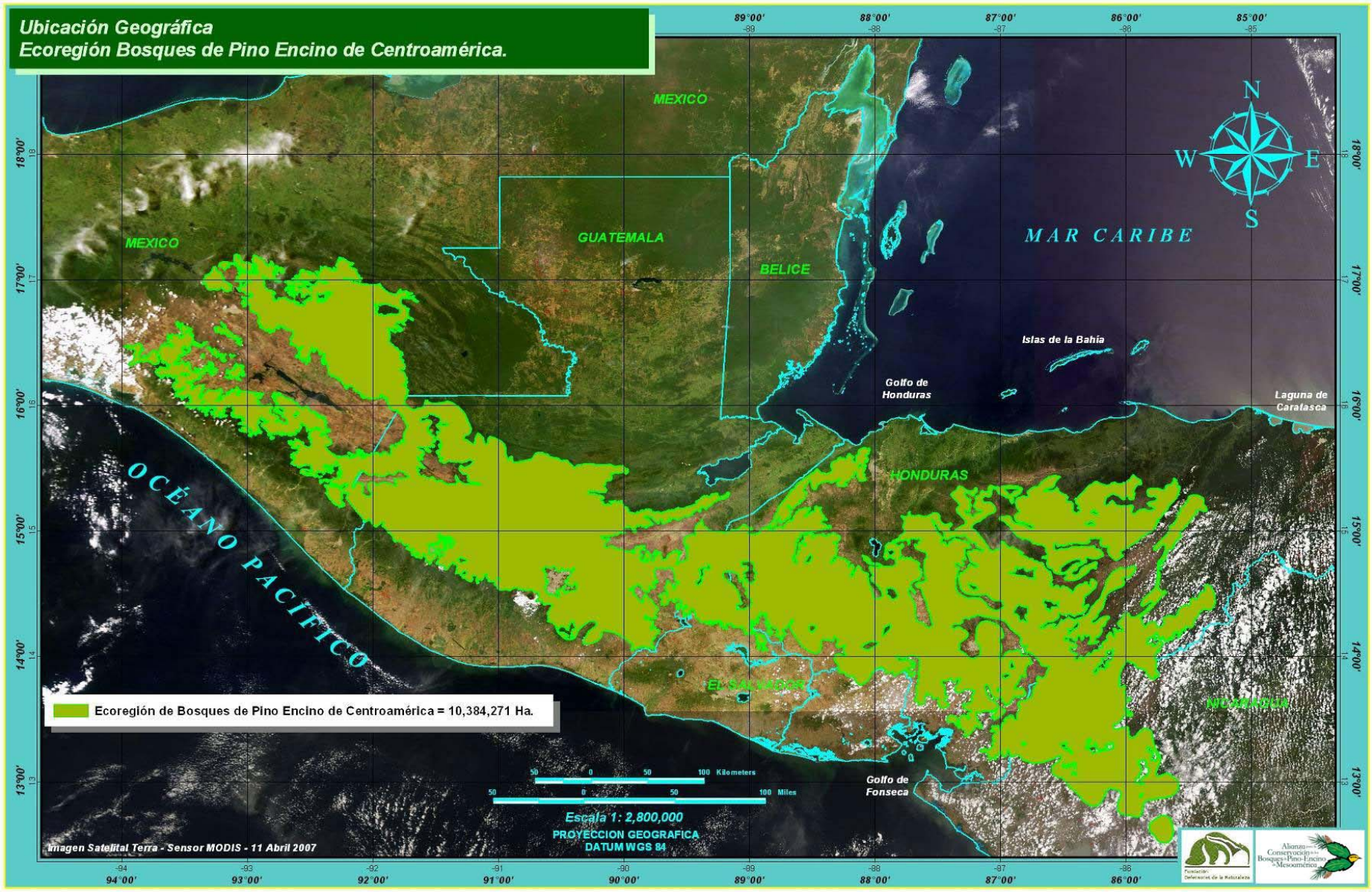

Figure 1. Geographic Location of the Central American Pine-Oak Forest Ecoregion. Source: TNC-GIS DEF.

In terms of faunal diversity, birds are the best represented group. The ecoregion is considered an "Endemic Bird Area" and a Priority Terrestrial Ecoregion (PTE or *Hotspot*; Conservation International). Apart from endemics, this hotspot is a critical trans-regional migration route for at least 225 migratory bird species as three out of the four major migratory bird routes in the western hemisphere converge in Mesoamerica.

Of the 650 species of migratory birds in North America, approximately 338 spend the winter in the Neotropics (Rappole 1995). The Central American pine-oak forest ecoregion is habitat to at least 305 bird species, of which 55 are migrants (Appendix 2). The ecoregion also serves as an important stopover site for migratory birds that overwinter in Central and South America (Rappole *et al.* 1999, Welton *et al.* 2006, Internet WWF 2007).

Pine-oak forests within the ecoregion range from 600 to 2,300 masl. Montane forests occur beyond this altitude and up to 3,000 masl. The temperature of pine-oak forests varies from 14 to 25°C depending on altitude, and rainfall varies from 900 to 3,700 mm depending on exposure to moist wind currents. This variation in temperature and precipitation, along with a large variety of land types, yield high variability in the pine-oak forests' composition and structure (González-Espinosa *et al.* 2005b). Studies conducted in Chiapas report that the pine-oak association is found only above 1,500 masl because all forest cover below this altitude has been destroyed over past decades. A study conducted from 1970 to 1990 demonstrated that Chiapas has lost around 50% of its primary forest cover. It is likely that similar changes have occurred across the entire ecoregion, although no data have been collected in other areas of the region.

The diversity of *Pinus* spp. and *Quercus* spp. within the region is high. González-Espinosa *et al.* (2005b) demonstrated that the number and distribution of pine and oak species vary by successional stage and altitudinal distribution. Up to 36 species of oaks and 11 species of pines can be found in mature pine-oak forests (Table 1). Studies conducted in Chiapas demonstrated that the diversity of oak, pine, and associated species was high between 1,000 and 2,000 masl across all successional stages of vegetation. Other genera associated with the pine-oak forests are: *Acacia*, *Ficus*, *Inga*, and *Lonchocarpus* (González-Espinosa *et al.* 2005a). *Quercus* spp. and *Pinus* spp. are also part of other vegetation associations, such as montane rain forests, deciduous forests, oak forests, and pine forests (Miranda and Hernández 1963 quoted by González-Espinosa *et al.* 1995a).

Table 1. Biological Diversity of Pine and Oak Species and Other Floral Diversity Associated with the Pine-Oak Forests of Chiapas, Mexico.

Number of species	Altitude Range (m)				
	500-999	1,000-1,499	1,500-1,999	2,000-2,499	2,500-3,000
By taxon					
Quercus spp.	17	24	23	20	8
Pinus spp.	5	6	10	11	4
Quercus and *Pinus* genera, combined	22	30	33	31	12
By successional stage					
Early	103	163	158	88	33
Middle	117	154	149	132	37
Mature	24	36	71	68	31
TOTAL	244	353	378	288	101
Total species richness of Chiapas pine-oak forests	**266**	**383**	**411**	**319**	**113**

Source: González-Espinosa *et al.* 2005a

2.1.3 Historical Context

The history and geography of much of the Central American pine-oak forest ecoregion coincide with the distribution and occupation of the Mayan civilization during the Formative and Middle (Pre-Classic) Periods. This period of occupation is one of the longest in the history of Mayan civilization (1,000 B.C. to 1,500 A.D.) even though evidence of earlier occupations dating back to 3,500 and 1,200 B.C. exists from caves in Santa Marta, Chiapas and Quiché, Guatemala (Sharer 1998). These areas currently have the largest indigenous population, which are now geographically differentiated sub-groups with distinct languages, dialects, customs and, unfortunately, the highest poverty and extreme poverty indexes. The space- and time-related diversity of the Pre-Classic and current Mayans can be attributed, in part, to natural factors such as geomorphological and cultural variability. Apparently, this condition never unified, politically nor territorially either former or current Mayans. The result is currently seen in the many languages and dialects spoken in the highlands of Guatemala and Chiapas. The Mayan political organization was based on "political headquarters or kingdoms" that acted vertically, with well-structured social classes, and horizontally, when the territories expanded through marriage between kingdoms or military conquests. But nothing defined better a kingdom's power than the abundance of resources, such as water, fertile lands, and geographic location, its military force, the Ahau[4] priest's leadership capacity, and the social structure, which was based on supernatural belief systems. All these conditions affected power- and business-related relationships with other kingdoms of the region (Sharer 1998).

The highlands' volcanic origin provided the Pre-Classic Mayans with fertile lands for crop farming, as well as obsidian, jadeite, and serpentine for manufacturing sharp tools and jewelry. However, volcanic eruptions and earthquakes in this unstable geological region caused disasters to crops and vegetation, as well as water pollution. Evidence from eruptions of the Ilopango Volcano around the year 450 A.D. suggests that ashes covered approximately 100 km and left the area uninhabitable for some 200 years (Sharer 1998).

Even with the constant threat of natural abiotic catastrophes, many densely populated areas self-destructed due to density-dependent factors, such as overhunting and loss of forest cover. The slash-and-burn method of converting forests[5] to farmland was and still is used by the Maya and their decsendents. The availablity of this resource determined the duration of the rise and fall of the inhabited cities, which were extremely variable in time and space during their archaeological history. The condition of the area suffered greatly after Spanish occupation because its unsustainable agricultural system and excessive bovine and ovine herding left many areas without any vegetative cover and without possibilities of natural regeneration.

Many inherent aspects of the Mayan ideology and cosmology are currently being rescued from within many ethnic groups of Mayan origin that are found throughout the region. In many ways, these aspects favor the conservation of nature and respect for life. Among the issues affecting these groups are the current processes of global economic change and their exclusion from sociopolitical processes in many of the region's countries. The most important cities of the Mayan civilization located in pine-oak forests include Kaminal Juyú, Iximché, Utatlán, and Zaculeu in Honduras, El Portón in Guatemala, and Chihuatán, Tenam Puente and Chinkultic in Chiapas, Mexico (Sharer 1998).

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[4] *Ahau*: social standing equivalent to a Mayan king of the Classic Period. The Ahau had political powers that came from his lineage and was the connector, priest, or shaman between the natural and supernatural world; that is, he had the power to influence each and every type of activity in the social structure.

[5] The effect of this practice is less severe when population density is low.

2.1.4 Sociopolitical and Economic Context

An analysis of Central America's sociopolitical and economic conditions must begin with its independence from the Spanish Empire in 1821 since, even then, the economy and policies were not designed to satisfy the minimum needs of the rural and urban poor. The huge gap between the rich and the poor is strong evidence of the modern model of economic and political power that exists in Central America today. An interesting example of this model exists in Guatemala, where disparities in the distribution of wealth have created huge inequalities among different economic classes[6] (Clement and Vivero 2006).

Poverty reaches extreme levels in all the region's countries, mainly in the rural areas[7] (65 to 70% of the poor population of the region) where the poor are twice as likely to continue to live in poverty when compared to the poor living in peri-urban zones (Sauma 2004). In the international socioeconomic order, the region, like the rest of Latin America, has been affected by the international economic policies of the 1980s – the Washington Consensus (Williamson 2000) – and the recent globalization process[8], which is characterized mostly by the increase of financial speculation regarding the actual exchange economy (production – demand commerce) (ECLAC 2002).

At times, globalization processes have led to cultural identity problems, but they have also prompted positive changes in ethics, better options for consumers, quality improvement through business competition, and the incorporation of global environmental problems into public policies (ECLAC 2000). During the last 30 years, there has been an unprecedented compilation of research regarding environmental issues worldwide. This compilation shows that a higher level of ecological dependency between industrially developed countries, generally with little natural resources, and developing countries has created new cooperative relationships and opportunities, such as the renown "debt-for-nature" swaps, carbon sequestration, clean energy, etc. (ECLAC 2002).

The adherence of Central America to various free trade agreements and globalization (Puebla-Panamá Plan, DR-CAFTA[9]) presents both opportunities and risks to the conservation and management of natural resources in these developing countries. These risks include the developed countries' lack of economic openness, protectionism over some products, oversupply of raw materials manufactured in low-income countries, ancestral intellectual property, bioprospecting, and import/export tariffs that penalize less technologically advanced, and therefore, less competitive products, such as textiles (ECLAC 2002).

Guatemala and El Salvador have the best opportunity to experience the direct benefits of economic growth in the region. Hope for other countries in the region that tend to be less cared for is bleak due to the fact that the gross domestic product's (GDP) growth is lessened by population growth exceeding 2.50% (ECLAC 2005). According to the World Report on Human Development (UNDP 2005, 2006a), The Human Development Index for Guatemala, Nicaragua, and Honduras is just above medium (Table 2). This region's average Human Development Index does not exceed Latin America's average of 0.78.

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[6] The country's Gini Index (index used to measure inequality in income) is among the worst worldwide: Guatemala ranks 13 out of 111 countries evaluated in the year 2000 by UNDP.

[7] It is very likely that the poor in these regions belong to indigenous groups, families with many members and little or no education, very limited access to land and a high vulnerability to natural disasters (Sauma 2004).

[8] According to analysts (ECLAC 2002), the globalization process started at the end of the 1990s, with the emergence of financial centers worldwide, such as New York, London, Bombay, etc., the transnational enterprises' capital expansion, and the creation of national and multilateral financing institutions (World Bank, International Development Bank, etc.).

[9] DR-CAFTA: United States-Dominican Republic-Central American Free Trade Agreement.

The Human Development Index in El Salvador and Chiapas is above this average, but they are not considered developed countries or states compared to Costa Rica, where the average Human Development Index is >0.80 (Table 2). The mean human development ratios in Central America (Table 2) demonstrate that little investment in education, health, and technology are ultimately the factors responsible for slowing down human development.

The level of human development in the region is strongly affected by the unequal sociopolitical and economic conditions that exist in rural areas. These conditions make it difficult to include indigenous and rural populations in economic and political decisions made at local and national levels (UNDP 2005). The territories and their cultural, economic, and political interconnections are key to promoting human development, from the foundation up, which is planned with a long-term perspective (Bass *et al.* 2005).

Most importantly, all these variables must be combined and used to develop proposals that are competitive, environmentally friendly, sustainable in the long term, and allow poor rural areas, e.g., populations inhabiting areas near pine-oak forests, to be developed, yet retain their cultural identity.

Table 2. Socioeconomic Indicators for Central America and Chiapas.

Indicators	Guatemala	El Salvador	Honduras	Nicaragua	Chiapas, Mexico	Costa Rica
Human Development Compound Index	0.66	0.73	0.68	0.69	0.71	0.84
Life Expectancy, in years (UNDP 2005)	67.30	70.90	67.80	69.70		78.20
Social Investment in Education: % GDP	2.45	2.00	3.70	4.30	47.60 (state level)	
GDP – Income per capita (US$)	4,148	4,781	2,665	3,262	15,012	9,606
Literacy Rate (%)		83.00	81.00		86.00 (national level)	
Social Investment in Health: % GDP	1.34	1.40	2.70	4.20	0.16 (state level)	
Population without Access to improved water sources (%), 2000	8.00	26.00	10.00	21.00	14.00 (national level)	2
Ratio of undernourished – total population (2002)	24	11	22	27	-	4
Investment in Research and Development (8% of GNP)	0.20	2.20	-	-	0.08 (state level)	0.10
Research and Development Scientists and Engineers (per million inhabitants)	103	19	-	203	213 (national level)	533

Source: UNDP 2005; UNDP 2006a, 2006b; Internet HCD's CEFP 2007

2.1.5 Conservation of Natural Resources in the Region

Natural resource conservation in Mesoamerica is facing a crucial moment in history during which it is imperative to act decisively in order to guarantee the conservation of currently protected areas. Proposing more flexible rural development models will allow the sustainable use of goods and services produced and extracted from these areas.

Many deficiencies exist in the conservation and management of protected areas in Latin American countries. Many of these areas are protected on paper only because policies and provisions in the legal instruments that created them are never actually enforced (UNEP 2003). For example, Guatemala's *Zonas de Veda Definitiva* (Definite Banned Zones) were declared in 1956 to protect the volcanic cones. However, conservation measures designed to protect them have never been implemented.

Most of the conservation efforts in the region have focused on moist tropical forests, while pine-oak forests have received little attention. According to an analysis carried out by members of the Alliance in 2006, only 8.30% (8,656.79 km^2) of the ecoregion that has been designated as a protected area has institutional presence ensuring its conservation (Table 3).

One of the most promising mechanisms for the conservation of pine-oak forests is the private nature reserve model because it represents a sustainable, productive strategy for natural resources, such as water, wood, land stability, fuel, etc., as well as an opportunity to create new sources of income from ecotourism, payment for environmental services, and certification of forest products.

Table 3. Legally declared protected areas with an institutional presence in the Central American Pine-Oak Forest Ecoregion.

Country	Protected Areas Management	Km^2
Mexico (Chiapas)	El Triunfo	1,192.00
	Lagunas de Montebello	60.00
	Huitepec	1.35
	Moxviquil	0.86
	La Sepultura	1,673.00
	La Frailescana	1,813.00
Nicaragua	Dipilto-Jalapa	412.00
	Cerro Tisey	64.00
Honduras	Celaque	270.00
	Pico Pinol	114.00
	La Tigra	58.00
	Montaña de Yoro	88.00
	Sierra de Agalta	59.00
	Corralitos	15.00
	Cusuco	177.00
	El Chile	65.00
Guatemala	Sierra de las Minas	2,408.03
	Cordillera Alux	53.72
	Parque Municipal de Tecpán	17.06
	Private Nature Reserves	8.00
	Municipal Reserves in the Atitlán Watershed	9.00
	El Trifinio	46.77
El Salvador	Montecristo	52.00
Total		**8,656.79**

Source: Information provided by members of the Alliance

2.2 Biology and Ecology of the Golden-cheeked Warbler in the Neotropics

The Golden-cheeked Warbler is a Neotropical migratory bird that belongs to the Family Parulidae, Order Passeriformes (Figure 2). It is a species of restricted distribution and is globally endangered (Internet IUCN 2008). This species reproduces in a small area of central Texas and migrates to the Neotropics for the winter (Pulich 1976, Howell & Webb 1995, Rappole *et al.* 1999).

This species' migration period ranges from 7 to 8 months each year. According to Rappole (1995) and Keddy-Hector (1998), the first individuals arrive on the wintering grounds at the beginning of September and return to the breeding grounds at the end of February. Members of the Alliance, however, have recorded the presence of this species on the wintering grounds as early as July and as late as April.

a. Adult Male
Photo: Rebecca Peak

b. Adult Female
Photo: Andrea Nájera

Figure 2. Photos of the Golden-cheeked Warbler

2.2.1 Distribution

Figure 3 shows the existing occurrence records for Golden-cheeked Warblers on the wintering grounds. This map was developed from historical records (Pulich 1976, Vidal *et al.* 1994, Thompson 1995, Rappole *et al.* 1999) and unpublished records of studies carried out by members of the Alliance (Komar 2008).

The map shows new records of this species in northwestern Chiapas, Mexico, the central highlands of Guatemala, and northeastern Honduras. In Nicaragua, new observations have been recorded in forests where this species had not been sighted for many decades. Furthermore, recent research by members of the Alliance demonstrated that in El Salvador the Golden-cheeked Warbler has increased its range south (Komar 2008).

The sources of information of unpublished data used to develop the abovementioned map (Figure 3) are:

- *Secretaría de Recursos Naturales y Ambiente* (Secretariat of Natural Resources and Environment). 1998. Honduras.
- Fundación Defensores de la Naturaleza. *Investigaciones de temporadas de campo 2001 – 2006* (Research Studies for Field Seasons 2001-2006). Guatemala.
- Fundación EDUCA. *Temporadas de campo 2003 – 2005* (Field Seasons 2003-2005). Honduras.
- SalvaNATURA. *Proyecto Quercus y Aves. Temporadas de campo 2003-2004* (*Quercus* and Birds Project. Field Seasons 2003-2004). El Salvador.
- Pronatura Sur. *Temporadas de campo 2001-2006* (Field Seasons 2001-2006). Chiapas, Mexico
- The Nature Conservancy Honduras-Nicaragua. *Temporada de campo 2007* (Field Season 2007).
- Alliance for the Conservation of Mesoamerican Pine-Oak Forests. *Proyecto de Monitoreo de Dendroica chrysoparia en la ecoregión. Temporada de campo 2006-2007* (Komar 2008: Field Season 2006-2007).

2.2.2 Potential Habitat in the Ecoregion

The planning team considered pine-oak forests and pure oak stands (*Quercus* spp.) ranging from 900 to 2,200 masl as "potential habitat" for the Golden-cheeked Warbler. The area covered by these tree species and found within this range is 19,509.72 km^2, 18.78% of the ecoregion's total area (Figure 4).

The estimated potential habitat for the Golden-cheeked Warbler within the ecoregion's legally declared protected areas (Table 3) is 1,448.89 km^2, which is 1.40% of the ecoregion's total area and 16.74% of the legally declared protected areas. These percentages show that the species' survival during winter is not guaranteed.

Recent studies regarding the vegetation in different known sites of the species' winter habitat report that the forests contain ≥20 to 30% encino and roble oak species and 70% pine as the dominant species (Kroll 1980, Rappole *et al.* 1999, Pérez and Morales 2004).

Currently, the initiative of proposals to assign Important Bird Areas in Central America represents an opportunity to promote the conservation of globally threatened and endangered species, such as the Golden-cheeked Warbler.

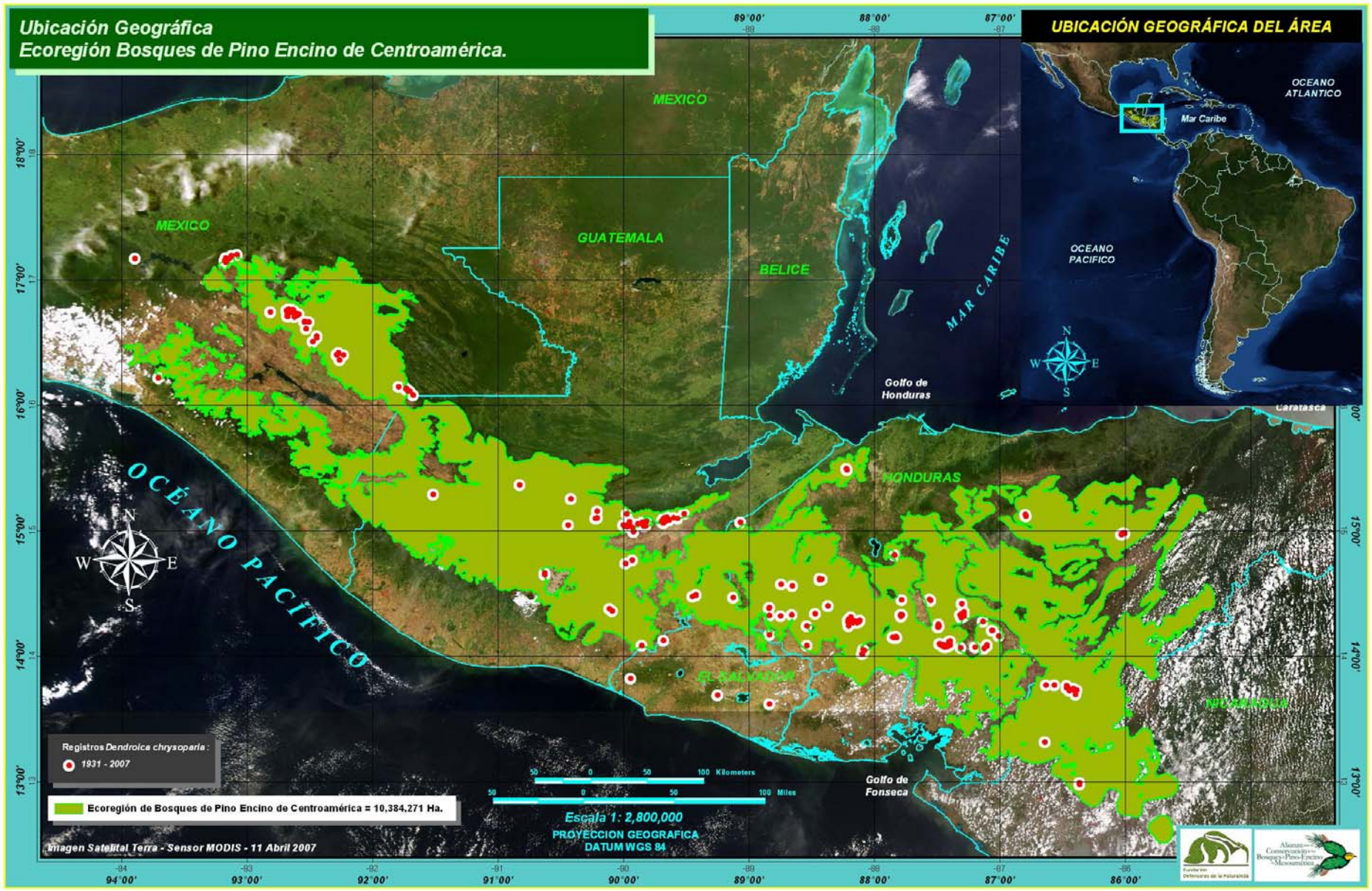

Figure 3. Records of Golden-cheeked Warblers in Winter Habitat. Data from historical research and unpublished data by members of the Alliance for the Conservation of Mesoamerican Pine-Oak Forests during the past 10 Years.

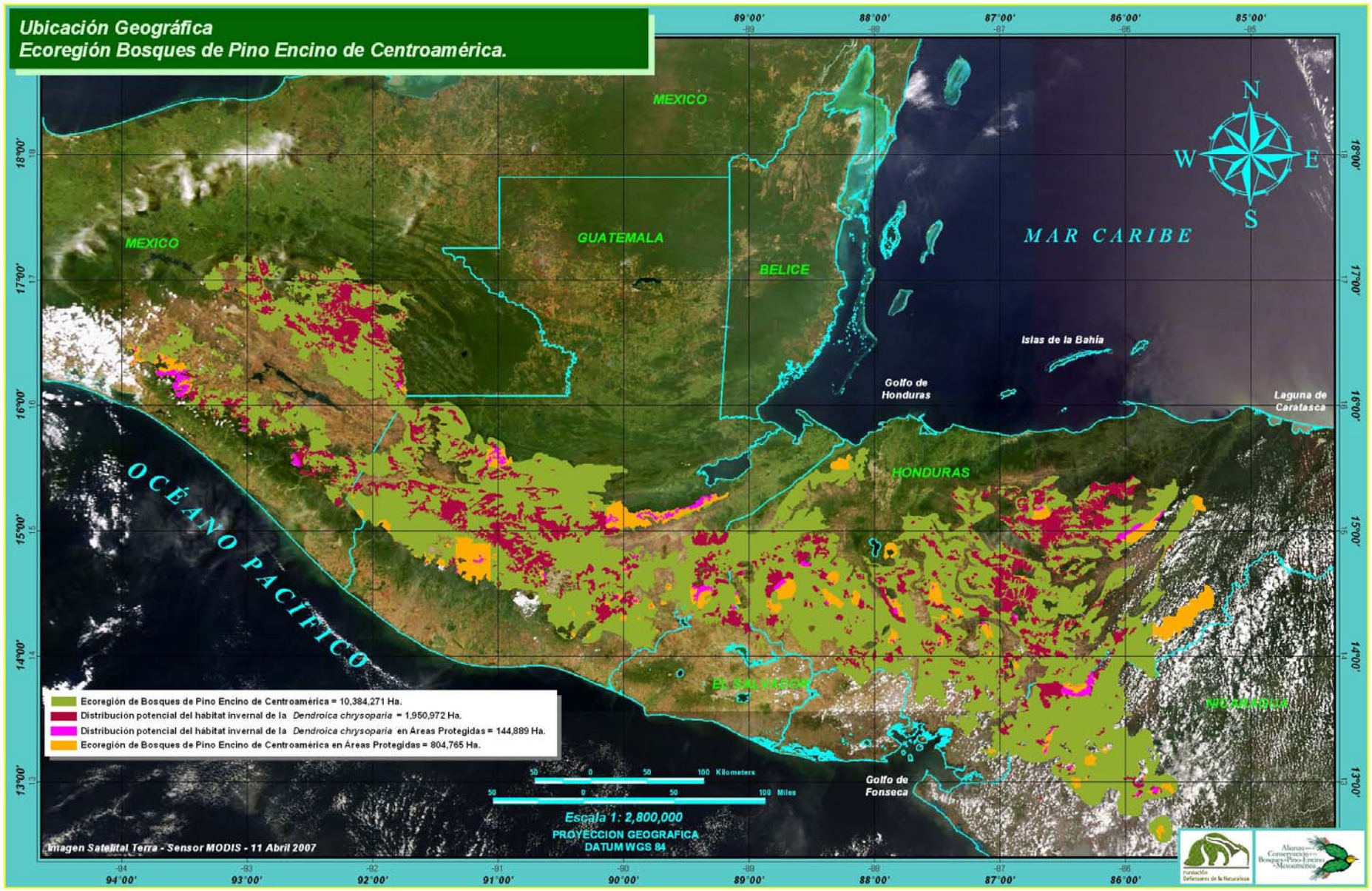

Figure 4. Potential Golden-cheeked Warbler habitat and protected areas within the Central American pine-oak forest ecoregion. Source: GIS-DEF – Pronatura Sur.

2.2.3 Ecology of Golden-cheeked Warblers in the Neotropics

Studies examining the Golden-cheeked Warbler's winter ecology (Vidal *et al.* 1994, Rappole 1995, Thompson 1995, Keddy-Hector 1998, Rappole *et al.* 1999, Komar 2008) have documented the following observations:

- They occur in mixed pine-oak forests between 1,100 – 2,400 masl, but are most commonly found between 1,200 – 1,700 masl.
- They often forage in the outer middle and upper layers of encino oaks[10] as opposed to in pines and roble oaks. *Quercus sapotaeifolia*, *Q. tristis, Q. elongata, Q. elliptica,* and *Q. cortesii* are among the live oak species commonly used by Golden-cheeked Warblers for foraging (Rappole *et al.* 1999).
- They employ "gleaning and sally-hovering" foraging maneuvers (Vidal *et al.* 1994, Thompson 1995, Rappole *et al.* 1999).
- They are generalist insectivores (Pulich 1976, Wharton *et al.* 1996).
- According to Rappole *et al.* (1999), there is little segregation of habitat by sex (but see Vidal *et al.* 1994 and Komar 2008).
- Generally, they occur in mixed-species foraging flocks (85.35%, *n*=157) with Hermit Warbler (*Dendroica occidentalis),* Townsend's Warbler (*D. townsendi),* Greater Pewee (*Contopus pertinax*), Black-and-white Warbler (*Mniotilta varia*), Painted Redstart (*Myioborus pictus*), Slate-throated Redstart (*M. miniatus*), Black-throated Green Warbler (*D. virens*), Acorn Woodpecker (*Melanerpes formicivorus*), Crescent-chested Warbler (*Vermivora superciliosa*), Wilson's Warbler (*Wilsonia pusilla*), Tufted Flycatcher (*Mitrephanes phaeocercus*), and Spot-crowned Woodcreeper (*Lepidocolaptes affinis*) (Rappole *et al.* 1999).

2.2.4 History of Research on Golden-cheeked Warblers in the Ecoregion

The first observations of the Golden-cheeked Warbler occurred in the Neotropics. Osbert Salvin recorded the species in Tactic, Alta Verapaz, Guatemala in 1859. Sclater & Salvin described it in 1860. Warren Pulich conducted a comprehensive study, which detailed the species' life history, distribution, and habitat (Pulich 1976). He called for awareness about the species' conservation status across its entire range.

It was not until the following decade that Kroll (1980) conducted a study of the Golden-cheeked Warbler in the Neotropics. Fifteen years later, other researchers conducted studies about the species' winter ecology (Vidal *et al.* 1994, Rappole 1995, Rappole *et al.* 1999).

Publications about the species' ecology in the Neotropics, and an interest in research and conservation of the region have increased significantly since 1995. Studies of the species in the Neotropics are briefly summarized in Appendix 3.

[10] Residents of rural areas in Latin America group oaks morphologically and these terms have been incorporated into wider use by the conservation and scientific communities. **Encino oaks** are non-deciduous with small, complete leaves, densely cupped foliage, and branches with an upward orientation. This group of oaks includes *Quercus sapotaeifolia*, *Q. tristis, Q. elongata, Q. elliptica,* and *Q. cortesii.* **Roble oaks** are semi-deciduous, with larger, sometimes lobed leaves, less dense foliage, and branches that are less vertically oriented than encinos. This group of oaks includes *Q. rugosa, Q. conspersa, Q. skinerii, Q. peduncularis,* and *Q. acatenanguensis.* (Rappole *et al.* 1999 and S. Pérez unpublished data).

3 Background of the Planning Process

3.1 Alliance for the Conservation of Mesoamerican Pine-Oak Forests

Worried about the conservation threats to Central American pine-oak forests, SalvaNATURA (El Salvador), Fundación Defensores de la Naturaleza (Guatemala), and Pronatura Sur (Mexico) joined efforts to promote international collaboration directed toward conservation of these forests in 2003. Each organization already was working in its own country to tackle different aspects of conservation in the region.

From 1990 to 1993, Pronatura Sur carried out field studies to document the winter range of the Golden-cheeked Warbler in the region of Los Altos de Chiapas, Mexico. This organization also was conducting education, inter-institutional steps, and international collaborative activities to promote conservation actions for the region's pine-oak forests during this time.

In 1999, a group of natural resource professionals gathered in "Los Albores", Sierra de las Minas, Guatemala. With support from the National Fish and Wildlife Foundation, the U.S. Army, and the Nature Conservancy, they designated Sierra de las Minas Biosphere Reserve as a platform site to start conservation projects related to the Golden-cheeked Warbler in the Neotropics. Between 2000 and 2003, both Fundación Defensores de la Naturaleza and Pronatura Sur independently focused their efforts on studying the winter distribution and ecology of the Golden-cheeked Warbler in Guatemala and Mexico; they also implemented many conservation actions for the pine-oak forests that comprise this species' winter habitat. In 1999, SalvaNATURA initiated efforts to document the birds of the pine-oak forests in El Salvador and promote the conservation of these forests.

In January 2001, Fundación Defensores de la Naturaleza organized the first workshop for the conservation of the Golden-cheeked Warbler in its winter range in Río Hondo, Zacapa, Guatemala. Representatives of the *Universidad Autónoma de Honduras* (Honduras Autonomous University), Pronatura Sur, the Nature Conservancy, and the National Fish and Wildlife Foundation attended. Participants began developing a standardized methodology for studies of the Golden-cheeked Warbler at wintering sites and an initiative to establish the "Alliance for the Conservation of the Golden-cheeked Warbler" in Central America.

During 2002 and 2003, SalvaNATURA, Fundación Defensores de la Naturaleza, Pronatura Sur, and the American Bird Conservancy furthered collaborative conservation efforts in Central American pine-oak forests by implementing the "*Quercus* and Birds" Project with the support of the U.S. Fish & Wildlife Service's Neotropical Migratory Bird Conservation Act. One of the project's main objectives was to establish multi-national collaborations for the conservation of temperate forests in Mesoamerica, using migratory birds as a symbol for conservation. While working together on the project, the common interests of the three organizations became apparent. This collaboration laid the foundation to start outlining conservation efforts at a regional scale to protect Central American pine-oak forests and their avifauna. The organizations chose the Golden-cheeked Warbler as an umbrella species.

In 2003, Pronatura Sur initiated the formation of a working group comprised of organizations from the United States (the Nature Conservancy, Texas Parks and Wildlife Department, and Environmental Defense), Mexico (Instituto Montebello and Instituto de Historia Natural y Ecología), Guatemala (Fundación Defensores de la Naturaleza), and Honduras (Fundación EDUCA). The objectives of the workshop were to reinforce the Alliance's initiative that began in Guatemala in 2001 and carry out joint

conservation actions for Mesoamerican temperate forests and their birds. This proposal was supported financially by the Neotropical Migratory Bird Conservation Act through the "Conservation of Temperate Forests and Capacity Building in Mexico, Guatemala, and Honduras" project.

In order to consolidate conservation efforts focused on Central American pine-oak forests and publicize the most relevant results regarding Golden-cheeked Warbler ecology, SalvaNATURA, Fundación Defensores de la Naturaleza, and Pronatura Sur organized the "Conservation of Pine-oak Forests and the Golden-cheeked Warbler" symposium, which took place during the VII Congress of the Mesoamerican Society for Biology and Conservation in Tuxtla Gutiérrez, Chiapas, Mexico on November 7, 2003.

Nearly 120 people attended the symposium. They included students, researchers, conservationists, and public officials from eight countries (United States of America, Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama). Members of organizations involved in the management and conservation of the region's pine-oak forests attended, as well as those organizations that carry out research and conservation actions for the Golden-cheeked Warbler in breeding and wintering areas. Presentors shared results of studies conducted prior to the symposium.

After the presentations, the participating organizations held a round table discussion about establishing an alliance for the conservation of Central American pine-oak forests and using the Golden-cheeked Warbler as an umbrella species to further collaborative efforts to conserve and protect Central American pine-oak forests and the birds that inhabit them. The round table discussion allowed the attendees to analyze the advantages of forming a regional alliance and establish considerations regarding the importance, priority actions, and conservation strategies for Central American pine-oak forests.

Given the richness of avifauna and endemism in the area, as well as the ecoregion's importance as a migratory route for a large number of birds, participants decided that birds would be used as an emblematic group to promote the conservation of this ecoregion's temperate forests. Special emphasis was given to the Golden-cheeked Warbler and the ecoregion's pine-oak forests, due to their conservation status and the fact that they are shared resources between North America and Mesoamerica.

As a result of the symposium and round table discussion, a letter of agreement establishing the "Alliance for the Conservation of Mesoamerican Pine-Oak Forests" was signed by representatives of ten conservation organizations from six countries (United States, Mexico, Guatemala, Honduras, El Salvador, and Nicaragua) (Appendix 4).

The Alliance's initial objectives included:

- Promote the conservation of pine-oak forests as habitat for threatened migratory and resident bird species.
- Focus research efforts on the study and conservation of the Golden-cheeked Warbler throughout its entire range.
- Implement training of technical staff, community leaders, and other social sectors involved in the management and conservation of the region's temperate forests.
- Involve all relevant stakeholders in decision-making, planning, procedures, management, and conservation of the forests and their avifauna.
- Establish cooperative programs to prevent, combat, and manage forest fires and plagues.
- Disseminate information about the importance of the conservation of the ecoregion's forests and its avifauna.
- Identify and secure financial resources that allow the development and implementation of the

actions proposed by the Alliance.

- Define the collaborative framework, as well as mechanisms for effective communication and coordination of the Alliance's efforts.

3.2 Methodology and Developmental Process for the Conservation Plan

The methodology used to develop the plan is called "Conservation Area Planning" (CAP) and it was developed by the Nature Conservancy and its partners. The methodology is used to analyze contextual information about a specific geographic area and plan activities focused toward the area's conservation priorities. These priorities include protection or improvement of the viability of the area's biodiversity and reduction or elimination of critical threats to the area. By identifying priorities, this methodology allows planning staff and protected areas managers to better allocate human and financial resources to conserve these areas.

The CAP methodology consists of five steps (Figure 5), starting with the identification of conservation targets. Conservation target is a term used to describe the species, ecologic communities or systems, and the natural processes that sustain them. Conservation targets justify the selection of a site for conservation actions. Next, the planning team conducts a series of situational and contextual analyses. Finally, the team determines strategies and measures of success. This process provides two specific results:

1. Prioritize conservation strategies to mitigate and/or eliminate the critical stresses that harm the site (mitigation of threats); restore or improve the viability of biodiversity at the site (through restoration and management); and strengthen conservation capacities at the site.

2. Develop a monitoring system to measure the impact of conservation actions at the site (measures of success) and provide feedback for the revision of conservation strategies whenever necessary.

More details about the CAP methodology can be found at www.conserveonline.org

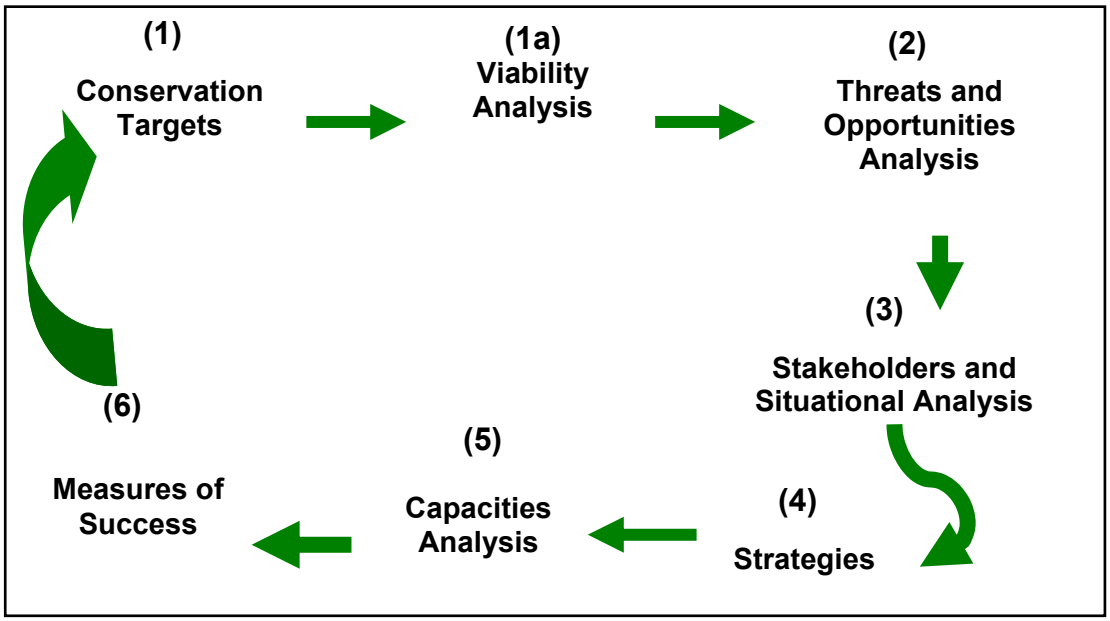

Figure 5. Methodological Scheme of Conservation Area Planning - CAP.

As a first step in the plan's development, the planning team defined existing pine-oak forests in each of the ecoregion's countries as the conservation targets. Even though the Golden-cheeked Warbler is a priority conservation species for the Alliance, it was not chosen as a conservation target since preserving it requires actions that protect, manage, and conserve pine-oak forests, its main winter habitat.

3.2.1 Developmental Process for the Plan

a) 1st Regional Meeting, Guatemala, June 2005:

The purpose of this meeting was to form a planning team comprised of members of the Alliance (Appendix 5) who would define a workplan for the development of the conservation plan for Central American pine-oak forests and the Golden-cheeked Warbler and agree on each country's responsibilities and commitments. During this first meeting, attendees also developed two out of the five steps of the CAP methodology: the definition of conservation targets and their viability analysis. This latter step was discussed preliminarily in order to validate and enrich the rationale behind the next step of the process.

b) National Workshops:

The planning team conducted five national consultation workshops within the region (one each in Chiapas, Guatemala, El Salvador, Honduras, and Nicaragua) and invited key stakeholders of the governmental and non-governmental sectors from their respective countries (Appendix 5). The team developed the objectives of the plan during these workshops and completed steps 2 through 4 of the CAP methodology. As a last step, representatives from each country integrated the strategies that they considered the most appropriate for the conservation of their own country's pine-oak forests.

c) 2nd Regional Meeting, Guatemala, October 2005:

The planning team, along with each country's stakeholders who had expertise and knowledge of the pine-oak forests' current situation, held a second regional meeting (Appendix 5). The purpose of this meeting was to revise and integrate the national workshops' results and create a regional plan at a Mesoamerican-scale. Also, the planning team reviewed, analyzed, and defined some of the CAP methodology's steps, strategies, and measures of success for the Central American pine-oak forest ecoregion at a regional scale. The planning team revised and defined the plan's objectives and, for the most part, completed all the steps of the CAP methodology. Additionally, they revised and analyzed the preliminary results achieved in the process of defining a portfolio of priority sites for the conservation of pine-oak forests (see Section 9).

d) 3rd Regional Meeting, Guatemala, May 2006:

The planning team developed a draft document of the plan based on the results achieved in the 2nd regional meeting. They distributed the plan to reviewers for feedback and revision. During the 3rd regional meeting, the team revised, enriched, and edited the plan's first edition and also worked on an estimated budget to implement the plan (see Section 10, Table 13). The team also revised and enhanced the final results of the site portfolio developmental process.

4 Objectives of the Conservation Plan

4.1 General

Promote the conservation, development, and sustainable use of natural resources in the Central American pine-oak forest ecoregion of Mesoamerica.

4.2 Specific

- Promote the conservation of the Golden-cheeked Warbler and its winter habitat.
- Identify and promote the most effective strategies for conservation and sustainable development at a regional scale.
- Involve key national and regional stakeholders in order to achieve the conservation and sustainable use of pine-oak forests.

5 Situational Analysis of the Ecoregion

5.1 Viability Analysis of the Pine-Oak Forests

Only an estimated 26,728.35 km², or 26%, of the total area of the ecoregion, remains forested (Fundación Defensores de la Naturaleza 2006). This estimate is similar to the percentage (29.80%) reported in Rappole *et al.* (2000), in which approximately half of the ecoregion's total area was analyzed. These data are alarming not only in terms of amount of forest cover lost, but also in terms of loss of habitat quality and are the reason the forest's viability is ranked *fair*. However, it is important to point

out that with effective management, pine-oak forests have a great natural capacity for regeneration. Furthermore, there are also reasons to believe that with immediate action it is possible to recover large areas of this important ecosystem.

Kroll (1980) suggested a structural similarity existed between wintering and breeding habitat. Recent studies by Rappole *et al.* (1999) and Pérez and Morales (2004) proposed that Golden-cheeked Warblers occur in the Neotropics in habitat with ≥30% encino (deciduous) and roble (semi-deciduous) oaks and 70% pines between 900 and 2,000 masl. Generally, the conservation targets currently ranked as *fair* still provide winter habitat for this species. Hence, initiatives to protect these conservation targets should be implemented immediately; otherwise, irreversible alterations may occur.

The planning team analyzed ecological attributes, such as amount of available habitat, connectivity, fire regimes, etc., according to existing pine-oak forests in each of the ecoregion's countries, i.e., the conservation targets. Since the attributes vary depending on each country's condition, their rankings differed by country. In all the national workshops, the planning team attempted to use the same key attributes with some slightly noticeable variations (Table 4). Interestingly, forest fires have decreased and are viewed as less of a threat in El Salvador, Honduras, and Nicaragua. This finding is likely a result of increased interest in fire prevention and management taken by the local and central governments in these countries.

Given the positive relationship that exists between biological diversity and the percentage of pine and oak species in pine-oak forests, the planning team decided that a key attribute to evaluate a forest's biological condition was presence of oaks (*Quercus* spp.). In each case, this attribute ranked *fair* (Table 4) given the existing selective felling of these trees for use as firewood and in charcoal production.

Table 4. Viability Analysis of Pine-Oak Forests in Each Country

Conservation Target		Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Ranking
1	Chiapas	Landscape context	Fire regime (season, frequency, intensity, area)	% and area of forest cover affected by fires in each country's pine-oak forests	Less than 40%	**40-60%**	60-80%	More than 80%	Fair
1	Chiapas	Condition	*Quercus* abundance	% *Quercus*/ha		**Less than 35%**	More than 35%		Fair
1	Chiapas	Size	Forest cover in the ecoregion	% current forest cover in terms of the ecoregion's area in each country	Less than 10%	10-30%	**30-50%**	More than 50%	Good
1	Chiapas	Size	Area of forests with presence of oaks	% forest cover with presence of oak in terms of original area in each country	Less than 10%	10-30%	**30-50%**	More than 50%	Good
1	Chiapas	Size	Area of potential habitat for GCWA	# km^2 of potential habitat for the species	Less than 3,000	**From 3,000 to 15,000**	From 15,000 to 25,000	More than 25,000	Fair
2	Guatemala	Landscape context	Connectivity between communities and ecosystems	Connectivity percentage	Less than 40%	**40-60%**	60-80%	More than 80%	Fair
2	Guatemala	Landscape context	Potential habitat for GCWA	Percentage of potential habitat for the species in terms of the original landscape	Less than 10%	**10-30%**	30-50%	More than 50%	Fair
2	Guatemala	Landscape context	Fire regime (season, frequency, intensity, area)	% and area of forest cover affected by fires in each country's pine-oak forests	More than 40%	**10-40%**	5-10%	Less than 5%	Fair
2	Guatemala	Condition	*Quercus* abundance	% *Quercus*/ha	Less than 10%	**From 10 to 20%**	From 20 to 30%	From 30 to 40%	Fair
2	Guatemala	Size	Forest cover in the ecoregion	% current forest cover in terms of the ecoregion's area in each country	Less than 10%	**10-30%**	30-50%	More than 50%	Fair
2	Guatemala	Size	Area of forests with presence of oaks	% forest cover with presence of oak in terms of original area in each country	Less than 10%	**10-30%**	30-50%	More than 50%	Fair
3	El Salvador	Landscape context	Connectivity between communities and ecosystems	Connectivity percentage	Less than 40%	40-60%	**60-80%**	More than 80%	Good
3	El Salvador	Landscape context	Potential habitat for GCWA	Percentage of potential habitat for the species in terms of the original landscape	Less than 10%	**10-30%**	30-50%	More than 50%	Fair
3	El Salvador	Landscape context	Fire regime (season, frequency, intensity, area)	% and area of forest cover affected by fires in each country's pine-oak forests	More than 40%	10-40%	**5-10%**	Less than 5%	Fair
3	El Salvador	Condition	*Quercus* abundance	% *Quercus*/ha	Less than 10%	**10-20%**	20-30%	30-40%	Fair

Conservation Target		Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Ranking
3	El Salvador	Size	Forest cover in the ecoregion	% current forest cover in terms of the ecoregion's area in each country	Less than 10%	10-30%	**30-50%**	More than 50%	Good
3	El Salvador	Size	Area of forests with presence of oaks	% forest cover with presence of oak in terms of original area in each country	Less than 10%	10-30%	**30-50%**	More than 50%	Good
4	Honduras	Landscape context	Connectivity between communities and ecosystems	Connectivity percentage	Less than 40%	**40-60%**	60-80%	More than 80%	Fair
4	Honduras	Landscape context	Potential habitat for GCWA	Percentage of potential habitat for the species in terms of the original landscape	Less than 10%	10-30%	**30-50%**	More than 50%	Good
4	Honduras	Landscape context	Fire regime (season, frequency, intensity, area)	% and area of forest cover affected by fires in each country's pine-oak forests	More than 40%	10-40%	**5-10%**	Less than 5%	Good
4	Honduras	Condition	*Quercus* abundance	% *Quercus*/ha	Less than 10%	**10-20%**	20-30%	30-40%	Fair
4	Honduras	Size	Forest cover in the ecoregion	% current forest cover in terms of the ecoregion's area in each country	Less than 10%	10-30%	30-50%	**More than 50%**	Very good
4	Honduras	Size	Area of forests with presence of oaks	Ratio or percentage of intervened (sparse) forest versus less disturbed, dense forests (dense)	Less than 10%	**10-30%**	30-50%	More than 50%	Fair
4	Honduras	Size	Area and ratio of mature (dense) and intervened (sparse) forests	Ratio or percentage of intervened (sparse) forest versus less disturbed, dense forests (dense)	Less than 10%	**10-30%**	30-50%	More than 50%	Fair
5	Nicaragua	Landscape context	Connectivity between communities and ecosystems	Connectivity percentage	Less than 40%	**40-60%**	60-80%	More than 80%	Fair
5	Nicaragua	Landscape context	Potential habitat for GCWA	Percentage of potential habitat for the species in terms of the original landscape	Less than 10%	10-30%	**30-50%**	More than 50%	Good
5	Nicaragua	Landscape context	Fire regime (season, frequency, intensity, area)	% and area of forest cover affected by fires in each country's pine-oak forests	More than 40%	10-40%	**5-10%**	Less than 5%	Good
5	Nicaragua	Condition	*Quercus* abundance	% *Quercus*/ha	Less than 10%	**10-20%**	20-30%	30-40%	Fair
5	Nicaragua	Size	Forest cover in the ecoregion	% current forest cover in terms of the ecoregion's area in each country	Less than 10%	**10-30%**	30-50%	More than 50%	Fair
5	Nicaragua	Size	Area of forests with presence of oaks	% forest cover with presence of oak in terms of original area in each country	Less than 10%	**10-30%**	30-50%	More than 50%	Fair

5.2 Threats to the Pine-Oak Forests

Stresses to the conservation targets are mainly: a) loss and fragmentation of habitat and; b) degradation of the forests' composition and structure. These two stresses have serious implications for the entire region, and if the current trends continue, they could severely deteriorate the pine-oak forests. The most important threats are shown in Table 5.

Table 5. Most Important Threats to the Region's Pine-Oak Forests

Threats throughout the Systems		Chiapas	Guatemala	El Salvador	Honduras	Nicaragua	Overall Hierarchical Threat Rank
1	Unsustainable forestry practices, incompatible with conservation	High	Medium	High	Medium	High	High
2	Forest fires	High	High	Medium	High	Medium	High
3	Agricultural expansion	Medium	High	Medium	Medium	High	High
4	Extraction of firewood and whole logs	High	High	Medium	Medium	Medium	High
5	Illegal utilization of wood	Medium	Medium	Medium	High	Medium	Medium
6	Forest plagues	Medium	Low	Low	Low	Medium	Medium
7	Construction of housing and infrastructure	Medium	Medium	-	-	-	Medium
8	Extraction of non-timber forest products	Medium	Low	-	-	-	Low
9	Strip mining	Low	-	-	-	-	Low
Threat status for the conservation targets and each site		**High**	**High**	**Medium**	**High**	**High**	**High**

5.2.1 Unsustainable Forestry Practices, Incompatible with Conservation

During national and regional workshops (Table 5), the planning team identified unsustainable forestry practices that are incompatible with conservation as the greatest threat to the pine-oak forests.

Interestingly, most of the conservation measures taken in the world's wood market originated out of the concern to maintain the biological diversity of the Neotropics and tropics worldwide. An additional concern arises for developing countries located in the Neotropics because most of these forests are in their natural state, which results in a high level of diversity that does not allow compliance with forest management and use standards. Competition with large companies that own forest plantations is difficult due to the lack of competitive management, large volumes of wood they produce, and inability to comply with established standards and certifications.

The criteria used to rank forest practices as *good* include: conservation of biological diversity, land and water; contribution to the carbon cycle (synthesis, capture, and sequestration); maintenance of health, ecosystem viability, and production capacity; long-term maintenance and improvement of socioeconomic benefits; and development of legal and institutional frameworks for forest conservation and management (Syrie *et al.* 2003). Given these criteria, examples of adequate forest management in Latin America are few, and thus, the region is not positioned as a strong international competitor. Utilization of the ecoregion's natural forests is taking place without sustainable or certified forest management and reductions in natural productivity are being reported (Albuquerque *et al.* 2000, FAO-FRA 2000, URL 2004).

This threat ranked *medium* for Guatemala and Honduras because they have a legal framework and actions that favor the sustainable use of forest resources in both natural forests and plantations. These actions are oriented toward sustainable use through forest incentives to recover zones lacking vegetation. However, this legal framework allows clearcutting, which affects environmental vulnerability, soil conservation, water production, forest fragmentation, and loss of diversity resulting from the conversion of natural mixed forests into single-species plantations or plantations of exotic species, practices approved by each country's national forest institute.

5.2.2 Forest Fires

The scope and damage of forest fires are sometimes overestimated because their visual impact is often alarming. The damage is cyclical and reaches catastrophic levels if no preventive measures are taken. This threat ranked *high* for Chiapas, Guatemala, and Honduras, and *fair* for El Salvador and Nicaragua. In Chiapas and Guatemala, incidence of fires is high due to agricultural activities and slash and burn farming. Also, the transformation of oak forests to pine forests occurring in this region is changing the composition and structure of the vegetation and microclimatic conditions, making these ecosystems more vulnerable to forest fires (González-Espinosa *et al.* 2005a).

At a regional level, a tendency towards decreasing the number of forest fires can be seen even though recurring fires, both creeping and crown, can have severe effects on the ecosystem.

Fire management and the maintenance of non-catastrophic conditions regarding forest fires are of vital importance for the entire pine-oak forest ecoregion. Although these forests evolved with seasonal fires, recurring forest fires in places like Sierra de las Minas, are due to extensive cattle farming[11].

Global climatic events, such as La Niña and El Niño, are characterized by extended drought and rainy seasons approximately every 4 to 6 years. These conditions make the forest more vulnerable to catastrophic forest fires.

In terms of habitat quality for migratory and resident birds, forest fires can alter the seasonal availability of insects, affect the seasonal survival of birds in the Neotropics (Pérez and Solórzano, in prep.), and stimulate the maintenance of tree species that tend to adapt best under these altered conditions, such as *Pinus oocarpa*, and compete with encino and roble oaks in the region.

Therefore, it is necessary to implement a system that reduces forest fires and accumulated organic matter. The system must be managed both spatially and temporily so that the potential for catastrophic forest fires will be minimized (Mark Kaib personal communication). Residents must be trained to adopt and carry out integrated fire management measures. Social pressure encouraging complete eradication of forest fires is neither healthy nor adequate for establishing and maintaining proper forest management.

[11] Extensive cattle-farming is an activity associated with human-caused creeping fires.

5.2.3 Agricultural Expansion

The loss of pine-oak forest habitat is mainly due to changes in land use across the region. In Guatemala and Honduras, data obtained from historical analyses demonstrate that up to 60% of the loss of total forest cover can be attributed to poverty and deforestation (FAO-FRA 2000, Loening and Markussen 2003).

Pine-oak forests are located in rural areas and are more susceptible than other forest types to slash and burn agriculture for the following reasons: i) the poorest families with the least access to services, such as water, transportation, health, education, etc., live in the area; and ii) pine-oak forests occur on steep slopes with nutrient deficient, acidic soils, and thus, do not produce the minimum amount of staple foods, i.e., corn and beans, needed to survive for one year (PAHO 2004). Consequently, rural families living in pine-oak forests rely on the combination of the illegal sale of wood and the conversion of pine-oak forests to agricultural crops for their survival.

How plant succession proceeds after agricultural activities have ceased in the area is not well documented. Succession depends on many variables such as altitudinal range, seasonal rain cycle, soil type, slope, etc. Recent studies of succession in Chiapas, Mexico (González-Espinosa *et al.* 2005) show that initially, an average of 100 species may be present in these areas, including pine and oak species.

The average deforestation rates in Guatemala and Honduras are 20,700 ha/year and 58,970 ha/year, respectively (FAO-FRA 2001, Melgar 2003). According to Molina (1997), from 1964 to 1990 Honduras lost 35% of its pine-oak forests. With an average regional deforestation rate of 60,000 ha/year, the current forest cover will be gone in 45 years. Latin America has the highest deforestation rate worldwide, and it is associated with poverty indexes (ECLAC 2002) that could accelerate the abovementioned approximation as the population continues to increase.

5.2.4 Extraction of Firewood and Whole Logs

In Guatemala and Chiapas, this threat ranked *high* because numerous rural communities have been established in pine-oak forests in these areas. These communities extract firewood and whole logs from the forests, and these activities exert a high level of stress on the forests. In the other countries, the ecoregional population density is lower so this threat ranked *medium* in those countries.

Firewood is extracted mostly for use in homes. It is estimated that approximately 75% of the region's population uses firewood to cook their meals. Honduras and Guatemala have the largest remaining amount of pine-oak forest in the region (Table 5), but also the highest extraction rate of firewood. In 1993, Honduras reported that 7 to 7.5 million cubic meters of firewood were extracted by people living in rural communities (FAO-FRA 2000). In 1996, 92% of the wood legally extracted from Guatemalan pine-oak forests was used for cooking and only 8% for forest industry purposes (Internet INAB 2007).

The tree species used most frequently as firewood, in order of importance, include: encino oaks (*Quercus* spp.), roble oaks (*Quercus* spp.), pines (*Pinus* spp.), sweet gum (*Liquidambar* spp), and alders (*Alnus* spp.). Encino oaks are highly valued for firewood, whole logs, and charcoal. Pérez (2001) estimated that if wood extraction took place from a single location in Sierra de las Minas, 1,985 families could use up to 170 ha of forest a year.

5.2.5 Illegal Utilization of Wood

High rates of clandestine wood extraction exist in the ecoregion, both in broadleaf and pine-oak forests. A case study in Honduras revealed that in pine-oak forests, illegal utilization ranges from 350,000 to 600,000 cubic meters, which is equivalent to 30-50% of the total amount of wood extracted annually.

The gross economic value for this volume of wood is estimated around 55-70 million U.S. dollars (Internet *Tala Ilegal en Centroamérica* 2007). For this reason, illegal utilization of wood ranked *high* for Honduras.

The illegal utilization of wood is a necessity in some rural areas where it is impossible to survive on annual farming of staple foods. However, there are some illegal actions associated with activities that are considered "legal" and thus, increase the prevalence of this threat throughout the ecoregion. Those illegal actions include overexploiting authorized volumes of extracted wood, duplicating use of permits, bribing authorities, forging documents, etc.

5.2.6 Forest Plagues

Ineffective forest management such as cattle farming, deforestation, and selective logging, as well as natural disturbances like recurring ground and crown fires and extended droughts, increase the physiological vulnerability of forests and make them more susceptible to plagues. The most common plagues in the region include: the pine beetle (*Dendroctonus* spp.), other insects of the Cerambicidae family, and mistletoe (*Psittacanthus* spp., and *Arceuthobium aureum*).

Forest plagues do not appear to be a strong threat in terms of the area affected annually; only Chiapas and Nicaragua ranked *medium* for this threat. However, the effects of a plague can be catastrophic when forest management is poor and droughts and forest fires are common. For example, research carried out in Honduras between 1962 and 1963 demonstrated that forest damage from a plague that occurred in 1962 destroyed 3,148 ha/day, 1,700,000 ha total, and resulted in a loss of over 300 million dollars. The area of outbreak has decreased since then. By 1998, the total volume affected was 8,558 cubic meters, and the volume recovered was 5,558 cubic meters (FAO-FRA 2000). In 1980, the Department of Huehuetenango, Guatemala reported a loss of up to 100,000 ha from a forest plague (URL 2004).

5.2.7 Construction of Housing and Infrastructure

During the last few years, some cities in Guatemala and Chiapas have experienced rapid population growth and a subsequent increase in construction, mainly large-scale housing projects. This increase in construction has contributed to the loss and fragmentation of scarce forest remaining around these cities. Hence, this threat ranked *medium* for both Chiapas and Guatemala. In rural areas, housing construction is a continuous process linked to population growth, access to new farmland, and the construction of new highways.

5.2.8 Extraction of Non-timber Resources

In Chiapas and Guatemala, some non-timber resources, such as bromeliads, orchids, mosses, shrubs, and pine needles are extracted and used for cultural and religious ceremonies.

This threat ranked *medium* for Chiapas and *low* for Guatemala. However, there is inadequate documentation on the extent and impact these extractions have on the ecosystem. Efforts must be made to study this activity in order to have a sound scientific foundation with which to rank this threat.

5.2.9 Strip Mining

Strip mining through traditional methods has taken place in the ecoregion since colonial times. Recently, strip mining has been industrialized in Central America. Although the environmental impact from strip mining is great, it ranked *low* since it happens in a very small geographical area of the ecoregion. The planning team only assessed this threat for Chiapas.

6 Opportunities in the Ecoregion

6.1 Decentralization of the State: Local or Municipal Governments

Municipal governments are property owners (28% of land in Honduras is owned by municipal governments) in many countries in the ecoregion. Thus, strengthening the ability of municipal governments to enforce management and sustainable use of resources, especially those of high social importance, such as water for human use and irrigation, provides an opportunity to increase conservation efforts in the region. The management of forest cooperatives must follow the same management guidelines as any property owner must follow (Ferrouki 2003), so that the forests are competitive, efficient, and sustainable. The forest industry can be a mechanism for promoting development at rural and country levels. In Honduras, this sector currently contributes 10% of the GDP, but has the potential to contribute up to 25% (Flores 1997 quoted by Albuquerque *et al.* 2000).

The legal framework in these countries favors the creation of municipal planning technical units and grants municipal mayors the legal authority to stop landowners from using resources when it is detrimental to the common good or when the resources are limited, e.g., water. On the other hand, there are clear examples of regionalization and association of municipal governments that have proven to be more powerful in demanding rights at national and international levels[12]. To date, more than a dozen international organizations are supporting decentralization actions for management of limited resources and governance (Ferrouki, 2003).

The decentralization of the administration of states in Central America and Chiapas has taken place because of internal processes of political democratization and the influence of international organizations. In every sense, this process allows for a decrease in public spending, economic liberalization, and the need to answer the demands of civil society to advance the construction of a more participatory and democratic state (Chapman and Fisher 1999). To a certain extent, local governments have started actions associated with wood exploitation, reforestation, protected areas management, forest fire management, and many other forest- and environmentally related subjects. Most of the experiences with forest resource management, participatory democratic exercises, governance, and endogenous development in rural and urban communities, have been motivated by foreign cooperation,

[12] For example municipal associations in Honduras, Nicaragua, El Salvador, and Guatemala currently are receiving petroleum products from Venezuela, with extreme credit facilities, fair prices, and the possibility of investing part of the payment in Venezuela. This political position, above the national level in some cases, could not have happened without decentralization (Internet *Asociación Nacional de Municipalidades de Guatemala* 2007).

through civil society organizations, and rarely, through solid institutions with a long-term vision. This has greatly affected the sustainability of these projects and their binding mechanisms once financing ends. Successful models of indigenous and *mestizo* community forest management, such as the one that exists for the Totonicapán forests in Guatemala, are worth replicating.

Decentralized municipal management, even within a legal framework, faces some deficiencies due to lack of funds and clearly defined operational mechanisms. Sometimes, highly influential people like political leaders or landowners, at a local or national level, can take advantage of these conditions and exploit natural resources to the detriment of their neighboring communities (ECLAC 2002, Ferrouki 2003). Weak resource management and a low capacity to develop and implement strategies and activities are results of the performance of governments with limited leadership and real power. The greatest challenge for municipal management to achieve balance among interests for development at national and local levels is the equity of access to resources and sustainability.

6.2 Green Markets

Conservation has long been an investment sector without solid estimates of return rates. During the last years, contributions in this area have decreased to such an extent that each project should have its own financial sustainability mechanism, but they do not. There are, however, some financial mechanisms that encourage conservation and hold promise for financial sustainability. These mechanisms include the management and use of natural and planted forests, payment for environmental services, ecotourism and nature-based tourism, carbon sequestration, and the certification of timber and non-timber products. Although green markets hold promise for furthering forest management efforts in the region, they will not solve all problems related to forest management. Other variables must be taken into account, in a comprehensive manner, to guarantee the demand and sustainability of natural resources.

6.3 Productivity of Natural Forests, Wood Industry, and International Markets

Although most of the region still has a reasonable amount of forest cover, the productivity of pine-oak forests has decreased across the entire region (FAO-FRA 2000). Data for Honduras show a 75% decrease in annual biomass yield overall, decreasing production from 1 to 0.60 million m^3/year. This decrease in productivity could be due to limited natural regeneration resulting from overuse. This overuse affects the forest's genetic quality and generates genetic degradation when "parent" trees, with poor physical features, are left in the area.

Wood processing waste rates are high across most of the ecoregion. A high percentage of trees with commercial diameter are utilized as firewood (92% in Honduras, 87% in Guatemala). Also, wood processing in sawmills ranges from 15 to 35% of the real utilizable value of this resource (FAO-FRA 2000, URL 2004, Mairena and Flores 2006).

At an international level, the demand for forest products is slowing down. Except for Chile and Brazil, forest management criteria, in terms of the environment and productive sustainability, is deficient in Latin American countries (Albuquerque *et al.* 2000).

Essentially only whole logs and wood panels are available in Latin America for processing through international markets. Additionally, almost none of the countries have positive balances of exports and imports of wood or by-products, e.g., cellulose and paper. The market for wood production in the ecoregion is not dynamic and its prospects for the future are not promising (Albuquerque *et al.* 2000).

The competitive culture in Central America and Chiapas has been scarce and slow since the 1980s. Until 1992, Mexico (1992) and Costa Rica (1995) were the only countries that had created laws for competition and institutions to monitor their compliance. Guatemala and Nicaragua still have not considered these laws. A competitive culture improves growth and investment in countries where it exists and, to a certain extent, guarantees the transparency of the market. The countries in this region face a great challenge regarding competition with foreign products and technology. Room in markets that are not dynamic is limited, and without a policy or strategy to become more competitive and find a special niche in the market, the prospects of income and job improvement are low.

Developed countries have the capacity to easily enter dynamic markets because they often have large expanses of land, which have been converted to forest plantations, and large economies with which to finance wood production from these areas. Since these conditions do not exist in the ecoregion, it must find another strategy to enter these markets. Latin America does have a competitive advantage over the rest of the world in terms of forest products, more biological diversity, and more wintering and stopover sites for migratory birds. Even though forest certification was originally developed as an initiative to decrease the damages of selective use of forests in the tropics, Nearctic forest plantations that contain few tree species have the competitive advantage because they are "certified" with high standards (Syrie *et al.* 2003) given their low biodiversity and harvest cycles of up to 100 years.

Migratory birds would not be able to survive if only monocultures of pines existed. Currently, the market and final consumers of wood are not clear as to their preference between certified pine from the northern hemisphere (93% of all certified forests worldwide) and a possible new competitor in the market, Neotropical pine products (Syrie *et al.* 2003). Therefore, the creation of a brand and a special certification that allows the final consumer to choose a pine or wood product from natural, managed forests, will help ensure the survival of migratory birds and the completion of their migratory cycles. If not, landowners will be forced to plant pure pine stands in order to compete with forest plantations, technology, and certification criteria and meet the demands of the international market.

6.4 Ecotourism

The Mesoamerican region is known worldwide for its ecotourism, which is a source of foreign currency and an alternative to extractive industries in the region. Costa Rica was one of the first countries to take advantage of the great potential of ecotourism and organize itself to benefit from this source of income. In 2000, the country received 1.25 billion dollars from tourism-related industries and it is estimated that 70.70% of Costa Rican tourists visit protected natural areas. Considering the country has only 3.90 million inhabitants, this is a high number. There is, however, the need to find the delicate balance between tourism potential and income generated from agriculture.

The potential for tourism-based industry across the entire pine-oak forest region is ≥ to Costa Rica's. This region provides opportunities for tourists to experience culture, indigenous traditions, archaeology, and landscapes, but success will require governments in the region to develop policies that improve security, quality of services, host training knowledge of indigenous cultures, ecotourism routes, etc. Currently, there are government initiatives to promote nature-related tourism, such as avitourism, hiking, and rafting in Guatemala, activities in protected areas in the northwestern section of El Salvador, and the Atlantic zone and ruins of Copán in Honduras. Adventure tourism and ecotourism can bring benefits to rural areas, but they must be well planned and the tendency to overemphasize their impact must be avoided. Currently, tourism-based industry has little impact on conservation or the standard of living of rural populations.

7 Objectives and Strategies

The plan contains four main objectives that, if integrated with their own structure and functionality, guarantee the conservation, sustainable development, and human development of the priority areas in the medium term (see Section 9). These objectives will be challenging to implement. They can be adopted by civil society, central, local, regional, and international organizations, as well as others interested in the sustainable development, conservation, and management of pine-oak forests. The objectives include:

Objective 1. Institutional Coordination
By 2009, develop effective coordination among institutions and key stakeholders to design and implement programs and policies that promote the conservation and sustainable management of pine-oak forests.

Objective 2. Sustainable Forest Management
By 2015, protect one million hectares of pine-oak forest under conservation-compatible management practices (20 to 30% encino oaks, connectivity between patches, 10-30% of conservation areas under forest management).

Objective 3. Integrated Fire Management
By 2015, attain an integrated fire management program to minimize the negative impact of forest fires in ≥ one million hectares of priority pine-oak forests.

Objective 4. Formal Conservation Mechanisms
By 2015, protect an additional 250,000 hectares of pine-oak forest under formal conservation mechanisms (municipal parks, private reserves, ecological easements, etc.), especially in areas defined as priorities.

7.1 Description of Objectives and Strategies

The objectives are shown in order of importance for the plan's execution. The first objective is the plan's foundation. Consolidating the Alliance ensures that the objectives and strategies proposed in this plan will be carried out and reviewed. Objective 1 is a priority because the actions associated with it transversely affect objectives 2, 3, and 4, which contain the quantitive goals to be achieved in this plan. The strategies with greater impact will be emphasized in each objective.

The planning team assessed the priorities in each strategic action (Appendix 6) based on their benefits, effects, and contribution to threat mitigation, feasibility, costs, etc.

7.1.1 Objective 1: Institutional Coordination

The efficient coordination of this plan is based on the Alliance's proposed structure and function. The strategies associated with this objective determine whether or not the rest of the objectives are achieved in the long term. Therefore, these strategies form the foundation of the plan. It is the organization of the Alliance that will enable effective implementation of the plan. The structure of the Alliance is

subject to change and must reflect the participative consensus of its current, new, and potential members from each country within the ecoregion.

In order to achieve this objective, the plan proposes three transversal strategies that rank as *high* priorities (Table 6).

Table 6. Strategies for Objective 1

No.	Strategies	Overall Hierarchical Rank
1.1	Strengthen the regional Alliance for the Conservation of Mesoamerican Pine-Oak Forests (coordinator, mechanisms for communication and exchange, inclusion of key stakeholders, funds for operation and advocacy).	Very High
1.2	Promote national and multi-sectoral working groups for the conservation and management of pine-oak forests in each country.	Very High
1.3	Implement appropriate advocacy and outreach programs to strategically position the Alliance and this plan so that governmental institutions, civil society, and the international community recognize the Alliance and adopt the plan.	Very High

Other strategies that are part of this objective are strategic actions 2.2 and 2.5.

The Alliance represents one of few conservation initiatives established at a continental scale and focused on priority species and ecosystems. In order to strengthen this plan's viability at priority sites and local and regional levels, it must have integrated local criteria for developmental planning. Also, the proposed actions must represent local plans and be supported by other state and private institutions, as well as by non-governmental organizations.

The Alliance's strength is key to the plan's implementation. For this reason, it is imperative to define the structure, norms, and bylaws that establish the Alliance's functionality. In September 2007, members of the Alliance held a meeting in Guatemala to advance the structure, rights, and obligations of its members and the process of integrating new members. The members also developed a 2-year workplan for the Alliance.

In order to fulfill the objectives and strategies of the plan, it will be necessary to create national working groups within the Alliance that are based on each country's context and conditions. These groups will determine the appropriate mechanisms to implement in a given country so that each country contributes to the regional goals at priority sites identified by the Alliance (see Section 9).

The promotion of national working groups is probably the most important strategy associated with this objective since the formation of political and economic agreements within each country are integral to achieving conservation and management of natural resources in the priority conservation sites. Land use planning and other actions intended to achieve social, economic, and environmental sustainability differ among communities and local governments. The intent of this plan is to strengthen the technical capacities of local governments and leaders so that they can assist the Alliance in accomplishing the objectives of the plan. Given that each priority site will have its own agenda, the approach and strategies utilized to protect and conserve it must be a mutual commitment and jointly defined.

7.1.2 Objective 2. Sustainable Forest Management

The planning team determined that 1,250,000 hectares was the minimum amount of area that needed to be protected to ensure the survival of the Golden-cheeked Warbler and other biodiversity that inhabit the region.

Recent studies reported that the Golden-cheeked Warbler overwinters in forests containing ≥20 to 30% encino and roble oaks, and other broad-leaved species (Kroll, 1980; Rappole *et al.* 1999; Pérez and Morales 2004). Not surprisingly, not all pine-oak forest in the ecoregion meets this criterion[13]. Some areas consist of pure pine stands, and in other locations, encino oaks have been removed for use as firewood. This objective and its strategies (Table 7) will strengthen the maintenance, continuity, and sustainable use of the forest. This is the plan's most ambitious objective.

These forests have great potential to generate income in the region, but more studies are needed to determine how to guarantee the long-term sustainability of the forests. A detailed study is needed to evaluate how the proposed conservation, management, and development of priority sites will affect the natural and human resources in the region, as well as their potential for local or foreign investment.

Strategic action 1 refers to landuse planning (Table 7). It is highly related to the priority conservation sites chosen at an ecoregional level, mainly because of the low threat factors, i.e, few highways, low population density, few forest fires, and good forest cover. These factors hinder management and development opportunities, forest use, and the connection of markets at a national level. The lack of highways and nearby towns, however, provide an opportunity for sustainable land use planning and program development from a strategic perspective in consensus with civil society, local governments, and aid institutions.

The development of this strategy is costly both monetarily and temporally. However, as long as it is developed in cooperation with civil society, local governments, entrepreneurs, community leaders, etc., it will provide a strong foundation for strengthening an area. Thus, this strategic action must be legitimized or it will be a waste of resources in which the level of co-responsibility and appropriation of ideas by the inhabitants and local leaders will not outlive the duration of the programs and projects.

[13] It is necessary to clearly state which habitat and species proportions are the most adequate for the Golden-cheeked Warbler. The percentages reported in this plan are based on vegetation studies (Pérez and Morales, 2004) at sites in Guatemala where the presence of the species has been frequently recorded (San Lorenzo Mármol, Aldea Matanzas) and other locations with few to no records of the species.

Table 7. Strategies for Objective 2

No.	Strategies	Overall Hierarchical Rank
2.1	Identify and promote the sustainable use of pine-oak forest resources through applied research, best management practices, certification, and training (emphasizing oak plantation management and timber and non-timber products).	**Very High**
2.2	Promote the development and implementation of landuse planning proposals at sub-watershed, community, and property levels in priority conservation sites.	**High**
2.3	Promote forest management, use, and restoration incentives that meet appropriate criteria for the conservation of biodiversity (20-30% encino oaks in the canopy, individuals defined in each region, etc.).	**High**
2.4	Decrease stress on natural forests caused by extraction of firewood by establishing "energy forests" that contain native species and by promoting other activities, such as fuel-efficient stoves, alternative sources of energy, etc.	**High**
2.5	Improve the conservation and sustainable management of pine-oak forests by promoting and strengthening forest management at the municipal and community levels (encourage participation of civil society, provide training to municipal technical units, promote integrated management of fire and water, etc.).	**Medium**

Other strategies that are part of this objective are strategic actions 1.1, 1.2, 3.3, 4.1, 4.3, 4.4, 4.5, and 4.6.

Strategic action 2 promotes the use of applied research in the development of management and conservation guidelines for pine-oak forests (Table 7). It intends to use science as a foundation for innovation and a precursor to adequate technology to guide best management practices and competitive use of natural forests and their biodiversity. Best forest management practices must be supported by research and guarantee that goods and services from the forest, e.g., water, recreation, and land stability, will be maintained. In the local and international market, best forest management practices tend to be the basis of certified products and preferred by consumers.

Based on this information and opportunities that exist in the ecoregion to promote conservation and management of forest resources, the strategy for entering North American markets must be carefully chosen. Alternatives range from a new method of certification to the creation of a brand, or special certification, accompanied by marketing plans that encourage the consumer to choose timber and non-timber products from the region's pine-oak forests. These alternatives must be promoted by the Alliance, and national governments must have an adequate legal framework so that the market is competitive and investment in it guarantees sustainable management and protection of natural forests. For example, management guidelines could require that all managed forests in the region contain 20-30% encino oaks (strategies 3 and 4). These guidelines must be accompanied by an economic return ≥ that obtained from forests without these management guidelines, such as pure pine stands. In order to be successful, this objective must be supported by a good marketing plan, applied research, and certification that establishes not only a niche in the market, but also the opportunity for the conservation of the Golden-cheeked Warbler and other biodiversity.

Strategic action 3 proposes forest incentive programs and is strongly linked to actions 1 and 2. It supports the integration of forest harvest cycles using best management practices, certification, and applied research. Pilot projects in El Salvador and Honduras, and one institutional project in Guatemala, have proven successful. These projects also have been accepted by small and large property

owners including community properties, called ejidos in Latin America, with land title. Although this initiative is costly[14], it is very relevant to the ecoregion because poverty levels in rural areas do not allow forest harvest cycles >20 to 25 years. Forest incentive programs must not allow harvest in parcels that are less than 10 years old. That way, the trees have time to grow large enough so that small property owners can harvest these parcels and use the income from them to meet their basic food needs.

As a complement to these strategic actions, we also must seek support and integration of activities, such as forest fire management and prevention and energy forests, at a local level to reduce the demand on both managed and unmanaged natural forests (see objective 3, strategic actions 5 and 7). Energy forests have been strongly criticized by the conservation community mainly because not enough motivation exists to guarantee the care and management[15] required of them. However, from the perspective of local governments, energy forests promote reforestation or forest management as a mechanism for generating funds, maintaining a water supply, and identifying "municipal wood storage", or specific zones for the local extraction of firewood and whole logs for construction purposes.

Finally, regional governments must promote laws and mechanisms, such as banning the exportation of logs in Honduras, which motivate the forestry sector to encourage, at least initially, use of the products at a national level. Governments must also promote production standards for competitive management, processing, and quality so that these forest products are eligible to enter more dynamic markets and provide a foundation for sustainable economic growth that facilitates rural development within the region.

7.1.3 Objective 3: Integrated Fire Management

Forest fire management in Central American pine-oak forests is regionalized and linked to actions from the Central American Comission for the Environment and Development in Central America. Since the threat of forest fires is high throughout the region, planning and organizing to prevent them is a basic strategy for the management and conservation of the ecoregion. Because it comprises most of the actions in objectives 2 and 3, good management entails a forest without the threat of fire.

Although naturally-occurring forest fires regenerate and maintain pine-oak forests, more study regarding the effect of fire on them is needed. Knowledge about the effects of forest fires will raise public awareness about integrated fire management and the actual damage fires cause to the ecosystem.

Fire prevention and management can be expensive.[16] The impact of forest fires should decrease if more forested areas enter certification and incentive programs proposed as best forest management practices. Forest fires happen in the region because the forests' actual importance is not truly valued. If landowners do not practice best forest management practices, it is more beneficial for them to set ground fires and use the area for extensive cattle-farming. Therefore, helping landowners understand the true value and importance of maintaining forests and their potential to generate wealth is critical to protecting forests and guaranteeing proper forest management. Unfortunatley, integrated fire management for natural forests under best forest management practices in the Central American pine-

[14] Costs are reduced by creating a fund from an endowment, seed money, etc., that generates dividends distributed among the participants in the incentive programs. In Guatemala, this fund is managed through the *Instituto Nacional de Bosques* (National Forest Institute), an entity with political independence that has shown very good performance.

[15] For years in Guatemala, all government institutions (DIGESA, DIGEBOS, INAFOR) gave away small trees to plant; in very few cases did these trees actually became part of the forests.

[16] In Sierra de las Minas (240,000 hectares), this activitiy costs Q1,000,000 annually, approximately US$131,500 for equipment, salaries for fire crews, and logistics (personal comment, César Tot, 2007).

oak forest ecoregion is more costly than integrated fire management for forests located in northern latitudes because of differences in the climatic conditions and complexity of ecological interactions between these two regions.

For the aforementioned reasons, these strategies (Table 8) propose researching the effects of fire on pine-oak forests and disseminating the results. Currently, only fire prevention and combat activities are carried out in the region, so this exchange will be of immeasurable benefit.

Table 8. Strategies for Objective 3

No.	Strategies	Overall Hierarchical Rank
3.1	Systematize and share the most successful integrated fire management experiences at a regional level.	Very High
3.2	Promote and disseminate applied research about the effects of forest fires and their management on the composition and structure of pine-oak forests.	Very High
3.3	Develop and update with relevant institutions (forestry sector, municipalities, communities, private owners, etc.), integrated fire management plans for priority areas emphasizing the sites with high levels of forest fire recurrence.	High
3.4	Identify and promote incentives for the implementation of effective integrated fire management plans (restricted fund, rewards, etc.).	High

Other strategies that are part of this objective are strategic actions 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 2.5, 2.5, 4.1, 4.3, and 4.4.

7.1.4 Objective 4. Formal Conservation Mechanisms

Populations living in poverty and extreme poverty near protected areas must be allowed to implement sustainable forestry and agricultural practices in them. Community forest concessions in the Maya Biosphere Reserve, income generated from selling sea turtle eggs, and ecotourism in the Ostional and Cahuita protected areas of Costa Rica show how important sustainable use of protected areas is to the livelihood of the surrounding rural communities. There are also many problems related to inefficient management, or no management, of protected areas, which must be corrected to ensure that their use by surrounding rural communities does not jeopardize conservation efforts in these protected areas.

The main problems hindering effective management of protected areas are poor institutional capacity, insufficient equipment, limited mechanisms for local communities to capture the benefits derived from environmental services in these areas, and the permanent stress of the population on ecosystems and species, mostly in buffer and public use zones around national parks (Martínez de Anguita *et al.* 2006). These examples illustrate the need to create mechanisms that link conservation and sustainable development in a way that provides protection for these areas in perpetuity.

The preservation of one million hectares of pine-oak forest under formal conservation measures is truly a challenge, especially when the problems associated with managing these forests are taken into account. The diversity of formal conservation mechanisms associated with the strategic actions for this objective (Table 9) must be achieved in order to ensure their financial, social, and economic sustainability. Implementation of these actions will make preserving ecosystems like pine-oak forests, which are not currently well represented in the region's protected areas system, possible.

Certification of organic products like shade-grown coffee and cardamom is an example of an innovative mechanism that links formal conservation measures to productive processes. This innovative mechanism is a result of the creation of private nature reserves, which exist across Latin America. Currently, these preserves do not protect a significant amount of area, but that could change. For example, 102 private nature reserves have been established in Guatemala, and most of them have their own management plan (Internet CONAP 2007).

Table 9. Strategies for Objective 4

No.	Strategies	Overall Hierarchical Rank
4.1	Promote and strengthen the implementation of formal conservation mechanisms (national, state, private, community and municipal protected areas, ecological easements, conservation incentives, etc.) in priority areas.	Very High
4.2	Update and reprioritize areas listed as most important for the conservation and management of pine-oak forests as new areas in the region are identified.	Very High
4.3	Implement a study of the ecological, social, and economic importance of pine-oak forests in the conservation of biodiversity and sustainable development in the region, as well as threats to its continued existence, and disseminate the results.	Very High
4.4	Promote and strengthen ecological corridors among priority sites designated for the conservation of pine-oak forests.	High
4.5	Promote the development of mechanisms that provide payments for environmental services (water, carbon, disaster prevention, etc.) in pine-oak forests.	Low
4.6	Promote the development of avian tourism and ecotourism in potential pine-oak forest sites (identify potential sites, link them with specialized institutions, etc.).	Low

Other strategies that are part of this objective are strategic actions 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, and 2.5.

Municipal corporations, or ejidos, have set aside portions of their forests for formal conservation purposes in order to maintain limited resources like drinking water.

Although strategic action 3 is still in the developmental stage, some countries in the region have been successful in developing mechanisms that provide payments for environmental services. For example, *Programa para la Reconversión Agrícola y Productiva* (Agricultural and Productive Reconversion Program) and the *Instituto Nacional de Bosques* (National Forest Institute) have developed an incentive program that pays property owners to retain forest cover located within water recharge zones that are important for agricultural and energy use in Guatemala. These organizations allocate funds from their conservation budget to use as payment for this environmental service. Many of the areas included in the incentive program would likely have been unsustainably exploited, but now they are being used as regional municipal parks. Similar programs are taking place in Honduras, such as the Los Corralitos Wildlife Refuge.

In Chiapas, government programs coordinated by the *Comisión Nacional Forestal* (CONAFOR, National Forest Commission) provide payment for environmental services. These payments are focused on hydrological concepts, carbon capture, biodiversity protection, and agroforestry systems with shade-grown crops (Internet CONAFOR 2007).

Strategies that are complementary to the ones described in objectives 2 and 3 must be developed at specific sites that meet the appropriate criteria for other activities, such as avian tourism and ecotourism. Potential for these activities to act as mechanisms for pine-oak forest conservation has increased during the last two decades; it should be taken advantage of by implementing these actvities in sites that meet the appropriate criteria. The ecoregion also contains tourist attractions, such as nature adventure, moutain climbing, bird watching, volcanism, archaeology, indigenous culture, etc.

The analysis of current protected areas (Section 2.1.5) shows that not all areas declared as protected are actually protected. It also is important to add that not all the land included in these protected areas is potential habitat for the Golden-cheeked Warbler[17].

8 Monitoring and Research

8.1 Biological Monitoring Plan

Research and monitoring are an essential component of this plan because they will enable natural resource professionals to assess the effects of implementing the conservation goals and strategies. The biological monitoring plan will measure changes in a variety of environmental variables associated with the conservation strategies for protecting Central American pine-oak forests (Table 10). The monitoring plan is a result of the viability analysis carried out during the development of the plan and will assist members of the Alliance in assessing progress in the implementation of the strategies proposed in it.

With the support of key stakeholders, the results of this research will encourage the adoption and application of new techniques, criteria, methods, and processes to manage pine-oak forests, their products, by-products, and determine the best mechanisms to market these products. Monitoring the effects of these conservation strategies on aspects of human development also will be an important component of assessing their efficacy to protect Central American pine-oak forests in the long term.

[17] For example, Sierra de las Minas Biosphere Reserve, Guatemala covers 2,448 km², but only 1,430 km² of it is pine-oak forest.

Table 10. Biological Monitoring Plan for Pine-Oak Forests in the Ecoregion

Category	Indicator	Key Attribute	Method	Frequency	Annual Cost	Baseline Last Update
Landscape Context	Percentage of connectivity/fragmentation index	Connectivity between communities and ecosystems	Through recent analysis of satellite images, with "Fragstat" program	Every 3 years	US$5,000.00	
Landscape Context	Percentage of potential habitat with respect to the original	Potential habitat for GCWA	Analysis of satellite images available in CCAD	Every 3 years	US$5,000.00	TNC, 2006. *Informe de Priorización de Sitios en los bosques de pino en la región* (Report on Site Prioritization in the Region's Pine Forests)
Landscape Context	Percentage and area of forest cover of pine-oak forests affected by fires in each country	Fire regime (season, frequency, intensity, recurrence, area)	Unifying reports from the countries in the region, with annual statistics and hot spots of recurrence (in countries where this does not happen, it will be done through the analysis of hot spots)	Annual	US$2,000.00	TNC, 2006. *Informe de Priorización de Sitios en los bosques de pino en la región* (Report on Site Prioritization in the Region's Pine Forests)
Condition	Percentage of *Quercus*/ha	Abundance of *Quercus*	Abundance of oaks (*Quercus* spp.) by unit of area. Using Montes/FAO national forest inventory. Based on setting up 50 1 ha parcels at 300 dollars each, in the entire ecoregion	Every 5 years	US$15,000.00	FAO reports for each country/research studies for natural protected areas that include monitoring
Size	Percentage of current forest cover with respect to the ecoregion's area in each country	Forest cover in the ecoregion	Analysis of satellite images available at CCAD	Every 5 years		TNC, 2006. *Informe de Priorización de Sitios en los bosques de pino en la región* (Report on Site Prioritization in the Region's Pine Forests)
Size	Percentage/number of ha under formal conservation mechanisms	Connectivity between communities and ecosystems	Compilation of reports of conservation area systems (private and governmental) for each country and amount of pine-oak forests. This can be a constant process of database collection that the regional coordinator carries out	Every 3 years		a) TNC, 2006. *Informe de Priorización de Sitios en los bosques de pino en la región* (Report on Site Prioritization in the Region's Pine Forests). b) Support from promoting group to assess which or what amount of protected natural areas is currently under an administrative entity c) Reports from CCAD d) Environmental Profiles for each country
Size	a) Relative abundance of GCWA in priority areas b) Annual count of GCWA in each country	a) Population dynamics b) Number of individuals/man-hour	Estimation of relative density of GCWA and other species with the Alliance's standardized methodology. Annual count of GCWA, writing down the number of individuals/man-hour (to be carried out the same day in the entire region)	a) Every 3 years b) Annual observations	a) US$51,400.00 every 3 years b) US$4,000.00 every year (annual counting)	Baseline from the project's first year (TPWD)

9 Portfolio of Conservation and Development of Priority Sites

Site portfolios are a planning and decision-making tool that natural resource professionals can use to select areas with the appropriate characteristics and/or conditions for initiating conservation strategies when resources are limited. They are a starting point for large-scale conservation. These portfolios are the result of a georeferenced information analysis based on quantitative and/or qualitative criteria.

The planning team used the methodology proposed in "Designing a Geography of Hope" and "The 5-S Framework for Site Conservation" to design the site portfolio. First, the team defined the conservation targets and goals they wanted to achieve with the portfolio. For this specific study, Golden-cheeked Warbler habitat is the conservation target and there are two goals: 1) preserve 1 million hectares of potential habitat in the entire ecoregion in an eight-year period 2) preserve 250,000 hectares of potential habitat within sites outside natural protected areas.

The team used Spatial Portfolio Optimization Tool (SPOT), an ecoregional planning tool based on SITES[18], to perform the site portfolio analysis. SPOT is based on ArcView Geographic analysis software from ESRI© (Shoutis, 2003) and provides the same functionality as SITES but with a higher level of transparency, faster operations, and a more user-accessible interface.

SPOT is a cost optimization tool, which produces a portfolio of sites that will achieve a conservation goal established for one or many conservation targets, with the lowest investment cost, i.e., effort, money, and time. The cost can be assessed in economic terms or it can be represented as an index of effort to achieve conservation at one site.

9.1 Conservation Target

The conservation target for the ecoregion is existing pine-oak forests in each of the ecoregion's countries that are habitat for the Golden-cheeked Warbler. The planning team considered pine-oak and pure oak forests between 900-2,200 masl as potential habitat for this species. These variables correspond to the conditions where observations of Golden-cheeked Warblers have been recorded. However, it is important to point out that most of the ecoregion's pine-oak forests, from Chiapas to Nicaragua, are found within this elevational range.

In order to develop a portfolio of priority sites for the conservation target, the planning team used databases that provided information about the threats to the habitat at a national and regional level. For example, high-density population centers will demand more natural resources, such as firewood and timber extraction, from the forest compared to small villages with less people. Good access roads will increase the amount of materials and products that can be transported to and from forests. The presence of private and governmental natural protected areas represents a management scheme that favors conservation when compared to nonprotected areas.

[18] Site portfolio selection tool developed by Hugh Possingham and Ian Ball (University of Adelaide).

9.2 Definition of Cost per Analysis Unit

Cost is a numerical reference by analysis unit (AU) and represents an economic value. The planning team calculated cost by quantifying the expenditures required to preserve the conservation target in each AU given the current threats within it. Since no detailed information on the real economic value needed per AU to preserve the conservation target exists[19], the planning team decided to generate a stochastic index (based on points) that represents a relative cost according to the presence of threats or impacts. The index was developed based on the working group's experience; one of the most important considerations was the effort required to preserve the conservation target's viability under a certain threat or conservation status.

The determination of cost per AU was based on the general function:

$$Base\ Cost = \Sigma Costs\ per\ AU - \Sigma Discounts\ per\ AU$$

where **Costs per AU** are those threats present within an AU that impede the target's conservation and the **Discounts per AU** are the conditions that enable the implementation of conservation actions in each AU.

Definition of Conservation Costs

The planning team used the following criteria to define each threat's costs:

- Urban Area

1. The planning team obtained information on urban areas from BioData Ecosystems (CCAD-WB rev. 2003) coverage of the "GIS Database for Mesoamerica/CCAD-WB" (Internet CCAD 2007). They selected elements with the attribute "urban".
2. The index the planning team used for urban area was 100 points per hectare. This factor was used as the highest reference possible in order to define indices of subsequent factors. In an urban area, land use is the most expensive conservation cost since it is practically impossible and very costly to restore forest areas.

- Paved Highways

1. The planning team obtained paved highway information from the Road Network Infrastructure coverage of the "GIS Database for Mesoamerica/CCAD-WB" (Internet CCAD 2007). They selected elements with the attribute "paved highways".
2. The planning team used distance from a paved highway to weigh different levels of impact on the conservation target. For this reason, a 0 to 1- and 1 to 3-km buffer were created along paved highways. The area of influence for each AU was determined.
3. The costs per hectare of the paved highways' area of influence were weighted as follows:

[19] Currently, different initiatives using the cost of preserving protected areas have tried to determine the cost of preserving biodiversity in different parts of the world (Balmford *et al.* 2002). These data are general averages and do not allow cost estimates for the different levels of threat.

Distance from Paved Highway	Weight*
0 to 1 km	50 points per hectare
1 to 3 km	25 points per hectare

*Weight includes an index multiplied by one hectare. The greater the factor, the greater the cost for conservation per hectare.

4. Sites closer to paved highways were considered more likely to experience increased stress than sites farther away from paved highways. Consequently, the stress level of areas ≤1 km from paved highway was considered twice as high as the stress level for areas 1 to 3 km from paved highways.

- Unpaved Highways

1. The planning team also obtained unpaved highway information from the Road Network Infrastructure coverage of the "GIS Database for Mesoamerica/CCAD-WB" (Internet CCAD 2007). They selected elements with the attribute "unpaved highways".
2. Just as with paved highways, distance from unpaved highways was used to weigh different levels of impact on the conservation target. A 0 to 1- and 1 to 2-km buffer were created along unpaved highways. But in this case, the area of influence was reduced since there is less vehicle traffic and a higher level of travel difficulty. The area of influence for each AU was determined.
3. The costs per hectare of the unpaved highways' area of influence were weighted as follows:

Distance from Unpaved Highway	Weight*
0 to 1 km	25 points per Hectare
1 to 2 km	12 points per Hectare

*Weight includes an index multiplied by one hectare. The greater the factor, the greater the cost for conservation per hectare.

4. Sites closer to unpaved highways were considered more likely to experience increased stress than sites farther away from unpaved highways. Consequently, the stress level of areas ≤1 km from unpaved highways was considered twice as high as the stress level for areas 1 to 2 km from unpaved highways. The stress level within 1 km of unpaved highways was considered twice as low as the stress level within 1 km of paved highways.

- Hot Spot

1. Any source of heat that emits waves in the red to near infrared spectrum is strong enough to be detected by a sensor and referred to as a hot spot. On satellite imagery, any pixel with a minimum value of 25°C during the night and 42°C during the day is considered a hot spot (Internet CONABIO 2007). Hot spots can be caused by forest fires, agricultural burns, sun-heated lands, gas flames in oil wells, active volcanoes, etc. *Comisión Nacional para el Conocimiento y uso de la Biodiversidad en México* (National Commission for the Knowledge and Use of Biodiversity

in Mexico) uses thematic cartography and a statistical assessment to eliminate hot spots with a low probability of becoming forest fires.

2. The planning team obtained information on hot spots from the 2005 hot spots coverage generated by *Comisión Nacional para el Conocimiento y uso de la Biodiversidad en México* (National Commission for the Knowledge and Use of Biodiversity in Mexico). Hot spots are represented as square polygons of 100 ha that correspond to the nominal spatial resolution of 1.1 km x 1.1 km in a NOAA-AVHRR image nadir. The amount of area in each category per AU was determined with this coverage.
3. Since fire neither eliminates forest cover nor is harmful to an ecosystem, the planning team developed an index of 25 points per hectare to use for this factor's cost per AU. This value is similar to the area of influence near unpaved highways, suggesting a similar impact for forest management.

- Municipal Capitals

1. The planning team integrated municipal capitals from the Political-Administrative Division: Populated Centers (municipal capitals) coverage of the "GIS Database for Mesoamerica/CCAD-WB" (Internet CCAD 2007).
2. Given the lack of data about an urban area's size or number of inhabitants, experts attending the meeting used their personal knowledge about these factors to select a 10-km area of influence for each municipal capital.
3. The planning team used an index of 25 points per hectare to determine the amount of area in each AU. This result suggests that the areas of influence are sites that have some kind of management. Large-sized urban areas were differentiated from the same coverage used to integrate municipal capitals. Municipal capitals were not considered as large urban concentrations. Therefore, the main stress on the forest is firewood and timber extraction.

- Agricultural Zones

1. The planning team used the "agricultural systems" attribute from the BioData: Ecosystems (CCAD-WB rev. 2003) coverage of the "GIS Database for Mesoamerica/CCAD-WB" (Internet CCAD 2007) to determine agricultural zones.
2. The team selected a 1-km area of influence to quantify the stress that either possible growth of the agricultural frontier or management poses to the forest.
3. The planning team used an index of 20 agricultural system units per hectare to determine the amount of area present in each AU. Since the advance of the agricultural frontier is determined by land tenure, the team only considered stress from forest management in conservation cost. Agricultural zones can be designated as rest or restoration areas, so the conservation cost associated with them is much lower than conservation costs associated with urban zones.

Definition of Conservation Discounts

The presence of vegetation other than temperate forests in the AU is a criterion that favors its conservation. For this reason, the planning team obtained vegetation coverage from BioData: Ecosystems (CCAD-WB rev. 2003) of the "GIS Database for Mesoamerica/CCAD-WB" (Internet CCAD 2007). They determined the amount of area present in each category per AU and assigned an index of 15 points per hectare, which would be discounted from the cost generated by the conservation cost factors.

The presence of private or governmental natural protected areas indicates a management scheme that favors conservation when compared to areas that are not formally protected. The viability of ecosystems in natural protected areas is threatened by roads, human population, agricultural zones, etc., but this official declaration assumes that conservation measures exist for the area, whether they are resources allocated for it, restrictions placed on it in the form of an easement, or a simple acknowledgement of the importance of the resources located in it.

Given the above information, a location factor was generated that decreases the conservation cost by 30% if the site is located within a natural protected area. The planning team estimated the value of a natural protected area under the current state of attention and management of natural protected areas that exists in the region. In many cases, natural protected areas are declared only on paper, and in others, the social dynamics and interests within the area create challenges for the long-term preservation of ecosystem viability. The values are as follows:

Location	Factor (VF)*
Within a protected area	0.7 (Total cost per AU)
Outside a protected area	1 (Total cost per AU)

*The factor was selected under the supposition that a higher conservation cost occurs outside the reserve and a much lower cost occurs within the core zone.

The coverage of natural protected areas was extracted from BioData: Natural Protected Areas of the "GIS Database for Mesoamerica/CCAD-WB" (Internet CCAD 2007).

Definition of Final Cost

In order to avoid a negative cost, an initial value of 1000 was assigned to all AUs. The final formula for base cost per AU is as follows:

*Final Cost = (1000 + Cost for Urban Areas + Cost for Paved Highways + Cost for Unpaved Highways + Cost for Hot Spots + Cost for Municipal Capitals + Cost for Agricultural Zones - Discount for Vegetation) * Factor*

9.2.1 Results about Conservation Priorities and Management at a Regional Level

The site portfolio for each country includes areas with the greatest management and conservation possibilities. The planning team selected sites to include in the portfolio of each country based on their distribution, representation throughout the entire ecoregion, and formation of a corridor with stopover sites along the Golden-cheeked Warbler's migration route. The team developed two scenarios from the two conservation goals established in the plan.

The first scenario identified the entire ecoregion and the sites that if protected, will preserve 1 million hectares of Golden-cheeked Warbler habitat. The second scenario included sites that will form a corridor among the different forest fragments in the ecoregion (Figure 6). The team identified a total of 308 sites, with an area of 4,025 hectares each (Table 11).

Table 11. Priority sites and average area in each country (proposed scenario 1)

Country	Number of Sites	Area (ha)	Average Area per Site (ha)
Guatemala	103	355,861.51	3,455
Honduras	116	486,262.36	4,192
Mexico	68	303,424.26	4,462
Nicaragua	15	77,473.47	5,165
El Salvador	6	16,969.70	2,828
TOTAL	**308**	**1,239,991.30**	**20,102**

Currently, approximately 70% of the pine-oak forest ecoregion occurs in Honduras and Guatemala. However, the forest's continuity is closely tied to the diversity and processes that sustain it in the long term. Because of their own nature, the priority sites represent locations where strategies to protect them must be developed under a social legitimization criterion.

The second scenario involves the protection of 250,000 hectares of Golden-cheeked Warbler habitat located outside natural protected areas. The intent of the planning team here is to identify areas of importance that are not under any management scheme (Table 12). For this scenario, they identified 168 sites with an average area of 1,666 ha each and are distributed across each country as follows:

Table 12. Number of sites and area for each country (proposed scenario 2)

Country	Number of Sites	Area (ha)
Guatemala	52	72,489.45
Honduras	57	113,000.00
Mexico	47	74,000.00
Nicaragua	9	14,000.00
El Salvador	3	6,500.00
TOTAL	**168**	**279,989.45**

The sites identified in this portfolio follow the same distribution that the extended portfolio with the 1 million hectare goal follows (see details in site portfolio for each country). Sites in Honduras comprise the largest areas that are not under any protection scheme, and of those sites, the one located in the municipalities of Jano and La Unión covers more area (26,500 ha) than any other site in the ecoregion.

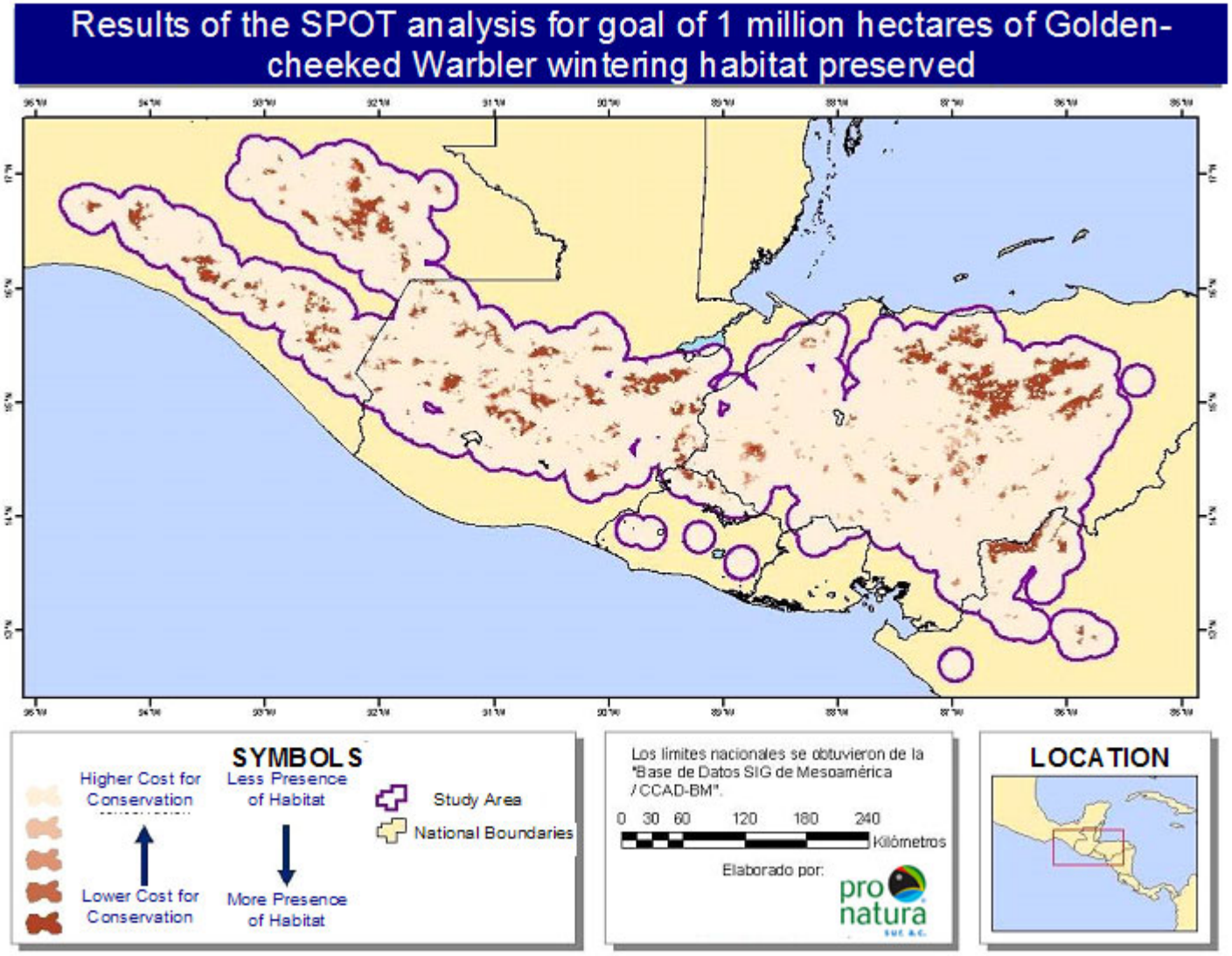

Figure 6. SPOT analysis for 1 million ha of Golden-cheeked Warbler potential wintering habitat

9.3 Site Portfolio for Chiapas

The fifteen portfolio sites in Chiapas (Figure 7) are located throughout the Sierra Madre de Chiapas and the mountain region of Los Altos de Chiapas. These areas mark the beginning of the species' wintering habitat and have the same geological origin as northern Central America. Sightings of the species have been reported in Lagunas de Montebello, Los Altos de Chiapas, and more recently, Sierra de la Sepultura. The Sierra Madre de Chiapas is an area that has not been confirmed as wintering habitat for the species yet. There are recent records of the species in this region (Pronatura Sur and Instituto de Historia Natural y Ecología 2007 personal communication), but confirmation that the species overwinters in the region is still needed.

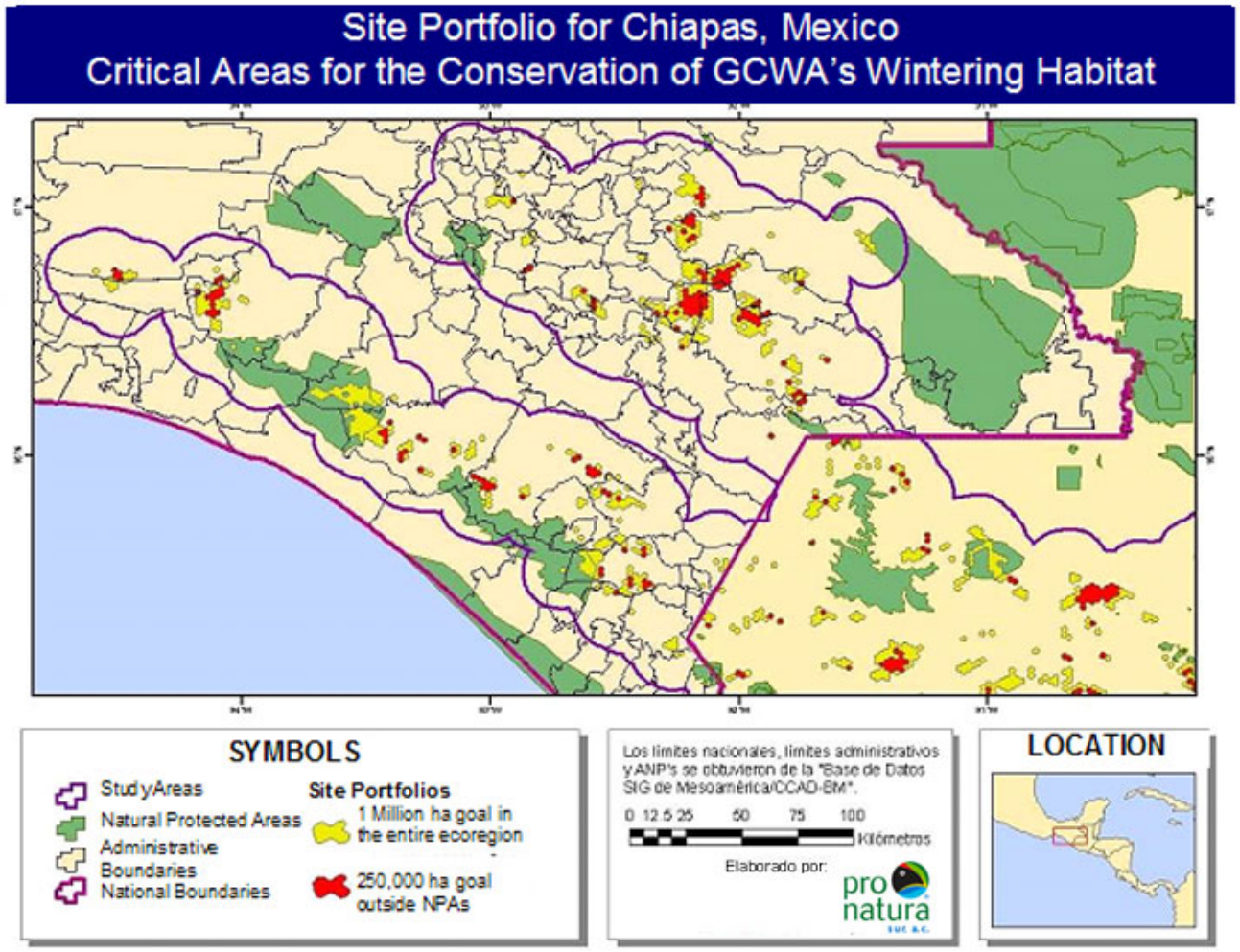

Figure 7. Site Portfolio for Chiapas, Mexico

9.4 Site Portfolio for Guatemala

All of the priority sites located in Guatemala are found outside protected areas, except for the pine-oak forests of Sierra de las Minas Biosphere Reserve (Figure 8). This result reflects the low level of representation of the ecoregion's pine-oak forests within the protected areas system (see Section 2.1.5).

In Guatemala, priority sites cover a larger area than those in Honduras and Mexico because the sites in Guatemala are more scattered throughout the country. The highest concentration of sites in Guateamala exists in Sierra de las Minas. These seven sites comprise a total of 83,000 ha. The rest of the sites are distributed throughout the highlandss of the Sierra Madre de Chiapas and form a corridor among the sites identified from Mexico to El Salvador and Honduras.

The ecoregion and some selected priority sites are located through the central portion of the Sierra Madre de Chiapas. This region has shown high levels of human occupancy and forest cover transformations since colonial times. The distribution of priority sites for this country is highly related to the relict contiguous forest and rural zones with low human development, i.e., few unpaved highways and low population density, with the exception of the zones in the departments of Chimaltenango, which have lots of small landholdings, and Guatemala. The Guatemalan working group selected zones in the departments of Huehuetenango, Quiché, Alta and Baja Verapaz, Chiquimula, Chimaltenango, specifically Tecpán, and the southeast forests of Huehuetenango as priority sites.

Sierra de las Minas Biosphere Reserve, along with its surrounding areas, constitute the most important priority site in the country; it represents the site with the highest number of historical and recent sightings of Golden-cheeked Warblers.

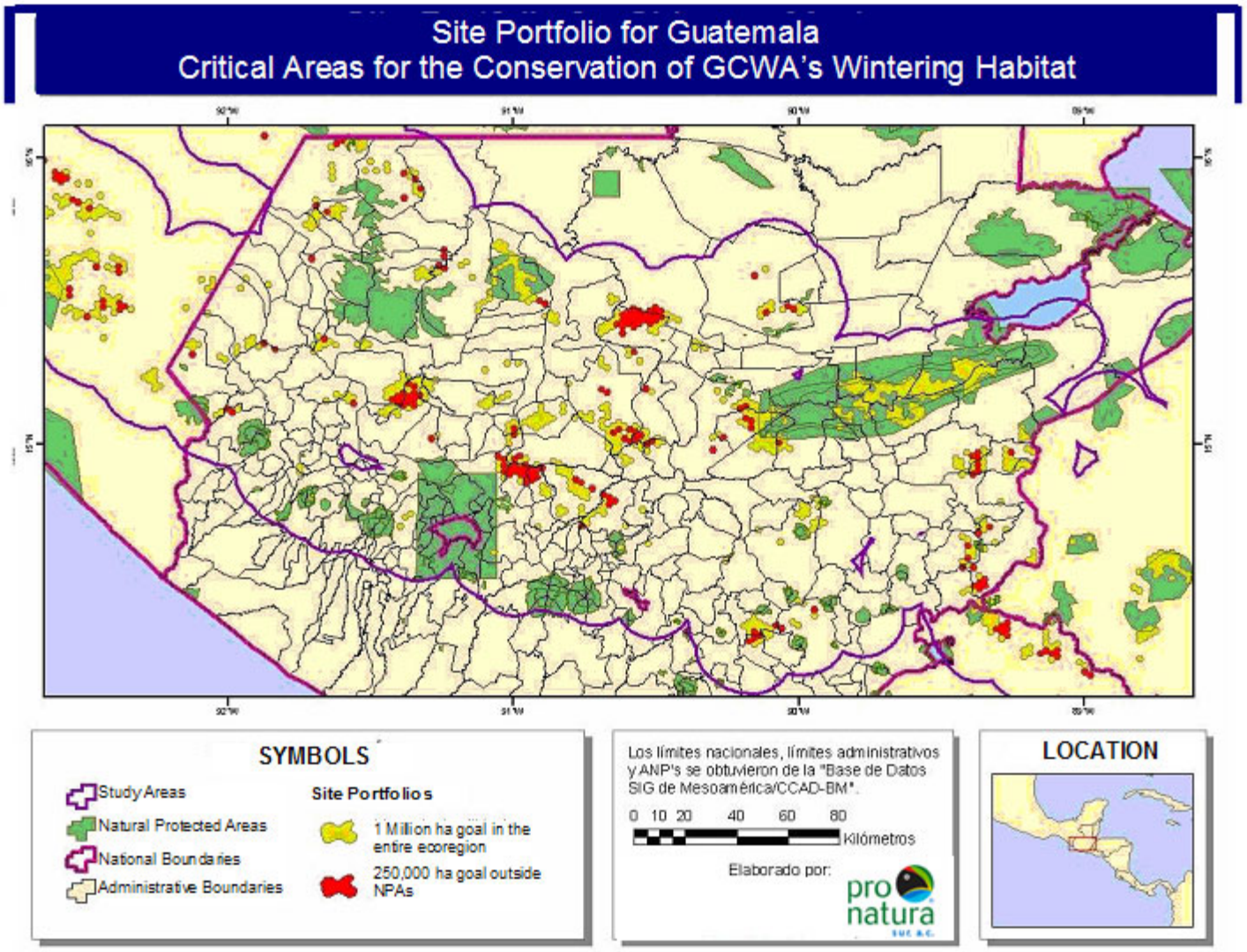

Figure 8. Site Portfolio for Guatemala

9.5 Site Portfolio for Honduras

The largest area identified in Honduras contained 116 sites that comprise over 486,000 ha; just 26 of them comprise 370,000 ha, or 76% of the identified area in Honduras. These sites are considered the most important in Honduras because of their connectivity. The sites are located in the departments of Olancho and Yoro, mainly in the Sulaco and Agalta mountain ranges, a predominantly forested region (Figure 9). Although La Muralla National Park is the only identified natural protected area in the region, many integrated watershed management initiatives also have been established in the region since it is an important hydric recharge zone.

The planning team ideantified 90 other sites in Honduras that are scattered across the southern and central portion of the country and cover a little over 116,000 ha. These sites are located together on small mountains, which create small fragmented areas with an average distance of 13 km between them.

The coniferous forests of Honduras contain seven different pine species. The most useful ones for the wood industry are *Pinus oocarpa*, which is found in the central part of the country between 800 and 1200 masl, and *Pinus maximinoii*, which is found in the mountains between 1200 and 1600 masl. The Honduran government does not allow clear cutting in natural forests. Therefore, almost every natural forest in Honduras, regardless of its health status, contains a mix of coniferous and deciduous trees. The only traditional use of roble and encino oaks in the region is as firewood for cooking purposes. Thus, if these mixed forests are managed properly, they can be an important sustainable resource for the country.

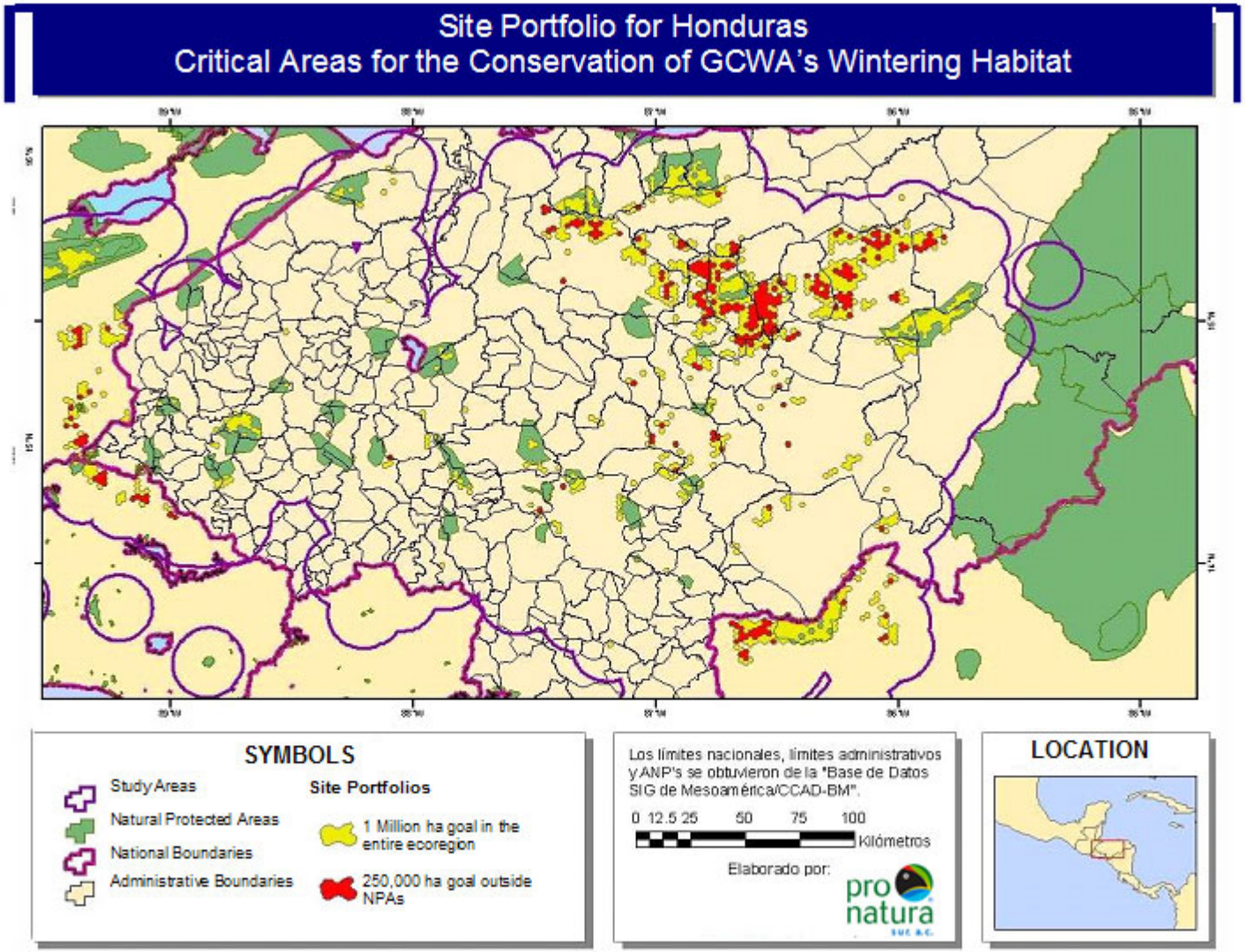

Figure 9. Site Portfolio for Honduras

9.6 Site Portfolio for Nicaragua

In Nicaragua, priority sites are found in the north-central region, mainly in the department of Nueva Segovia (Figure 10). This department contains the protected zones of Dipilito-Jalapa, Amerrisque, Dariense, and Isabela. These zones cover approximately 1,928.6 km^2, which is equal to 1.48% of the country's area. These zones represent the southern-most part of the Central American pine-oak forest ecoregion. They contain 9 out of the 15 priority sites for Nicaragua, and comprise 74,000 ha, or 96% of the area identified for this country.

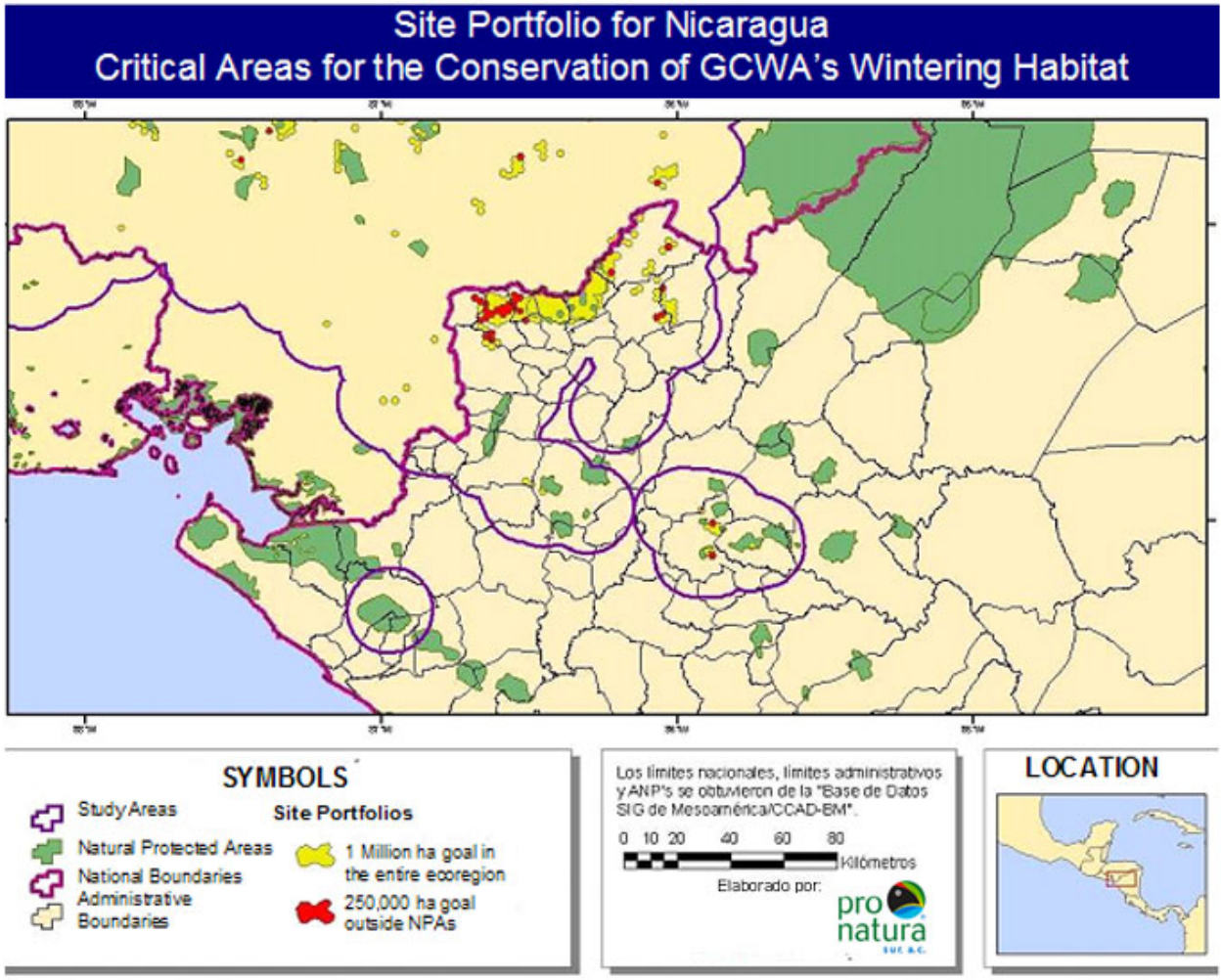

Figure 10. Site Portfolio for Nicaragua

9.7 Site Portfolio for El Salvador

The planning team identified 6 priority sites in El Salvador and they comprise less than 17,000 ha (Figure 11). These sites are located in the northern part of the country and form a corridor, which originates in Quetzaltepeque Volcano, Guatemala and extends through central and southern Honduras. The sites are located in the departments of Metapán and Chalatenango, in mountain ranges that bear these same names. The area has only one recorded natural protected area, Montecristo, which is located in the department of Metapán, and the zone known as "El Trifinio".

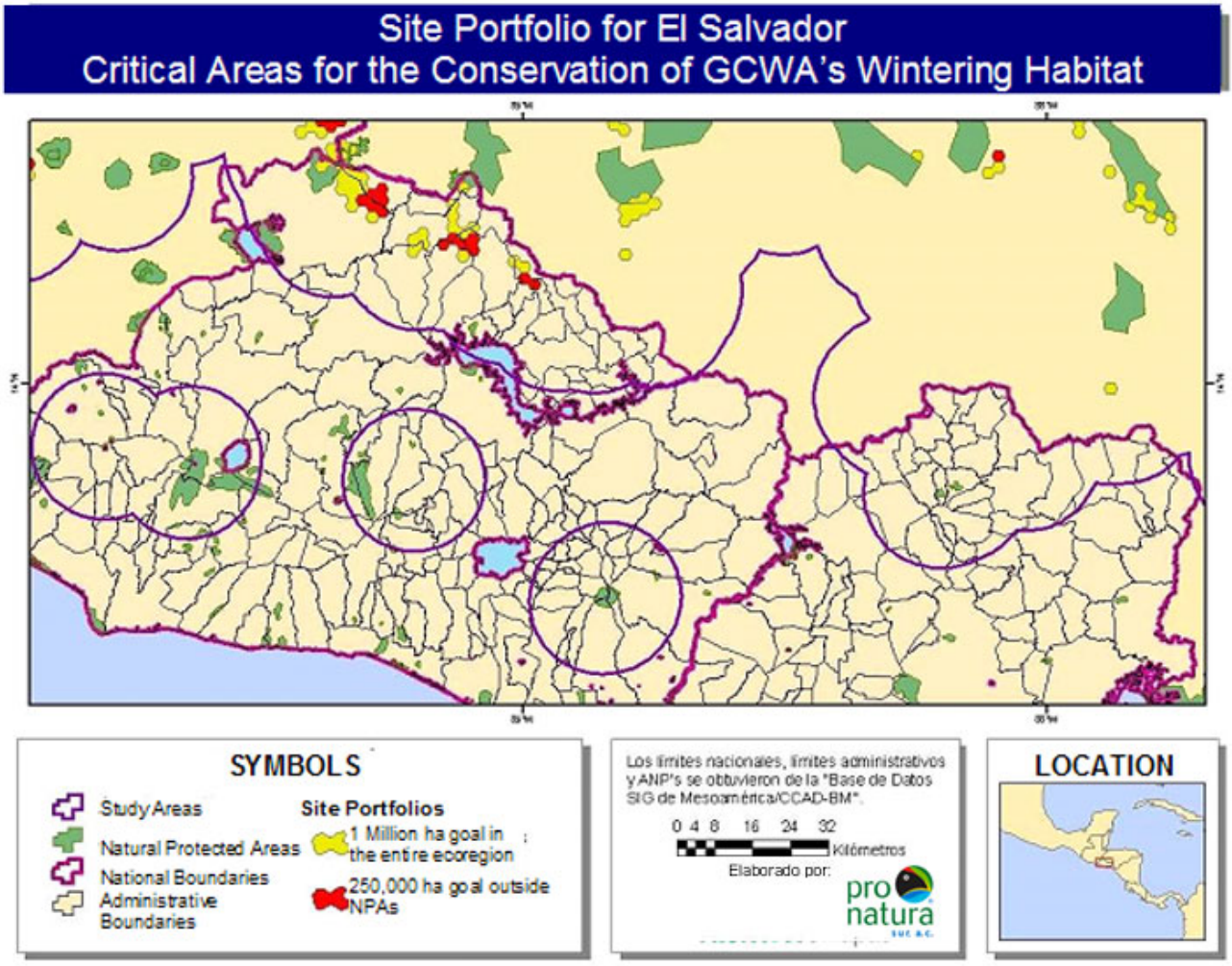

Figure 11. Site Portfolio for El Salvador

10 Chronogram and Budget for 5-year Execution

This budget represents an estimate of the funds required for the plan's implementation (Table 13). The working groups will develop more detailed actions at the local, territorial, national, and regional levels in the future. They will use this information to estimate costs associated with the development of the strategies, programs, and projects.

In order to obtain a cost estimate for the plan's 5-year execution, the planning team listed all the strategies and proposed a budget in U.S. dollars. The total budget for the 5-year execution of the plan is US $22,000,000.00. The cost associated with the 5-year budget needed to implement the strategies ranked as *very high* and is US $5,455,000.00.

Table 13. Estimated Budget for the Implementation of the Regional Plan

Strategies	Overall Hierarchical Value	5 Years of Execution (Costs in US$)					TOTAL
		2007	2008	2009	2010	2011	
01. Strengthen the regional Alliance for the Conservation of Mesoamerican Pine-Oak Forests (coordinator, mechanisms for communication and exchange, inclusion of key stakeholders, funds for operations and advocacy).	Very High	50,000	50,000	50,000	50,000	50,000	250,000
02. Promote national and multi-sector working groups for the conservation and management of pine-oak forests in each country.	Very High	25,000	25,000	15,000	15,000	10,000	90,000
03. Implement appropriate advocacy and outreach programs to strategically position the Alliance and this plan, so that governmental institutions, civil society, and the international community recognize the Alliance and adopt the plan.	Very High	10,000	10,000	10,000	10,000	10,000	50,000
04. Implement a study of the ecological, social, and economic importance of pine-oak forests in the conservation of biodiversity and sustainable development in the region, as well as threats to its continued existence, and disseminate the results.	Very High	10,000	30,000	20,000			60,000
05. Update and reprioritize areas listed as most important for the conservation and management of pine-oak forests as new areas in the region are identified.	Very High	50,000	50,000	50,000			150,000
06. Promote and strengthen the implementation of formal conservation mechanisms (national, state, private, community and municipal protected areas, ecological easements, conservation incentives, etc.) in priority areas.	Very High	250,000	250,000	250,000	250,000	250,000	1,250,000
07. Identify and promote the sustainable use of pine-oak forest resources through applied research, best management practices, certification and	Very High	10,000	200,000	200,000	100,000	50,000	560,000

Strategies	Overall Hierarchical Value	5 Years of Execution (Costs in US$)					TOTAL
		2007	2008	2009	2010	2011	
training (emphasizing oak plantation management and timber and non-timber products).							
08. Promote and disseminate applied research about the effects of forest fires and their management on the composition and structure of pine-oak forests.	**Very High**	200,000	200,000	50,000	50,000	20,000	520,000
09. Systematize and share the most successful integrated fire management experiences at a regional level	**Very High**				50,000	50,000	100,000
10. Promote the development and implementation of landuse planning proposals at sub-watershed, community, and property levels in priority conservation sites.	**High**	400,000	450,000	500,000	500,000	500,000	2,350,000
11. Develop and update, with relevant institutions (forestry sector, municipalities, communities, private owners, etc.), integrated fire management plans for priority areas emphasizing the sites with high levels of forest fire recurrence.	**High**	50,000	50,000	25,000	25,000		150,000
12. Decrease stress on natural forests caused by extraction of firewood by establishing "energy forests" that contain native species and by promoting other activities, such as fuel-efficient stoves, alternative sources of energy, etc.*	**High**		2,000,000	2,000,000	100,000	100,000	4,200,000
13. Promote forest management and restoration incentives that meet appropriate criteria for the conservation of biodiversity (20-30% encino oaks in the canopy, individuals defined in each region, etc.).	**High**	100,000	2,000,000	2,000,000	500,000	200,000	2,800,000
14. Promote and strengthen ecological corridors among priority sites designated for the conservation of pine-oak forests.	**High**			100,000	100,000	100,000	300,000
15. Identify and promote incentives for the implementation of effective	**High**	50,000	50,000	50,000	50,000	50,000	250,000

Strategies	Overall Hierarchical Value	5 Years of Execution (Costs in US$)					TOTAL
		2007	2008	2009	2010	2011	
integrated fire management plans (restricted fund, rewards, etc.).							
16. Improve the conservation and sustainable management of pine-oak forests by promoting and strengthening forest management at the municipal and community levels (encourage participation of civil society, provide training to municipal technical units, promote integrated management of fire and water, etc.).	**Medium**	1,000,000	1,000,000	1,000,000	1,000,000	150,000	4,150,000
17. Promote the development of mechanisms that provide payments for environmental services (water, carbon, disaster prevention, etc.) in pine-oak forests.	**Low**	25,000	75,000	75,000	75,000	15,000	265,000
18. Promote the development of avian tourism and ecotourism in potential pine-oak forest sites (identify potential sites, link them with specialized institutions, etc.).	**Low**	10,000	50,000	50,000	50,000	50,000	210,000
19. Carry out necessary monitoring actions in order to evaluate the ecoregion's biodiversity conservation status.*							2,000,000
							22,000,000

*This strategy is considered very important, but was not prioritized given that it does not contribute to threat reduction.

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12 Appendixes

Appendix 1. List of Globally Threatened and Endemic Species in the Pine-Oak Forests Ecoregion

Species	Common Name	Endemism	Category in IUCN Red List
MAMMALS			
Balantiopteryx io	Thomas's Sac-winged Bat	X	
Molossus aztecus	Aztec Mastiff Bat	X	
Glossophaga leachii	Gray's Long-Tongued Bat	X	
Hylonycteris underwoodi	Underwood's Long-tongued Bat	X	
Carollia subrufa	Gray Short-tailed Bat	X	
Dermanura azteca		X	
Dermanura tolteca		X	
Bauerus dubiaquercus	Van Gelder's Bat	X	Vulnerable
Marmosa mexicana	Mexican Mouse Opposum	X	
Liomys pictus	Spiny Pocket Mouse	X	
Microtus guatemalensis	Guatemalan Vole	X	
Ototylomys phyllotis	Big-eared Climbing Rat	X	
Peromyscus aztecus	Aztec Mouse	X	
Reithrodontomys sumichrasti	Sumichrast's Harvest Mouse	X	
Scotinomys teguina	Alston's Brown Mouse	X	
Panthera onca	Jaguar		Almost threatened
Felis concolor	Puma		Almost threatened
Tapirus bairdii	Tapir		Endangered
AMPHIBIANS			
Bolitoglossa celaque	Celaque Mushroomtongue Salamander		Endangered
Plectrohyla psiloderma	Spikethumb Frog		Endangered
BIRDS			
Dendroica chrysoparia	Golden-cheeked Warbler		Endangered
Tangara cabanisi	Azure-rumped Tanager	X	Endangered
Megascops barbarus	Bearded Screech-Owl	X	Almost threatened
Xenotriccus callizonus	Belted Flycatcher	X	Almost threatened
Ergaticus versicolor	Pink-headed Warbler	X	Almost threatened
Carduelis atriceps	Black-capped Siskin	X	Almost threatened
Cyrtonyx ocellatus	Ocellate Quail	X	Almost threatened
Strix fulvescens	Fulvous Owl	X	
Lampornis sybillae	Green-throated Mountain-Gem	X	
Lampornis viridipallens	Green-throated Mountain-Gem	X	
Atthis ellioti	Wine-throated Hummingbird	X	
Aspatha gularis	Blue-throated Motmot	X	
Notiochelidon pileata	Black-capped Swallow	X	
Troglodytes rufociliatus	Rufous-browed Wren	X	

Species	Common Name	Endemism	Category in IUCN Red List
Melanotis hypoleucus	Blue-and-white Mockingbird	X	
Turdus rufitorques	Rufous-collared Robin	X	
Icterus maculialatus	Bar-winged Oriole	X	
Cyanocorax melanocyaneus	Bushy-crested Jay	X	
Cyanolica pumilo	Black-throated Jay	X	
Notiochelidon pileata	Black-capped Swallow	X	

Source: Howell & Webb, 1995; Internet IUCN, 2007; Internet WWF, 2007

Appendix 2. Bird List of the Central American Pine-Oak Forest Ecoregion

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
1	*Crypturellus*	*cinnamomeus*		Thicket Tinamou			
2	*Ortalis*	*vetula*		Plain Chachalaca		*AIII*	
3	*Penélope*	*purpurascens*		Crested Guan		*AIII*	
4	*Penelopina*	*nigra*		Highland Guan	*NT*	*AIII*	*VU*
5	*Crax*	*rubra*		Great Curassow		*AIII*	
6	*Dendrortyx*	*leucophrys*		Buffy-crowned Wood-Partridge			
7	*Odontophorus*	*guttatus*		Spotted Wood-Quail			
8	*Dactylortyx*	*thoracicus*		Singing Quail			
9	*Ardea*	*herodias*		Great Blue Heron			
10	*Bubulcus*	*ibis*		Cattle Egret			
11	*Mycteria*	*americana*		Wood Stork		*AI*	
12	*Coragyps*	*atratus*		Black Vulture			
13	*Cathartes*	*aura*		Turkey Vulture			
14	*Sarcoramphus*	*papa*		King Vulture		*AIII*	
15	*Leptodon*	*cayanensis*		Gray-headed Kite		*AII*	
16	*Elanoides*	*forficatus*		Swallow-tailed Kite		*AII*	
17	*Accipiter*	*striatus*	*chionogaster*	White-breasted Hawk			
18	*Accipiter*	*striatus*		Sharp-shinned Hawk		*AIII*	
19	*Accipiter*	*cooperii*		Cooper's Hawk		*AII*	
20	*Buteogallus*	*anthracinus*		Common Black-Hawk		*AII*	
21	*Buteo*	*magnirostris*		Roadside Hawk		*AII*	
22	*Buteo*	*platypterus*		Broad-winged Hawk		*AII*	
23	*Buteo*	*nitidus*		Gray Hawk		*AII*	
24	*Buteo*	*brachyurus*		Short-tailed Hawk		*AII*	
25	*Buteo*	*albicaudatus*		White-tailed Hawk		*AII*	
26	*Buteo*	*albonotatus*		Zone-tailed Hawk		*AII*	
27	*Buteo*	*jamaicensis*		Red-tailed Hawk		*AII*	
28	*Spizaetus*	*tyrannus*		Black Hawk-Eagle		*AII*	
29	*Spizaetus*	*ornatus*		Ornate Hawk-Eagle		*AII*	
30	*Micrastur*	*ruficollis*		Barred Forest-Falcon		*AII*	

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
31	*Micrastur*	*semitorquatus*		Collared Forest-Falcon			
32	*Caracara*	*cheriway*		Crested Caracara		*AII*	
33	*Herpetotheres*	*cachinnans*		Laughing Falcon		*AII*	
34	*Falco*	*sparverius*		American Kestrel		*AII*	
35	*Falco*	*columbarius*		Merlin		*AII*	
36	*Falco*	*rufigularis*		Bat Falcon			
37	*Falco*	*peregrinus*		Peregrine Falcon		*AI*	
38	*Gallinula*	*chloropus*		Common Moorhen			
39	*Áulica*	*americana*		American Coot			
40	*Columba*	*livia*		Rock Pigeon			
41	*Patagioenas*	*flavirostris*		Red-billed Pigeon			
42	*Patagioenas*	*fasciata*		Band-tailed Pigeon			
43	*Zenaida*	*asiatica*		White-winged Dove			
44	*Columbina*	*inca*		Inca Dove			
45	*Claravis*	*mondetoura*		Maroon-chested Ground-Dove			
46	*Leptotila*	*verreauxi*		White-tipped Dove			
47	*Geotrygon*	*albifacies*		White-faced Quail-Dove			
48	*Aratinga*	*strenua*		Pacific Parakeet		*AII*	
49	*Aratinga*	*canicularis*		Orange-fronted Parakeet		*AII*	
50	*Bolborhynchus*	*lineola*		Barred Parakeet		*AII*	
51	*Brotogeris*	*jugularis*		Orange-chinned Parakeet		*AII*	
52	*Amazona*	*albifrons*		White-fronted Parrot		*AII*	
53	*Piaya*	*cayana*		Squirrel Cuckoo			
54	*Tapera*	*naevia*		Striped Cuckoo			
55	*Morococcyx*	*erythropygus*		Lesser Ground-Cuckoo			
56	*Geococcyx*	*velox*		Lesser Roadrunner			
57	*Crotophaga*	*sulcirostris*		Groove-billed Ani			
58	*Megascops*	*trichopsis*		Whiskered Screech-Owl		*AII*	
59	*Megascops*	*barbarus*		Bearded Screech-Owl	*NT*	*AII*	*NT*
60	*Bubo*	*virginianus*		Great Horned Owl		*AII*	
61	*Glaucidium*	*gnoma*		Northern Pygmy-Owl		*AII*	
62	*Glaucidium*	*brasilianum*		Ferruginous Pygmy-Owl		*AII*	
63	*Ciccaba*	*virgata*		Mottled Owl			

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
64	*Aegolius*	*ridgwayi*		Unspotted Saw-whet Owl		*AII*	
65	*Chordeiles*	*acutipennis*		Lesser Nighthawk			
66	*Nyctidromus*	*albicollis*		Common Pauraque			
67	*Caprimulgus*	*carolinensis*		Chuck-will's-widow			
68	*Caprimulgus*	*vociferus*		Whip-poor-will			
69	*Cypseloides*	*niger*		Black Swift			
70	*Streptoprocne*	*zonaris*		White-collared Swift			
71	*Chaetura*	*vauxi*		Vaux's Swift			
72	*Aeronautas*	*saxatalis*		White-throated Swift			
73	*Panyptila*	*sanctihieronymi*		Great Swallow-tailed Swift			
74	*Campylopterus*	*rufus*		Rufous Sabrewing		*AII*	
75	*Campylopterus*	*hemileucurus*		Violet Sabrewing		*AII*	
76	*Colibrí*	*delphinae*		Brown Violet-ear		*AII*	
77	*Colibrí*	*thalassinus*		Green Violet-ear		*AII*	
78	*Hylocharis*	*leucotis*		White-eared Hummingbird		*AII*	
79	*Amazilia*	*cyanocephala*		Azure-crowned Hummingbird		*AII*	
80	*Amazilia*	*beryllina*		Berylline Hummingbird		*AII*	
81	*Amazilia*	*rutila*		Cinnamon Hummingbird		*AII*	
82	*Lampornis*	*viridipallens*		Green-throated Mountain-gem		*AII*	
83	*Lampornis*	*sybillae*		Green-breasted Mountain-gem		*AII*	
84	*Lampornis*	*amethystinus*		Amethyst-throated Hummingbird		*AII*	
85	*Lamprolaima*	*rhami*		Garnet-throated Hummingbird		*AII*	
86	*Eugenes*	*fulgens*	*fulgens**	Magnificent Hummingbird		*AII*	
87	*Doricha*	*enicura*		Slender Sheartail		*AII*	
88	*Tilmatura*	*dupontii*		Sparkling-tailed Hummingbird		*AII*	
89	*Archilochus*	*colubris*		Ruby-throated Hummingbird		*AII*	
90	*Tais*	*ellioti*		Wine-throated Hummingbird		*AII*	
91	*Trogon*	*violaceus*		Violaceous Trogon			
92	*Trogon*	*mexicanus*		Mountain Trogon			
93	*Trogon*	*elegans*		Elegant Trogon			
94	*Trogon*	*collaris*		Collared Trogon			
95	*Pharomachrus*	*mocinno*		Resplendent Quetzal	*NT*	*AI*	*NT*
96	*Zapata*	*gularis*		Blue-throated Motmot			

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
97	*Momotus*	*momota*		Blue-crowned Motmot			
98	*Eumomota*	*superciliosa*		Turquoise-browed Motmot			
99	*Chloroceryle*	*amazona*		Amazon Kingfisher			
100	*Chloroceryle*	*americana*		Green Kingfisher			
101	*Aulacorhynchus*	*prasinus*		Emerald Toucanet			
102	*Ramphastos*	*sulfuratus*		Keel-billed Toucan		*AII*	
103	*Melanerpes*	*formicivorus*		Acorn Woodpecker			
104	*Melanerpes*	*aurifrons*		Golden-fronted Woodpecker			
105	*Sphyrapicus*	*varius*		Yellow-bellied Sapsucker			
106	*Picoides*	*scalaris*		Ladder-backed Woodpecker			
107	*Picoides*	*villosus*		Hairy Woodpecker			
108	*Piculus*	*rubiginosus*		Golden-olive Woodpecker			
109	*Colapses*	*auratus*		Northern Flicker			
110	*Dryocopus*	*lineatus*		Lineated Woodpecker			
111	*Campephilus*	*guatemalensis*		Pale-billed Woodpecker			
112	*Anabacerthia*	*variegaticeps*		Scaly-throated Foliage-gleaner			
113	*Automolus*	*rubiginosus*		Ruddy Foliage-gleaner			
114	*Sclerurus*	*mexicanus*		Tawny-throated Leaftosser			
115	*Dendrocincla*	*homochroa*		Ruddy Woodcreeper			
116	*Sittasomus*	*griseicapillus*		Olivaceous Woodcreeper			
117	*Xiphocolaptes*	*promeropirhynchus*		Strong-billed Woodcreeper			
118	*Dendrocolaptes*	*picumnus*		Black-banded Woodcreeper			
119	*Xiphorhynchus*	*flavigaster*		Ivory-billed Woodcreeper			
120	*Xiphorhynchus*	*erythropygius*		Spotted Woodcreeper			
121	*Lepidocolaptes*	*affinis*		Spot-crowned Woodcreeper			
122	*Thamnophilus*	*doliatus*		Barred Antshrike			
123	*Grallaria*	*guatimalensis*		Scaled Antpitta			
124	*Myiopagis*	*viridicata*		Greenish Elaenia			
125	*Elaenia*	*frantzii*		Mountain Elaenia			
126	*Tolmomyias*	*sulphurescens*		Yellow-olive Flycatcher			
127	*Xenotriccus*	*callizonus*		Belted Flycatcher	*NT*		*NT*
128	*Mitrephanes*	*phaeocercus*		Tufted Flycatcher			
129	*Contopus*	*pertinax*		Greater Pewee			

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
130	*Contopus*	*sordidulus*		Western Wood-Pewee			
131	*Contopus*	*cinereus*		Tropical Pewee			
132	*Empidonax*	*flaviventris*		Yellow-bellied Flycatcher			
133	*Empidonax*	*albigularis*		White-throated Flycatcher			
134	*Empidonax*	*minimus*		Least Flycatcher			
135	*Empidonax*	*hammondii*		Hammond's Flycatcher			
136	*Empidonax*	*affinis*		Pine Flycatcher			
137	*Empidonax*	*flavescens*		Yellowish Flycatcher			
138	*Empidonax*	*fulvifrons*		Buff-breasted Flycatcher			
139	*Sayornis*	*nigricans*		Black Phoebe			
140	*Pyrocephalus*	*rubinus*		Vermilion Flycatcher			
141	*Myiarchus*	*tuberculifer*		Dusky-capped Flycatcher			
142	*Pitangus*	*sulphuratus*		Great Kiskadee			
143	*Megarynchus*	*pitangua*		Boat-billed Flycatcher			
144	*Myiozetetes*	*similis*		Social Flycatcher			
145	*Tyrannus*	*melancholicus*		Tropical Kingbird			
146	*Tyrannus*	*verticalis*		Western Kingbird			
147	*Tyrannus*	*tyrannus*		Eastern Kingbird			
148	*Tyrannus*	*forficatus*		Scissor-tailed Flycatcher			
149	*Pachyramphus*	*major*		Gray-collared Becard			
150	*Pachyramphus*	*aglaiae*		Rose-throated Becard			
151	*Tityra*	*semifasciata*		Masked Tityra			
152	*Chiroxiphia*	*linearis*		Long-tailed Manakin			
153	*Vireo*	*griseus*		White-eyed Vireo			
154	*Vireo*	*bellii*		Bell's Vireo			*NT*
155	*Vireo*	*flavifrons*		Yellow-throated Vireo			
156	*Vireo*	*plumbeus*		Plumbeous Vireo			
157	*Vireo*	*solitarius*		Blue-headed Vireo			
158	*Vireo*	*huttoni*		Hutton's Vireo			
159	*Vireo*	*gilvus*		Warbling Vireo			
160	*Vireo*	*leucophrys*		Brown-capped Vireo			
161	*Vireo*	*philadelphicus*		Philadelphia Vireo			
162	*Vireo*	*olivaceus*		Red-eyed Vireo			

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
163	*Vireolanius*	*melitophrys*		Chestnut-sided Shrike-Vireo			
164	*Vireolanius*	*pulchellus*		Green Shrike-Vireo			
165	*Cyclarhis*	*gujanensis*		Rufous-browed Peppershrike			
166	*Cyanocitta*	*stelleri*		Steller's Jay			
167	*Calocitta*	*formosa*		White-throated Magpie-Jay			
168	*Cyanocorax*	*yncas*		Green Jay			
169	*Cyanocorax*	*morio*		Brown Jay			
170	*Cyanocorax*	*melanocyaneus*		Bushy-crested Jay			
171	*Cyanolyca*	*cucullata*		Azure-hooded Jay			
172	*Cyanolyca*	*pumilo*		Black-throated Jay			
173	*Aphelocoma*	*unicolor*		Unicolored Jay			
174	*Progne*	*chalybea*		Gray-breasted Martin			
175	*Tachycineta*	*albilinea*		Mangrove Swallow			
176	*Tachycineta*	*thalassina*		Violet-green Swallow			
177	*Notiochelidon*	*pileata*		Black-capped Swallow			
178	*Stelgidopteryx*	*serripennis*		Northern Rough-winged Swallow			
179	*Hirundo*	*rustica*		Barn Swallow			
180	*Psaltriparus*	*minimus*		Bushtit			
181	*Certhia*	*americana*		Brown Creeper			
182	*Campylorhynchus*	*zonatus*	*restrictus**	Band-backed Wren			
183	*Campylorhynchus*	*rufinucha*		Rufous-naped Wren			
184	*Thryothorus*	*rufalbus*		Rufous-and-white Wren			
185	*Thryothorus*	*modestus*		Plain Wren			
186	*Troglodytes*	*aedon*		House Wren			
187	*Troglodytes*	*rufociliatus*		Rufous-browed Wren			
188	*Henicorhina*	*leucophrys*		Gray-breasted Wood-Wren			
189	*Regulus*	*satrapa*		Golden-crowned Kinglet			
190	*Regulus*	*calendula*		Ruby-crowned Kinglet			
191	*Polioptila*	*caerulea*		Blue-gray Gnatcatcher			
192	*Polioptila*	*albiloris*		White-lored Gnatcatcher			
193	*Sialia*	*sialis*		Eastern Bluebird			
194	*Myadestes*	*occidentalis*		Brown-backed Solitaire			
195	*Myadestes*	*unicolor*		Slate-colored Solitaire			

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
196	*Catharus*	*aurantiirostris*		Orange-billed Nightingale-Thrush			
197	*Catharus*	*frantzii*		Ruddy-capped Nightingale-Thrush			
198	*Catharus*	*ustulatus*		Swainson's Thrush			
199	*Catharus*	*guttatus*		Hermit Thrush			
200	*Hylocichla*	*mustelina*		Wood Thrush			
201	*Turdus*	*infuscatus*		Black Robin			
202	*Turdus*	*plebejus*		Mountain Robin			
203	*Turdus*	*grayi*		Clay-colored Robin			
204	*Turdus*	*assimilis*		White-throated Robin			
205	*Turdus*	*rufitorques*		Rufous-collared Robin			
206	*Dumetella*	*carolinensis*		Gray Catbird			
207	*Mimus*	*gilvus*	*gracilis**	Tropical Mockingbird			
208	*Melanotis*	*hypoleucus*		Blue-and-white Mockingbird			
209	*Bombycilla*	*cedrorum*		Cedar Waxwing			
210	*Ptilogonys*	*cinereus*		Gray Silky-flycatcher			
211	*Peucedramus*	*taeniatus*		Olive Warbler			
212	*Vermivora*	*pinus*		Blue-winged Warbler			
213	*Vermivora*	*chrysoptera*		Golden-winged Warbler			*NT*
214	*Vermivora*	*peregrina*		Tennessee Warbler			
215	*Vermivora*	*ruficapilla*		Nashville Warbler			
216	*Parula*	*superciliosa*		Crescent-chested Warbler			
217	*Parula*	*americana*		Northern Parula			
218	*Parula*	*pitiayumi*		Tropical Parula			
219	*Dendroica*	*petechia*		Yellow Warbler			
220	*Dendroica*	*pensylvanica*		Chestnut-sided Warbler			
221	*Dendroica*	*magnolia*		Magnolia Warbler			
222	*Dendroica*	*caerulescens*		Black-throated Blue Warbler			
223	*Dendroica*	*coronata*		Yellow-rumped Warbler			
224	*Dendroica*	*chrysoparia*		Golden-cheeked Warbler	*EN*		*EN*
225	*Dendroica*	*virens*		Black-throated Green Warbler			
226	*Dendroica*	*townsendi*		Townsend's Warbler			
227	*Dendroica*	*occidentalis*		Hermit Warbler			
228	*Dendroica*	*fusca*		Blackburnian Warbler			

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
229	*Dendroica*	*dominica*		Yellow-throated Warbler			
230	*Dendroica*	*graciae*		Grace's Warbler			
231	*Mniotilta*	*varia*		Black-and-white Warbler			
232	*Helmitheros*	*vermivorum*		Worm-eating Warbler			
233	*Seiurus*	*aurocapilla*		Ovenbird			
234	*Seiurus*	*noveboracensis*		Northern Waterthrush			
235	*Seiurus*	*motacilla*		Louisiana Waterthrush			
236	*Oporornis*	*formosus*		Kentucky Warbler			
237	*Oporornis*	*tolmiei*		MacGillivray's Warbler			
238	*Geothlypis*	*trichas*		Common Yellowthroat			
239	*Geothlypis*	*poliocephala*		Gray-crowned Yellowthroat			
240	*Wilsonia*	*pusilla*		Wilson's Warbler			
241	*Wilsonia*	*canadensis*		Canada Warbler			
242	*Cardellina*	*rubrifrons*		Red-faced Warbler			
243	*Ergaticus*	*versicolor*		Pink-headed Warbler	*VU*		*VU*
244	*Myioborus*	*pictus*		Painted Redstart			
245	*Myioborus*	*miniatus*	*miniatus**	Slate-throated Redstart			
246	*Euthlypis*	*lachrymosa*		Fan-tailed Warbler			
247	*Basileuterus*	*culicivorus*		Golden-crowned Warbler			
248	*Basileuterus*	*rufifrons*		Rufous-capped Warbler			
249	*Basileuterus*	*belli*		Golden-browed Warbler			
250	*Icteria*	*virens*		Yellow-breasted Chat			
251	*Chlorospingus*	*ophthalmicus*		Common Bush-Tanager			
252	*Habia*	*fuscicauda*		Red-throated Ant-Tanager			
253	*Piranga*	*flava*		Hepatic Tanager			
254	*Piranga*	*rubra*		Summer Tanager			
255	*Piranga*	*olivacea*		Scarlet Tanager			
256	*Piranga*	*ludoviciana*		Western Tanager			
257	*Piranga*	*bidentata*		Flame-colored Tanager			
258	*Spermagra*	*leucoptera*		White-winged Tanager			
259	*Thraupis*	*episcopus*		Blue-gray Tanager			
260	*Volatinia*	*jacarina*		Blue-black Grassquit			
261	*Sporophila*	*torqueola*		White-collared Seedeater			

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
262	*Tiaris*	*olivaceus*		Yellow-faced Grassquit			
263	*Diglossa*	*baritula*		Cinnamon-bellied Flowerpiercer			
264	*Atlapetes*	*albinucha*		White-naped Brush-Finch			
265	*Atlapetes*	*gutteralis*		Yellow-throated BrushFinch			
266	*Atlapetes*	*pileatus*		Rufous-capped Brush-Finch			
267	*Buarremon*	*brunneinucha*		Chestnut-capped Brush-Finch			
268	*Melozone*	*biarcuata*		Prevost's Ground-Sparrow			
269	*Melozone*	*leucotis*		White-eared Ground-Sparrow			
270	*Pipilo*	*erythrophthalmus*		Eastern Towhee			
271	*Aimophila*	*ruficauda*		Stripe-headed Sparrow			
272	*Aimophila*	*rufescens*		Rusty Sparrow			
273	*Spizella*	*passerina*		Chipping Sparrow			
274	*Melospiza*	*lincolnii*		Lincoln's Sparrow			
275	*Zonotrichia*	*capensis*		Rufous-collared Sparrow			
276	*Junco*	*phaeonotus*		Yellow-eyed Junco			
277	*Saltator*	*atriceps*		Black-headed Saltator			
278	*Pheucticus*	*ludovicianus*		Rose-breasted Grosbeak			
279	*Passerina*	*cyanea*		Indigo Bunting			*NT*
280	*Sturnella*	*magna*		Eastern Meadowlark			
281	*Dives*	*dives*		Melodious Blackbird			
282	*Quiscalus*	*mexicanus*		Great-tailed Grackle			
283	*Molothrus*	*aeneus*		Bronzed Cowbird			
284	*Icterus*	*wagleri*		Black-vented Oriole			
285	*Icterus*	*maculialatus*		Bar-winged Oriole			
286	*Icterus*	*spurius*		Orchard Oriole			
287	*Icterus*	*chrysater*		Yellow-backed Oriole			
288	*Icterus*	*pustulatus*		Streak-backed Oriole			
289	*Icterus*	*pectoralis*		Spot-breasted Oriole			
290	*Icterus*	*gularis*		Altamira Oriole			
291	*Icterus*	*galbula*		Baltimore Oriole			
292	*Amblycercus*	*holosericeus*		Yellow-billed Cacique			
293	*Psarocolius*	*wagleri*		Chestnut-headed Oropendola			
294	*Psarocolius*	*montezuma*		Montezuma Oropendola			

No	*Genus*	*Species*	*Sub-species*	Name (in English)	Threat Category		
					IUCN	CITES	BirdLife International
295	*Euphonia*	*affinis*		Scrub Euphonia			
296	*Euphonia*	*elegantissima*		Elegant Euphonia			
297	*Chlorophonia*	*occipitalis*		Blue-crowned Chlorophonia			
298	*Carpodacus*	*mexicanus*		House Finch			
299	*Loxia*	*curvirostra*		Red Crossbill			
300	*Carduelis*	*pinus*		Pine Siskin			
301	*Carduelis*	*atriceps*		Black-capped Siskin			
302	*Carduelis*	*notata*		Black-headed Siskin			
303	*Carduelis*	*psaltria*		Lesser Goldfinch			
304	*Coccothraustes*	*abeillei*		Hooded Grosbeak			
305	*Passer*	*domesticus*		House Sparrow			

EN: Endangered; VU: Vulnerable; NT: Almost Threatened

AI: Appendix I; AII: Appendix II; AIII: Appendix III

Source: Alliance for the Conservation of Pine-Oak Forests of Mesoamerica

Appendix 3. Summary of Research Studies about the Golden-cheeked Warbler in the Neotropics

In 1980, Kroll describes the "winter" habitat conditions and the similarity in structure that exists between the mixed pine-oak forests of Central America, wintering habitat, and the juniper-oak woodlands (*Juniperus ashei-Quercus* spp.), breeding habitat in Texas, U.S.A. (Kroll 1980).

In 1992, the United States Fish and Wildlife Service proposes the recovery plan for the Golden-cheeked Warbler, which shows research gaps for the Neotropics. It is from this plan that basic research begins (USFWS 1992).

In 1994, Charles Duncan, Claudia Macias Caballero, and Rosa María Vidal publish a research study carried out in Chiapas, from 1990-1993, showing many records of Golden-cheeked Warblers, confirming its presence in the area as a winter resident, and describing some basic aspects of its ecology (Vidal *et al.* 1994).

In 1995, Daniel Thompson starts research about the species' ecology by sampling many locations in Guatemala and Honduras and specifying conservation areas. This research shows the species' preference to flock and forage in live-oak trees, compared to deciduous oaks and pines (Thompson 1995).

Between 1999 and 2000, John Rappole and collaborators collect data for the species over two field seasons in Guatemala, Honduras, and Chiapas, describing the "winter" ecology of the species and their available habitat in the Neotropics (Rappole *et al.* 1999 and 2000).

Between 2001 and 2005, Selvin Pérez carries out research studies on the ecology of the species in Sierra de las Minas and the Guatemalan highlands. This study includes ecological aspects studied by Rappole and also includes new locations for this species' distribution. Studies about available food for the species in Sierra de las Minas are also carried out during this time (Pérez 2002 and 2005, Pérez and Solórzano in preparation).

In 2005, Julio Morales Can and Selvin Pérez carry out a comparative study of the vegetation in the Guatemalan highlands and in Sierra de las Minas, in order to compare the structure and composition of the vegetation at locations where sightings of the species had been reported to locations where no sightings had been reported (Pérez and Morales 2004).

Between 2003 and 2005, researchers initiated studies in Chiapas, Honduras, and El Salvador to monitor this species. These projects confirmed the existence of populations in Chiapas during the winter, documented the first records of the species in El Salvador, and enhanced the monitoring carried out in Honduras. At the same time, sightings of the species in Nicaragua were recorded, after a 50-year absence.

In 2005, researchers conduct a workshop in Río Escondido Nature Reserve, Guatemala, which included scientists from Texas, Chiapas, Mexico, Guatemala, El Salvador, Honduras, and Nicaragua. At this workshop, the standardization of methodologies for the study of the Golden-cheeked Warbler, resident, and other migratory birds is proposed.

Between 2006 and 2007 the Conservancy increased the number of studies examining the presence of the species in Nicaragua and Honduras during the winter season.

Also between 2006 and 2007, the Alliance carries out the first study focused on the winter ecology and relative abundance of the species at a regional level (Chiapas, Mexico-Nicaragua) using the standardized methodology developed by the Alliance in 2005. The project was funded by the Texas Parks and Wildlife Department (Cooperative Endangered Species Funds, Section 6, Endangered Species Act), and coordinated by Dr. Oliver Komar of SalvaNATURA's Department of Conservation Sciences. This project is funded for four seasons (2006 – 2009).

Appendix 4. Agreement Letter for the Formation of the Alliance

ALIANZA CONTINENTAL PARA LA CONSERVACION DE LA ECORREGIÓN DE BOSQUES DE PINO-ENCINO DE CENTROAMÉRICA Y SUS AVES

Considerando;

Que la ecorregión de pino-encino de Centroamérica, constituida por diferentes asociaciones vegetales[1] contiene una importante biodiversidad regional y sostienen poblaciones silvestres de aves migratorias y residentes consideradas prioritarias.

Que las asociaciones vegetales de la ecorregión de pino-encino de Centroamérica tienen un origen geológico y evolutivo común, comparten endemismos y son corredores biológicos clave para poblaciones de flora y fauna silvestres de la región.

Que la conservación de las poblaciones de aves migratorias y residentes requiere un esfuerzo continental que permita el mantenimiento de las mejores condiciones posibles de los hábitat de reproducción, de paso y de residencia invernal.

Que los bosques del Sur de México y Centroamérica, representan el hábitat de por lo menos 500 especies de aves residentes y migratorias, de las cuales aproximadamente el 30% se consideran amenazadas.

Que la conservación de especies amenazadas, como *Dendroica chrysoparia*, requiere de una coordinación de esfuerzos en todo su rango de distribución, reproducción, de paso y de invierno.

Que se requiere de acciones efectivas de investigación, conservación y manejo de los hábitat, así como un mayor conocimiento de la distribución, abundancia y tendencias poblacionales de las especies amenazadas de aves.

Que existen marcos de cooperación entre los países de la región que favorecen el establecimiento de acciones coordinadas entre ciudadanos, organizaciones de la sociedad civil, gobiernos locales, estatales e instituciones de investigación, para aumentar la efectividad de los esfuerzos de manejo sustentable y conservación de la biodiversidad[2].

Que en esta ecorregión se encuentran diversas poblaciones humanas que han convivido con estos ecosistemas por siglos y dependen de ellos para su sobrevivencia, por lo que es fundamental trabajar conjuntamente en los procesos institucionales de conservación y manejo de sus recursos naturales.

---

[1] Estas asociaciones pueden ser, entre otras bosques de pino-encino, encino, liquidámbar-encino.
[2] Entre estos se encuentran la Iniciativa para la Conservación de las Aves de Norteamérica, respaldada por la Comisión de Cooperación Ambiental, y los acuerdos de cooperación en materia de conservación de la biodiversidad entre México y Centroamérica.

Que las instituciones abajo firmantes comparten objetivos de conservación de la biodiversidad y el manejo sustentable de recursos naturales, y que en particular tienen interés en colaborar en programas, proyectos y acciones conjuntas de conservación de la ecorregión y sus especies asociadas.

Acuerdan:

1. Establecer una alianza continental para la conservación de los bosques de la ecorregión, con el fin de favorecer el hábitat de especies de interés común, en particular las aves migratorias y residentes amenazadas.

2. Enfocar sus esfuerzos inmediatos en promover la investigación y conservación de las poblaciones de *Dendroica chrysoparia* en todo su rango de distribución, y otras especies que se identifiquen como prioritarias para la Alianza. Lo cual incluye entre otras, las siguientes acciones:

   - Compartir y establecer protocolos estandarizados de monitoreo. De ser posible, la Alianza integrará un sistema continental de monitoreo para la especie y sus hábitat, incluyendo un sistema de información geográfico y bases de datos compartidos.

   - Colaborar en el diseño y la aplicación de estudios orientados a profundizar el conocimiento sobre *Dendroica chrysoparia*, y en particular el uso de hábitat invernal, la dinámica de sus poblaciones, sus relaciones inter-específicas y todos los temas que se consideren relevantes.

   - Compartir información y recursos tecnológicos necesarios para aumentar la capacidad técnica de monitoreo, investigación, manejo y conservación de los bosques de la ecorregión.

   - Integrar un Plan de conservación para *Dendroica chrysoparia* y sus hábitat, incluyendo consideraciones para la diversidad avifaunística y biológica de la región, que permita aumentar el número de interesados en la conservación y manejo sustentable de los bosques de la ecorregión y las aves.

   - Identificar oportunidades de conservación de sitios que sean relevantes como hábitat de invierno de *Dendroica chrysoparia* y respaldar a las instituciones locales de los esfuerzos de protección que se lleven a cabo

3. Colaborar en el entrenamiento de técnicos, líderes comunitarios y otros sectores sociales involucrados en el manejo y conservación de los hábitat.

4. Involucrar a todos los actores que sean relevantes para la toma de decisiones, planeación, gestión y en el manejo sustentable y conservación de los bosques de la ecorregión y las aves, particularmente a las comunidades y autoridades locales.

5. Compartir experiencias y establecer programas de cooperación para la prevención, combate y manejo de incendios y plagas forestales.

6. Colaborar en la difusión de la importancia de la conservación de estos hábitat y de las aves, mediante la producción de materiales de divulgación, medios electrónicos y campañas apropiadas a los contextos sociales y culturales.

7. Colaborar en la identificación de fuentes de financiamiento y en la elaboración de proyectos para la gestión de recursos que permitan facilitar la realización de estas acciones.

8. Elaborar un documento que describa el marco de colaboración de la Alianza y establezca un mecanismo de comunicación interno que ayude a coordinar los esfuerzos.

Por último las instituciones acuerdan que esta es una carta de entendimiento, que establece el marco de colaboración entre los grupos, que está basado en la buena voluntad e intención de las partes.

La firma de esta carta no obliga legal ni moralmente a ninguna de las instituciones a suscribir actos promovidos por una o más de las partes de la Alianza, sin su pleno consentimiento.

La adscripción a la Alianza es libre y voluntaria, por lo que su separación de ella puede realizarse mediante un aviso a las partes, donde se explique las razones de la misma.

Tuxtla Gutiérrez, Chiapas, México. 7 de noviembre de 2003

Luis Castillo
Defensores de la Naturaleza
Guatemala

Oliver Komar
Salva Natura
El Salvador

Romeo Domínguez
Pronatura Chiapas A.C.
México

Craig Farquhar
Texas Parks and Wildlife Department
Estados Unidos de Norteamérica

Miguel Moncada
Fundación EDUCA
Honduras

Rebecca G. Peak
The Nature Conservancy, Texas
Estados Unidos de Norteamérica

Salvadora Morales
Alianza para las Areas Silvestres
Nicaragua

Estuardo Secaira
The Nature Conservancy
Guatemala

Daniel Hilliard
Zoo Conservation Outreach Group
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Pablo Muench Navarro
Instituto de Historia Natural y Ecología
México

Alejandro Hernández
The Nature Conservancy, Chiapas
México

Rafael Martínez Castellanos
Instituto Montebello, A.C.
México

CONTINENTAL ALLIANCE FOR THE CONSERVATION OF THE CENTRAL AMERICAN PINE-OAK FOREST ECOREGION AND ITS BIRDS

Whereas:

The Central American Pine-oak Ecoregion, constituted by different vegetation associations[1] contains important regional biodiversity and sustains populations of wild migratory and resident birds considered as priority.

The vegetation associations of the Central American Pine-oak Ecoregion have a common geologic and evolutionary origin, share endemisms, and are biological corridors key to the region's wild flora and fauna populations.

The conservation of the migratory and resident bird populations requires a continental effort that will allow the maintenance of the best possible conditions of the reproduction, stopover, and winter residence habitats.

The forests of south Mexico and Central America represent the habitat of at least 500 species of resident and migratory birds, of which, approximately 30% are considered threatened.

The conservation of threatened species, such as *Dendroica chrysoparia* (Golden-cheeked Warbler), requires a coordination of efforts in all its range of distribution, reproduction, stopover, and wintering.

The effective habitat research, conservation, and management actions, as well as a greater knowledge about the distribution, abundance, and population's tendencies of the threatened bird species, are required.

There are cooperation frameworks among the region's countries that favor the establishment of coordinated actions among citizens, civil society organizations, local and state governments, and research institutions, in order to increase the effectiveness of the sustainable management and biodiversity conservation efforts[2].

In this ecoregion there is a diversity of human populations that have lived together with these ecosystems for centuries and depend on them for their survival; and therefore it is fundamental to work jointly on the institutional processes for their natural resources' conservation and management.

(Eleven rubrics appear on the right and lower margins of the first sheet).

[1] These associations can be, among others, pine-oak, oak, sweet gum tree-oak.
[2] Among them there are, the North American Bird Conservation Initiative, supported by the Commission for Environmental Cooperation, and the cooperation agreements regarding the conservation of biodiversity between Mexico and Central America.

The undersigning institutions share the biodiversity conservation and the natural resources' sustainable management objectives and each one has the interest to collaborate in joint conservation programs, projects, and actions for the ecoregion and its associated species.

They agree to:

1. Establish a continental alliance for the conservation of the ecoregion's forests, in order to favor the habitat of species of common interest, particularly threatened migratory and resident birds.

2. Focus their immediate efforts to promote the research and conservation of the populations of *Dendroica chrysoparia* (Golden-cheeked Warbler) in all its distribution range, and other species that are identified as priority for the Alliance. This includes the following actions, among others:

    - Share and establish standardize monitoring protocols. If possible, the Alliance will integrate a continental monitoring system for the species and its habitat, including a shared geographic information system and databases.

    - Collaborate in the design and application of studies guided to deepen the knowledge about *Dendroica chrysoparia* (Golden-cheeked Warbler) and, in particular, the use of winter habitat, their populations' dynamics, inter-specific relationships, and all subjects considered relevant.

    - Share information and technological resources necessary to increase the technical capacity for monitoring, research, management, and conservation of the ecoregion's forests.

    - Integrate a conservation Plan for *Dendroica chrysoparia* (Golden-cheeked Warbler) and their habitats, including considerations for the region's avifauna and biological diversity, which allows increasing the number of individuals interested in the conservation and sustainable management of the ecoregion's forests and birds.

    - Identify site conservation opportunities that are relevant as a winter habitat of *Dendroica chrysoparia* (Golden-cheeked Warbler) and support the local institutions in the protection efforts they carry out.

3. Collaborate in the training of technical staff, community leaders, and other social sectors involved in the management and conservation of the habitats.

4. Involve all stakeholder that are relevant for decision-making, planning, and management, and for the sustainable management and conservation of the ecoregion's forests and birds, particularly, the communities and local authorities.

(Eleven rubrics appear on the right and lower margins of the second sheet).

5. Share experiences and establish cooperation programs for the prevention, combat, and management of forest fires and plagues.

6. Collaborate in the dissemination of the importance of the conservation of these habitats and the birds, through the publication of dissemination materials, electronic media, and campaigns appropriate to the social and cultural contexts.

7. Collaborate in the identification of financing sources and in the development of projects for the management of resources that will allow carrying out these actions.

8. Develop a document that describes the Alliance's collaboration framework and establishes an internal communication mechanism that helps coordinating the efforts.

Lastly, the institutions agree that this is a letter of understanding that establishes the collaboration framework among the groups, based on the parties' good will and intention.

Signing this letter does not bind, neither legally or morally, any of the institutions to endorse the actions promoted by one or more of the Alliance's parties, without its full consent.

The affiliation to the Alliance is free and voluntary wherefore, the separation from the Alliance can take place through a notice to the parties, explaining the reasons for said separation.

Tuxtla Gutiérrez, Chiapas, Mexico. November 7, 2003.

(Signature). Luis Castillo, Defensores de la Naturaleza, Guatemala.
(Signature). Oliver Komar, Salva Natura, El Salvador.
(Signature). Romeo Domínguez, Pronatura Chiapas A.C. (currently Pronatura Sur), Mexico.
(Signature). Craig Farquhar, Texas Parks and Wildlife Department, United States of America.

(Page 3 of 4)
(Six rubrics appear on the right margin of the third sheet).

(Signature). Miguel Moncada, Fundación EDUCA, Honduras.
(Signature). Rebecca G. Peak, The Nature Conservancy, Texas, United States of America.
(Signature). Salvadora Morales, Wild Areas Association, Nicaragua.
(Signature). Estuardo Secaira, The Nature Conservancy, Guatemala.
(Signature). Daniel Hilliard, Zoo Conservation Outreach Group, United States of America.
(Signature). Pablo Muench Navarro, Instituto de Historia Natural y Ecología, Mexico.
(Signature). Alejandro Hernández, The Nature Conservancy, Chiapas, Mexico.
(Signature). Rafael Martínez Castellanos, Instituto Montebello, A.C., Mexico.

(Page 4 of 4)

Appendix 5. Attendees to the Consultation Meetings and Workshops for the Development of the Conservation Plan

Name	Institution/ Organization	1st Regional Workshop	National Workshops					2nd Regional Workshop	3rd Regional Worskhop
			Chiapas	Guatemala	El Salvador	Honduras	Nicaragua		
Alan Meyrat	INAFOR						X		
Alejandra Martínez	ALAS	X							
Alejandro Hernández	TNC		X						X
Alma Bojórquez	ECOSUR		X						
Angélica Camacho	BIOCORES		X						
Arelis Blandón	SINIA-Estelí						X		
Claudia Macias	Pronatura Sur	X	X					X	X
Claudia Martínez	*Cooperativa El Manzano* (El Manzano Cooperative)				X				
David Angulo	PRISMA				X			X	
Délmar Cancino	IHNE		X						
Edgar Selvin Pérez	FDN	X		X				X	X
Eduardo Morales	IHNE	X							
Eduardo Ramírez	Pronatura Sur		X						
Efraín Castellanos	Pronatura Sur		X					X	
Ernesto Flores	REHNAP					X			
Estuardo Secaira	TNC	X		X				X	X
Evelyn Larios	SalvaNATURA				X				
Fátima Obregón							X		
Fernando Castillo	USAC			X					
Francisco Aceituno	Fundación EDUCA	X				X		X	X
Guillermo Daringher	Pronatura Sur		X						
Héctor Portillo						X			
Igor de la Roca	FDN	X		X					X

Name	Institution/ Organization	1st Regional Workshop	National Workshops					2nd Regional Workshop	3rd Regional Worskhop
			Chiapas	Guatemala	El Salvador	Honduras	Nicaragua		
Israel Amezcua	Pronatura Sur							X	X
Jacinto Cedeño	MARENA						X		
Jaime Mauricio Talavera	AFE-COHDEFOR					X			
Jason Seagle	Peace Corps/ PRODETUR				X				
Johanna Felger	SalvaNATURA				X				
Johannes Enssle	SalvaNATURA				X				
José López	CONAP			X					
José Manuel Bojorge							X		
José Manuel Zolotoff	*Fundación Cocibolca* (Cocibolca Foundation)						X		
José Tobías Guevara	PRODETUR				X				
Juan Barrios	AFE-COHDEFOR					X			
Julio Morales Can	USAC			X					
Lemuel Valle	*Consultora OTUS* (OTUS Consulting Firm)			X					
Lety Andino	SalvaNATURA				X				
Lucky Medina Moncada	AFE-COHDEFOR					X			
Luis Cortés	AFE-COHDEFOR					X			
Luis Galindo	BIOCORES		X						
Ma. Patrocinio Alba	Pronatura Sur		X						
Marcela Nissen	*Dirección de Biodiversidad* (Biodiversity Office)						X		
Margarita Ocampo	Pronatura Sur		X						
Mario Delgado	INAFOR-Estelí						X		
Mario Díaz	INA Bosques			X					
Mario González	ECOSUR		X					X	

Name	Institution/ Organization	1st Regional Workshop	National Workshops					2nd Regional Workshop	3rd Regional Worskhop
			Chiapas	Guatemala	El Salvador	Honduras	Nicaragua		
Espinosa									
Marta Moreno	AFE-COHDEFOR					X			
Maynor Ovando	*Consultora OTUS* (OTUS Consulting Firm)			X					
Miguel Sandoval	ATRIDEST-Metapán				X				
Neptalí Ramírez Marcial	ECOSUR		X						
Oliver Komar	SalvaNATURA	X			X			X	X
Osmar Arróliga	FUNDAR						X		
Paul House						X		X	
Rosa María Vidal	Pronatura Sur		X						
Salvadora Morales	ALAS							X	
Sandra Mendoza	TNC					X			
Sergio Vilchez	Grupo Guardabarranco						X		
Virginia Rubio	MARENA –Ocotal						X		
Pablo Herrera	FDN							X	
Edgard Herrera	TNC								X
Marisol Mena	ALAS								X

Appendix 6. Priority Strategies of the Conservation Plan

Strategies	Overall Hierarchical Value
01. Strengthen the regional Alliance for the Conservation of Mesoamerican Pine-Oak Forests (coordinator, mechanisms for communication and exchange, inclusion of key stakeholders, funds for operations and advocacy)	Very High
02. Promote national and multi-sector working groups for the conservation and management of pine-oak forests in each country	Very High
03. Implement appropriate advocacy and outreach programs to strategically position the Alliance and this plan, so that governmental institutions, civil society, and the international community recognize the Alliance and adopt the plan	Very High
04. Implement a study of the ecological, social, and economic importance of pine-oak forests in the conservation of biodiversity and sustainable development in the region, as well as threats to its continued existence, and disseminate the results	Very High
05. Update and reprioritize areas listed as most important for the conservation and management of pine-oak forests as new areas in the region are identified	Very High
06. Promote and strengthen the implementation of formal conservation mechanisms in priority areas (national, state, private, community and municipal protected areas, ecological easements, conservation incentives, etc.)	Very High
07. Identify and promote the sustainable use of pine-oak forest resources through applied research, best management practices, certification and training (emphasizing oak plantation management and timber and non-timber products)	Very High
08. Promote and disseminate applied research about the effects of forest fires and their management on the composition and structure of pine-oak forests	Very High
09. Systematize and share the most successful integrated fire management experiences at a regional level	Very High
10. Promote the development and implementation of landuse planning proposals at sub-watershed, community, and property levels in priority conservation sites	High
11. Develop and update, with relevant institutions (forestry sector, municipalities, communities, private owners, etc.), integrated fire management plans for priority areas, emphasizing the sites with high levels of forest fire recurrence	High
12. Decrease stress on natural forests caused by extraction of firewood by establishing "energy forests" that contain native species and by promoting other activities, such as fuel-efficient stoves, alternative sources of energy, etc.**	High
13. Promote forest management and restoration incentives that meet appropriate criteria for the conservation of biodiversity (20-30% encino oaks in the canopy, individuals defined in each region, etc.)	High
14. Promote and strengthen ecological corridors among priority sites designated for the conservation of pine-oak forests	High
15. Identify and promote incentives for the implementation of effective integrated fire management plans (restricted fund, rewards, etc.)	High
16. Improve the conservation and sustainable management of pine-oak forests by promoting and strengthening forest management at the municipal and community levels (encourage participation of civil society, provide training to municipal technical units, promote integrated management of fire and water, etc.)	Medium
17. Promote the development of mechanisms that provide payments for environmental services (water, carbon, disaster prevention, etc.) in pine-oak forests	Low
18. Promote the development of avian tourism and ecotourism in potential pine-oak forest sites (identify potential sites, link them with specialized institutions, etc.)	Low
19. Carry out necessary monitoring actions in order to evaluate the ecoregion's biodiversity conservation status*	

- This strategy is considered very important, but was not prioritized given that it does not contribute to threat reduction.

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