4.0 REINTRODUCTION OF THE SCARLET MACAW (*ARA MACAO*) TO EL SALVADOR: PHASE I, FEASIBILITY

Author: Robin Bjork, Ph. D., Senior Scientist, Department of Conservation Science, SalvaNATURA, San Salvador, El Salvador.
Spanish Translation: Celina Montis, SalvaNATURA.

4.1 Introduction

In 2007, SalvaNATURA received a 3-year grant from private U.S. donors, Joe and Cornelia Bruderer-Schwab, for the reintroduction of Scarlet Macaws to El Salvador. SalvaNATURA is a Salvadoran, non-profit, non-governmental environmental organization with a trinational (El Salvador, Honduras, Nicaragua) program in research and inventory of flora and fauna and co-manages two Salvadoran national parks with the Ministry of the Environment. The Bruderer-Schwabs have recently opened an ecolodge in western coastal El Salvador, and in 2007 they approached SalvaNATURA with interest in supporting a project focused on conservation of nature in El Salvador. The idea of reintroducing Scarlet Macaws to El Salvador, initially conceived in 2003 with a pre-proposal report jointly developed by the Wildlife Conservation Society and SalvaNATURA, was revived. With funding from the project, SalvaNATURA co-sponsored the Guatemala workshop to strengthen regional efforts and collaboration with the Wildlife Conservation Society for restocking of Scarlet Macaws into the wild.

The primary goal of the project is to establish a wild, self-sustaining population of the Scarlet Macaw (*Ara macao*) in El Salvador. Reestablishing a species to a landscape where it historically occurred, or reintroduction, is moving beyond trial and error of releasing individuals into a site with the hope that they survive. Reintroduction should be conducted using a strategy with scientifically-based preliminary evaluation of the physical and social landscapes and pre- and post-release monitoring. Given best available phylogenetic data, an explicit decision (or agreement among an advisory group) should be made regarding the genetic makeup of stock for the reintroduction and consideration of availability and quality of stock. Site-specific protocols should be developed and subject to revision based on careful observation and results as the project proceeds (adaptive management). Given the increasing occurrence of reintroduction projects across the globe and the concomitant potential of reintroduction to cause adverse effects of great impact to existing biodiversity, the International Union for the Conservation of Nature/Species Specialist Commission (IUCN/SSC) established the Reintroduction Specialist Group (RSG). The RSG developed guidelines for reintroduction which help insure that reintroduction achieves its intended conservation objectives, that it is “both justifiable and likely to succeed, and that the conservation world can learn from each initiative, whether successful or not” (Appendix 4-A, IUCN/SSC 1995). Guidelines specific to parrot reintroduction are found in Snyder et al. (2000) and Wiley et al. (1992).

4.2 Objectives, Methods & Activities

Our initial considerations for the project are that the reintroduction site is within the historic distribution of the species, there is sufficient habitat in the reintroduction area, the causes of extirpation have been identified and addressed, and potential impacts (+ and -) of the reintroduction on local biodiversity is assessed. The initial phase of the project (2-3 years) is a feasibility study. The feasibility study and reintroduction require approval and permits from the Ministry of the Environment, El Salvador. Objectives of the feasibility study are to:

1) Review historic occurrence and current status of extant Scarlet Macaw populations in the northern Central American Pacific coast,

2) Evaluate foraging habitat for Scarlet Macaws in the ~300 km^2 area proposed for the reintroduction,

3) Develop and specify reintroduction protocols and strategies,

4) Assess potential impact of the reintroduction on the endangered Yellow-naped Parrot (*Amazona auropalliata*) population in the project area,

5) Identify specific sites within the study area which we consider to be most appropriate for the reintroduction, and

6) Disseminate information on and discuss the possible reintroduction of Scarlet Macaws with communities in the project area, and initiate an environmental awareness component focused on psittacine conservation.

The project area is the El Imposible-Barra de Santiago Corridor in the Department of Ahuachapán, southwestern El Salvador (Fig. 4-1). This area was chosen because it has three protected areas within the Central American dry forest ecoregion of the species, it falls within the focal area of a USAID/SalvaNATURA biodiversity conservation and environmental education project which seeks to increase the protection of biodiversity (2007-2009), and it is an area with potential for ecotourism development which would provide incentive to local communities to support the project. The 3 protected areas and their dominant vegetation are: El Imposible National Park: dry tropical forest; Santa Rita Protected Area: seasonally-inundated tropical evergreen forest; and Barra de Santiago Protected Area: mangrove forest. A description of activities and findings follows.

4.2.1 Synthesis of northern Central America Pacific Distribution of Scarlet Macaw

Historic Occurrence
Although generally thought to have historically occurred along much of the Pacific coast of northern Central America (Howell and Webb 1995, Fig.4-2A) from southern Mexico through Nicaragua, there is little documentation of the historic occurrence of the Scarlet Macaw in El Salvador. Figure 4-2B shows the locations of historic accounts and current occurrence of the species along the Pacific coast in El Salvador, Guatemala, and Honduras. Based on reports in El Salvador by Dickey and van Rossem (1938), Scarlet Macaws were “Probably formerly all along the coastal plain, but now completely extirpated except in the almost uninhabited southeast part of the republic.” Further, they state that “As a result of constant persecution, dating from the first days of trading ships, these macaws are now reduced to a comparatively few pairs which are said

to nest in the wild section of the coast south of the Colinas de Jucuarán." They collected 3 specimens in that region, at Lake Olomega, in September 1925. Thurber (1987) attributes their

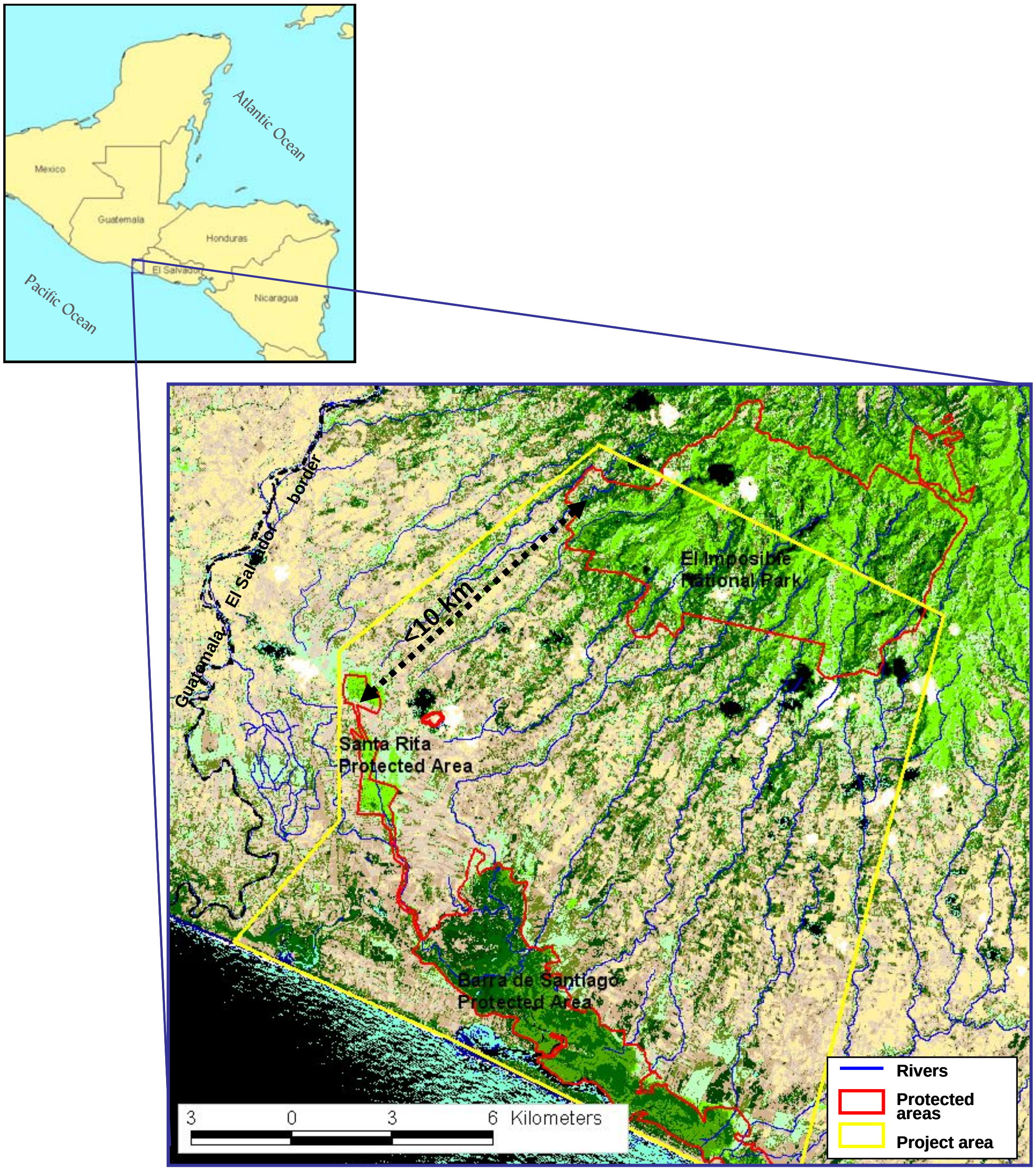


Figure 4-1. Area proposed for Scarlet Macaw reintroduction in western El Salvador referred to as the El Imposible-Barra de Santiago Corridor. The green colors represent forest cover, including primary, second- growth and shade-coffee forests, and agroforestry; the beige colors represent non-forest cover including agriculture, pasture, and other converted lands. Protected areas are in red outline and the project area is in yellow outline. Map of forest cover was produced using unsupervised classification analysis (ERDAS 2003) on 2006 high-resolution satellite imagery (ASTER image). White and black splotches on the image are clouds and their shadows, respectively.

extirpation in El Salvador to "deforestation, hunting for food and feathers, and nest robbing for the pet trade". Salvadoran biologist, Nestor Herrera (Ministry of the Environment, pers. comm.) recounted a description from a book about the history of El Salvador which described Scarlet Macaws as pests in cacao plantations in the Department of Sonsonate, southwestern El Salvador (Fig. 4-2B) in the 1600s (*from* Escalante Arce 1992). Land (1970) stated that Scarlet Macaws were uncommon residents in the lowlands of Guatemala; his distribution map shows their occurrence extending across the western two-thirds of the Pacific Guatemalan lowlands where they are now extirpated. Monroe (1968) wrote about the status of the species in Honduras: "This macaw is uncommon in most of Honduras though fairly common locally in portions of the arid Pacific lowlands. It is found not only in the vicinity of forests but also in the scrubby growth of the Pacific coast." It is perplexing why there are not accounts of macaws in the project area since the 1600s, yet they were reported ~100 km to the west in Guatemala in 1970 and ~200 km to the east in El Salvador in 1925 (Figure 4-2B).

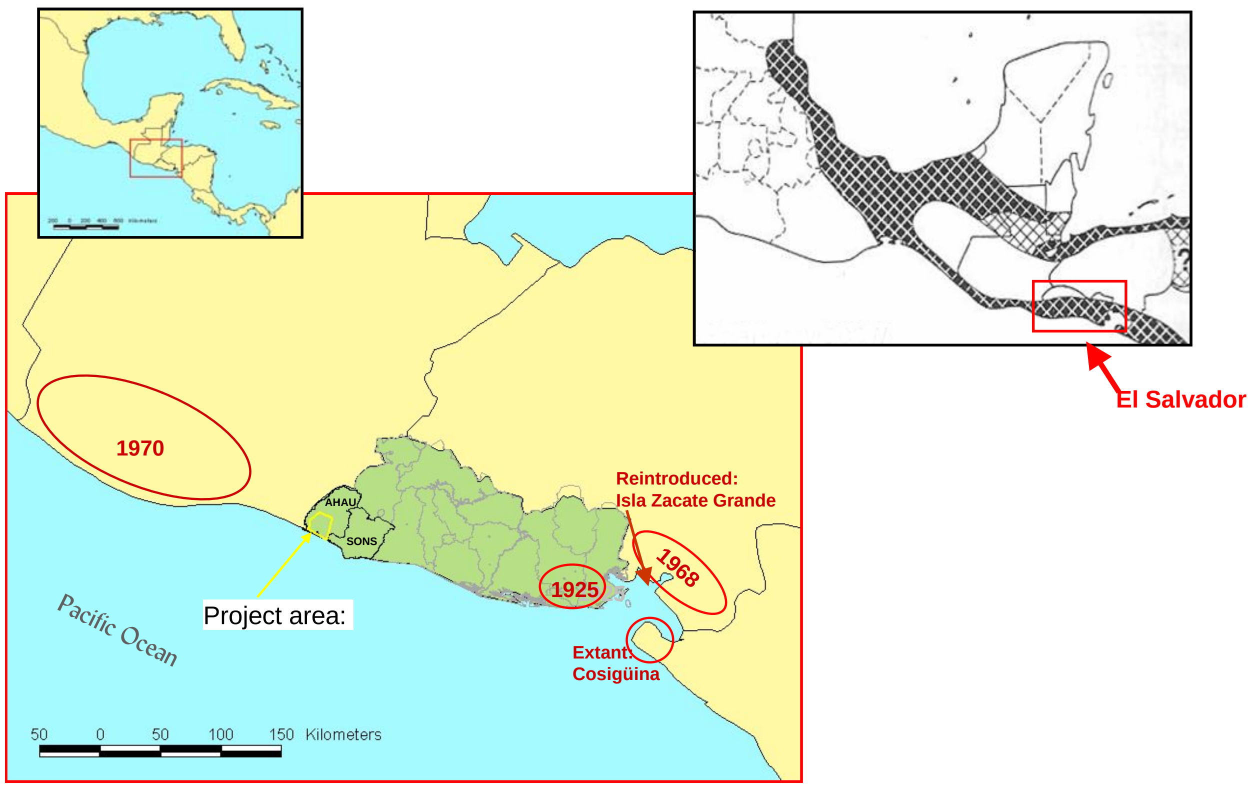


Figure 4-2. RIGHT: Historic (black hatch) and current (white hatch) distribution of the Scarlet Macaw in northern Central America and Mexico (*from* Howell and Webb 1995). LEFT: Locations of historic accounts of the species along the Pacific coast in Guatemala, El Salvador, and Honduras, the highly threatened, small extant population in the Cosigüina Peninsula, Nicaragua, and the reintroduced flock at Isla Zacate Grande, Honduras. The project area is in the Department of Ahuachapán (AHAU) and a historic report of macaws in the 1600s was in the adjacent Department of Sonsonate (SONS). Distribution accounts come from Dickey & Van Rossem 1938, Thurber 1987, Escalante Arce 1992 (El Salvador), Land 1970 (Guatemala), and Monroe 1968 (Honduras). Historic location in Honduras is approximated on the figure based solely on Monroe's (1968) written description.

Status of extant coastal Pacific Scarlet Macaws in Nicaragua and Honduras

Cosigüina Peninsula, Nicaragua and Isla Zacate Grande, Honduras (Fig 4-2B) were two sites reported to have a population or flock of free-living Scarlet Macaws. Little published information was available on the status of these macaws, which are the closest in proximity (~250 km) and habitat to conditions for macaws that once occurred in El Salvador. Our objective was to visit the sites and document what is currently known about each population/flock and investigate the potential to collaborate with Nicaraguans and/or Hondurans in further research of their birds.

Nicaragua:

Dr. Oliver Komar (Director of Conservation Science, SalvaNATURA) and I made an expedition to the region from 3-8 April, 2008 (Fig. 4-3). Based on field observations, we know that Scarlet Macaws still exist in the wild in the Cosigüina Volcán Nature Reserve, Cosigüina Peninsula. In one day, we observed at least 2 pairs of wild macaws and possibly up to 7 different individuals. Based on unpublished reports (Camacho and Martínez 2006, Frontier Nicaragua 2004), interviews with a community-based park guard, volunteer park guard, and 2 long-time residents (a fisherman and rancher), and on the limited area we covered, we estimated the population to be very small, maybe 20 to 50 birds. The population's continued existence is extremely threatened. Fig. 4-4 provides a few photos of our expedition.

Funding severely limits the ability of LIDER (Luchadores Integrado Desarrollo de la Región), the NGO responsible for co-management of Cosigüina with MARENA (Ministry of Environment and Natural Resources), to protect and manage for their macaw population. There are reports of ongoing chick poaching and 'winging'(i.e. shooting to injure the wing of a flying bird to facilitate its capture) of adult Scarlet Macaws in Cosigüina, which are usually then transported across the Bay of Fonseca to sell in El Salvador. Continued involvement in conservation of and research on this population is not only of highest priority for the population, but valuable to our project as these birds provide a model of wild macaw behavior and habitat use in a similar biogeographic region.

Honduras:

At an initial planning meeting for our project in 2007, a Scarlet Macaw reintroduction effort carried out in the 1990s on Isla Zacate Grande (Gulf of Fonseca), Honduras, was described by a SalvaNATURA board member. There was no information about the current status of the project or specific details of how it developed, and we decided that a site visit was in order. The Zacate Grande Biological Station, a 2100 ha private reserve on the island, is owned by Miguel Facussé of Corporación DINANT, a large food industry based in Tegucigalpa, Honduras. Señor Facussé established this reserve, and 2 others in Honduras, for protection of biodiversity. Activities at the station include community agroforestry, seminars on wildfire management and laws for park guards and police, and reforestation projects.

On 8 April, Olvin Andino, Director of Environmental Planning for DINANT, gave us a tour of the facility (Figs. 4-5). Prior to joining DINANT, Andino worked with the Centro de Rescate de Fauna in Tegucigalpa and was interested in reintroduction of wildlife. Although the details of the project are a bit sketchy and not formally documented, what we understand from Andino is that their work with Scarlet Macaws began in about 1996-97 when they were given 4 chicks confiscated from poachers; the birds are thought to have originated from the Mosquito (Caribbean) region of Honduras. A few years later they received another 5 macaws (adults and chicks), also confiscations of unknown origin. They set up a macaw feeding platform and erected artificial nests on trees in the well-developed center of the facility where they liberated the birds a few years after receiving them. The birds are provided daily supplemental food and they also feed on wild fruits, including cashew, mango, and tamarindo. None of the birds have been banded and the status of individuals is not known. They have not formally monitored breeding activities or reproductive success; however some of the birds nest and produce young. In 2007, Andino observed the first nesting in a natural cavity—a guanacaste (*Enterolobium cyclocarpum*) tree. Previous nesting had been attempted in artificial nests. They observed 3 nesting attempts in 2008, one in which the eggs were predated, success of the other two nests.

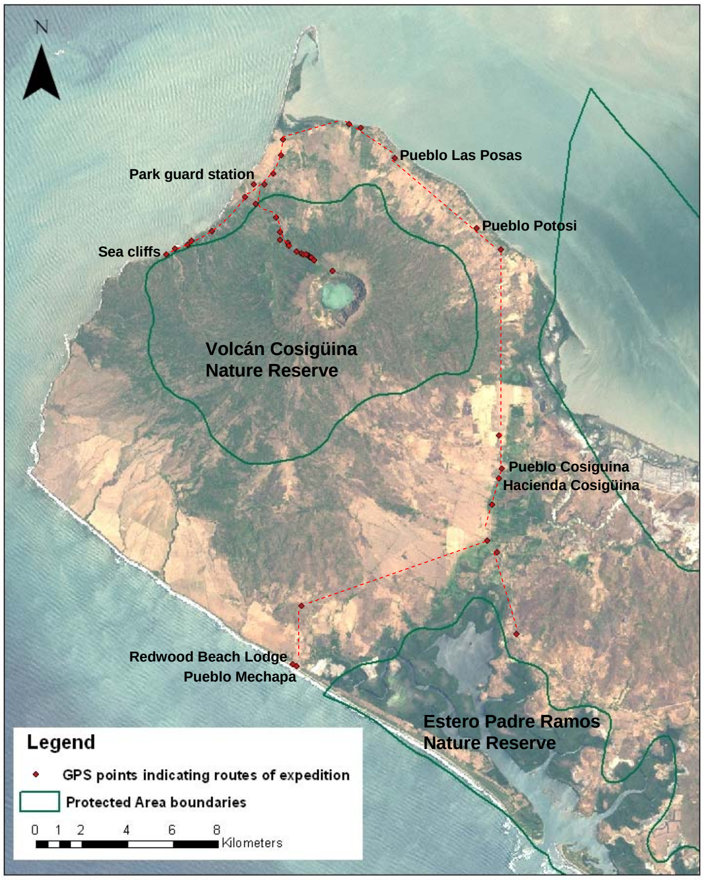


Figure 4-3. Satellite image (ETM+) showing the Cosigüina Peninsula and delineation of protected areas. The red dashed line traces our route during the expedition. We traveled around the east side of the peninsula to reach our lodgings for the next 2 nights—the Cosigüina Park Guard Station in the north. From the park station, we explored the region, including the crater of the volcano and the sea cliffs. At the end of the expedition, we visited the Redwood Beach Lodge on the southwest side of the peninsula; the American owner who provides ecotours to the crater did not know that Scarlet Macaws occurred in the region. Figure 4-2 shows the regional geographic referente of Cosigüina.

Figure 4-4. TOP LEFT: The park guard station at Cosigüina Volcano Nature Reserve with a view of the volcano as the backdrop. TOP RIGHT: Oliver Komar, Martín Lezama, and Zoraida Martínez stand at the edge of the Cosigüina crater. BOTTOM LEFT: Pet Scarlet Macaw in Pueblo Potosi located on the eastern shore of the Cosiguiña Peninsula (Fig. 4-3). The 3-year old bird was brought to the residence as a chick that was poached from a wild nest in the area. A poster stating: YO PROTEJO LA LAPA ROJA" or "I PROTECT THE SCARLET MACAW", was hanging on the front door of the home. BOTTOM RIGHT: Another pet macaw, said to be 22 years old, perches on its owner's arm in Pueblo Potosi.

At least some of the birds range outside the reserve; Andino has received reports of free-flying macaws being trapped in nearby communities and on the adjacent island of Amapala and he believes that there are now ~20 free-flying macaws. Isla Zacate Grande is only ~35 km (over-water) from the Cosigüina Peninsula, an overland flight distance within documented range for Scarlet Macaws. Contact between the Zacate Grande and Cosigüina birds is within the realm of possibility. During our short visit, we observed at least 6 macaws perched in trees and 1 pair nesting in a guanacaste tree located near buildings of the central facility (Fig. 4-5). The birds showed no fear of humans and allowed our close approach. It is encouraging to learn that even without pre-release conditioning these birds are feeding in the wild and breeding. As a model, there are serious concerns about this sort of 'reintroduction'. Disease testing was not performed nor was there documentation of the project. The birds have no fear of humans, continue to depend on regular supplemental food, and appear to have been conditioned to nest in inappropriate situations (e.g. low to the ground) which makes them highly vulnerable to human and non-human predators alike (Fig. 4-5). High security and long-term daily maintenance is required. However, there may be cases where this strategy (semi-wild and managed flocks) is acceptable because it is the only way the species will survive outside of zoos or 'rescue' critically small populations (Chapter 10, *Semi-wild Releases and Managed Populations*), e.g. the possible situation between Cosigüina and Isla Zacate Grande. However, given the potential transmission of disease from released birds to wild populations, appropriate health evaluation should be considered a critical component of any strategy.

Figure 4-5. The Zacate Grande Biological Station, Honduras, where a small Scarlet Macaw reintroduction project with birds released in 1996-97 and in the early 2000s. TOP LEFT: The macaws' feeding station; fresh fruits and corn are placed in trays and the free-living macaws come in to feed daily. RIGHT: Olvin Andino (left) describes the view from the patio of the dining area. Reportedly, macaws fly to nearby islands; El Salvador is barely visible across the Gulf of Fonseca. Free-living Scarlet Macaws at Zacate Grande Biological Station are highly acclimated to the presence of humans. BOTTOM: During our visit to the station, we observed several macaws perched in trees and observed a pair nesting in a guanacaste (*Enterolobium cyclocarpum*) tree around the central facility buildings. The birds showed no fear of humans and allowed our close approach.

4.2.2 Habitat Evaluation

Scarlet Macaws inhabit tropical humid and tropical deciduous dry forests (Weidenfeld 1994). They are considered a lowland species, generally reported to occur from sea level to approximately 400-600 m (IUCN 2001: 600 m, Vaughn 1983: 500 m, Weidenfeld 1994: 400 m); however, other published reports suggest that the upper elevation limit of the species is higher: 900m (Land 1970), 1000m (Renton 2000), 1100m (Monroe 1968). Our project area covers an elevation range of approximately 0-600m above sealevel (Fig. 4-6A), although the park extends well beyond the project area up to 1425m and down the northern slope to approximately 1000m. Headwaters of eight rivers originate in El Imposible. The project area encompasses appropriate dry forest and humid forest types used by Scarlet Macaws (Fig. 4-6B).

Scarlet Macaws are primarily granivores (seed-eaters); they forage on a wide variety of plant species consisting primarily of immature seeds, but also fruit pulp, flowers, and other plant parts (leaves and stems). The species is considered relatively adaptable in diet (Renton 2000) and can exist in somewhat degraded natural habitats (Vaughn et al. 2006) if anthropogenic impacts to survival, such as hunting and poaching, are minimized. They are known to range widely, traveling 15 km or more daily, from roosting to foraging areas (Myers and Vaughn 2004) and more than 100 km in seasonal migrations (Morales et al. 2001) probably tracking variation in food resources. Note that the distance between montane El Imposible National Park and coastal Barra de Santiago and Santa Rita protected areas is 10-15 km (Fig. 4-1).

To evaluate the capacity of the existing foraging habitat in the project area to sustain a population of reintroduced Scarlet Macaws throughout their annual cycle, we are conducting an analysis to determine what natural food resources occur in the area, where and when they are available, and in what quantity. Note that evaluation of nesting resources is a low priority in this phase of the project; once we advance to the phase of preparing for release of birds, we can evaluate nesting resources in the release area and, if insufficient, we can supplement the area with artificial nests which have been successfully utilized by Scarlet Macaws in the wild (Brightsmith 2000; Vaughn et al. 2003; WCS-Guatemala, unpubl. data). Because Scarlet Macaws are known to range widely in search of food and because fruiting within and among species can vary by elevation, fruit monitoring is being conducted across an elevation gradient of 0-600 m. Strategy and progress in this component of the project is detailed below.

We have:

- Produced a map of current forest landcover in the corridor using an unsupervised classification analysis (ERDAS 2003) of 2006 high resolution imagery (ASTER satellite imagery; Fig. 4-1). The map aided in locating sampling sites. In an ongoing mapping effort by USAID, a finer-scale landcover map will be produced and should allow us to quantify the extent (i.e. area) of different forest types. GIS mapping and analyses are carried out with ArcGIS software (ESRI 2005).

- Compiled information on known natural food resources of Scarlet Macaws from published literature and reports (Appendix 4-B; Matuzak et al. 2008; Peréz 1998; Renton 2006; Vaughn et al. 2006). This list was then used as the basis for generating a list of species to be

A.

B.

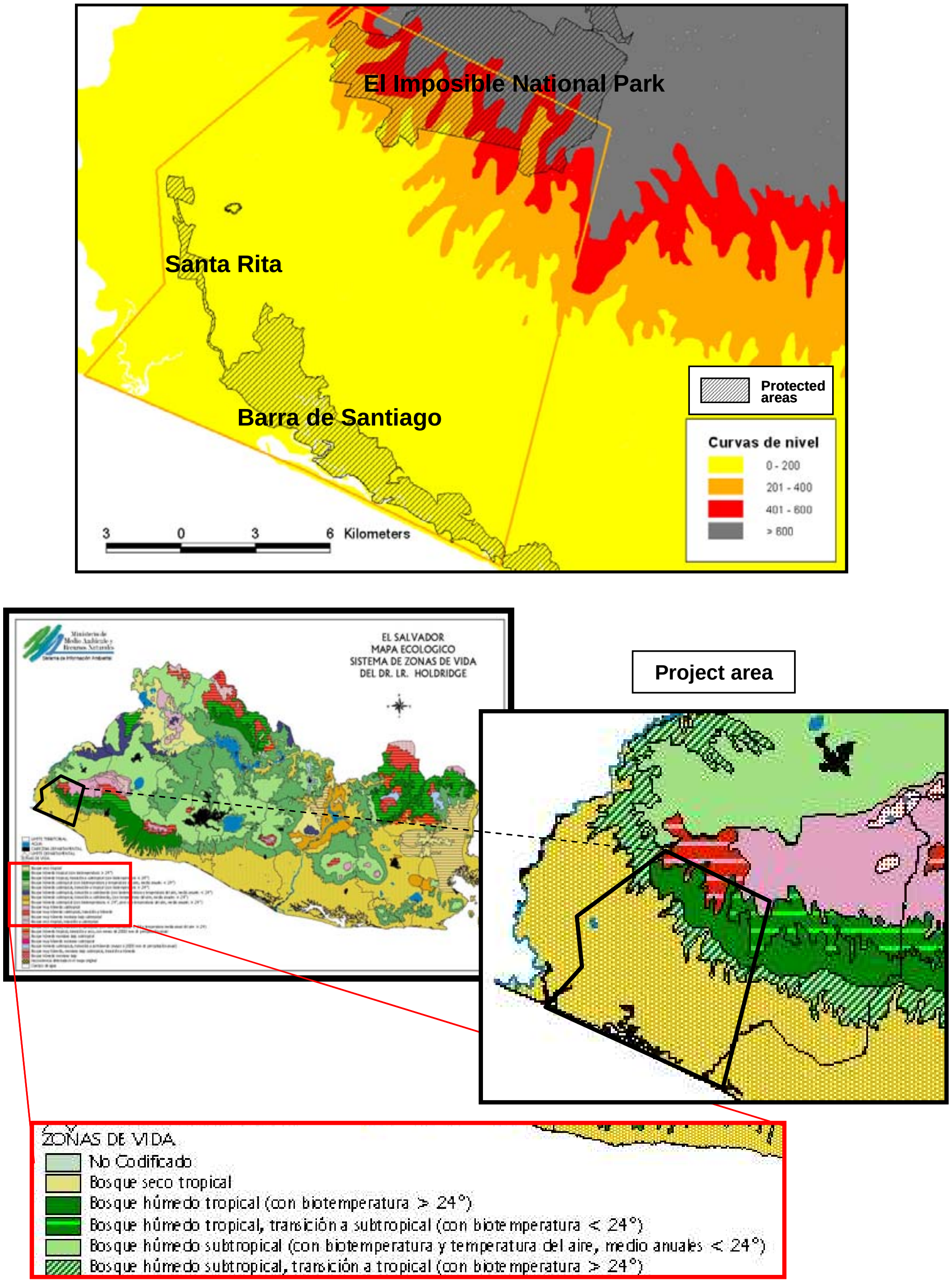


Figure 4-6. **A.** Elevation range in project area (orange polygon). Scarlet Macaws are generally reported to occur from sea level to approximately 400-600 m. **B.** Map of natural vegetation of El Salvador (*from* Centeno et al. 2000) and enlarged section showing the project area.

monitored for reproductive phenology and fruit abundance in the project area. A total of 95 tree and palm species in 29 families was summarized from the Central American literature; dominant families were Anacardiaceae, Apocynaceae, Bombacaceae, Fabaceae, Moraceae, Palmae, and Sapotaceae. Some species are non-native or exotic, including species common to the project area, such as beach almond (*Terminalia catalpa*).

- Contracted Salvadoran botanist, M.Sc. José Linares, in February for initial surveys of different forest types throughout the project area, identification of tree species occurring in the project area that may provide food resources for macaws, and training the field team in identification of these species. 'Potential food resources' include tree and palm species occurring in the project area that match or are similar to documented species, i.e. same genus or family of species on the list of known food species. We identified 76 species in the project area as potential food resources for macaws (Appendix 4-C). Fig. 4-7 provides a few photos to illustrate forest and other land cover types in the project area.

- Divided the project area into 3 elevation zones (0-200 m, 200-400 m, and 400-600 m) and established 4-6 sampling sites in forested lands in each zone (Fig. 4-8A). Obtaining permission to establish sampling sites on private land (outside the protected areas) has been problematic. SalvaNATURA is often equated with the Ministry of the Environment (MARN) and is sometimes viewed with suspicion, especially with respect to land rights and enforcement of illegal activities.

- Marked approximately 5 individuals at each site of any target species that occur at the site, not to exceed approximately 120 marked individuals in order to be able to complete sampling of 1-2 sites in one day. For sampling species that occur on private lands and/or close to community centers (e.g. beach almond, *Terminalia catalpa*), we have instituted an alternative to sampling in discrete sites. We sample trees along public access routes using only a GPS to locate individuals, thereby eliminating the obvious identification number painted on the tree and the need for landowner permission.

Monitoring began in April 2008 of over 2000 individually-marked trees in 21 sites which we observe monthly to document timing of fruiting and abundance of fruit. The variables collected for each marked tree are (1) state of leaves, (2) presence of flowers, (3) number of fruits (classified into numerical-range categories), and (4) percent categories of the fruit crop present relative to maximum expected fruit crop for the given species (Appendix 4-D). We will use these data, interpreted with reference to tree species composition, density, and size distribution, as well as extent of forest, to estimate potential food resources for Scarlet Macaws throughout the region and throughout the annual cycle (Fig. 4-8B).

These data will then need to be assessed in terms of carrying capacity for a target population size considered to be viable over the long-term in order to reach a conclusion about habitat sufficiency for the reintroduction. It is suggested that a "Population and Habitat Viability Analysis will aid in identifying significant environmental and population variables and assessing their potential interactions, which would guide long-term population management" (IUCN/SSC 1995). A PVA for Scarlet Macaws was done as part of the workshop (Chapter 7, *PVA & Vortex Modeling*). A relative sense of carrying capacity for Scarlet Macaws can be made by a comparison of environmental and habitat characteristics between the project area and sites with Scarlet Macaw populations in Costa Rica and Nicaragua. The analysis indicates that the project area is within the general range of habitat conditions and size of the other sites (Appendix 4-E; Brightsmith et al. 2005, Myers and Vaughn 2004).

4.2.3 Reintroduction Protocols and Strategy

Development of our strategy and protocols includes review of relevant reintroduction literature and learning from other parrot/macaw reintroduction attempts and experts. In December 2007, Janice Boyd, Gabriela Ponce, and Robin Bjork were provided an up-close look at the Puerto Rican Parrot (*Amazona vittata*) Recovery Program (White et al. 2005). It is collaboration among the U.S. Fish and Wildlife Service, U.S. Forest Service, the Puerto Rico Department of Natural and Environmental Resources, and the U.S. Geological Survey. Dr. Thomas White (FWS Program Director) and the staff at both the Río Abajo and the El Yunque facilities detailed their protocols and experiences from 40 years of building a program which has attained huge success and has a wealth of knowledge to impart (Fig. 4-9). In April 2008, the workshop in Guatemala (this Proceedings) was held to unite a multi-disciplinary team of experts in the fields of psittacine' health, genetics, ecology, and population modeling, and develop protocols and obtain consensus on optimal strategies for restocking of Scarlet Macaws into the wild. To build capacity for our project in El Salvador, we sponsored two Salvadoran veterinarians to attend the workshop: Dr. Paola Tinetti, an avian veterinarian for the National Zoo and Dr. Ameríco Reyna, a private veterinarian and ecotourism businessman. Both of these professionals have expressed interest in participating in the reintroduction project.

Ms. Kari Schmidt presented preliminary results of her range-wide phylogenetic analysis of Scarlet Macaws (see appendix in this proceedings on Scarlet Macaw genetics study). Her results align well with Weidenfeld (1994) who described 2 subspecies of Scarlet Macaws based on morphometric data: the northern Central American subspecies, *Ara macao cyanoptera* and the southern Central American/South American subspecies, *A. m. macao*. Samples from central and southern Pacific Nicaraguan birds cluster more closely with the southern subspecies than the northern subspecies. Museum samples from macaws collected in El Salvador and coastal Honduras and Guatemala are pending analysis. Additional samples could be obtained from captive macaws on the Cosigüina Peninsula, Nicaragua. Based on regional topography, macaws once existing in El Salvador may be more closely related to *A. m. macao* than to *A.m. cyanoptera* (Schmidt, pers. comm.). Upon completion of Schmidt's analysis, we will be better informed about genetic stock to target with the goal of releasing macaws that most genetically resemble the population that once existed in El Salvador.

4.2.4 Yellow-Naped Parrot Population Evaluation

The Yellow-naped Parrot, *Amazona auropalliata*, is the largest (~400 g) of six extant psittacines in the project area; the others are Pacific Parakeet, *Aratinga nana*; Orange-fronted Parakeet, *Aratinga canicularis*; Red-throated Parakeet, *Aratinga rubritorquis*; Orange-chinned Parakeet, *Brotegaris jugularis*; White-fronted Parrot, *Amazona albifrons*. The Yellow-naped Parrot

Row 1

Row 2

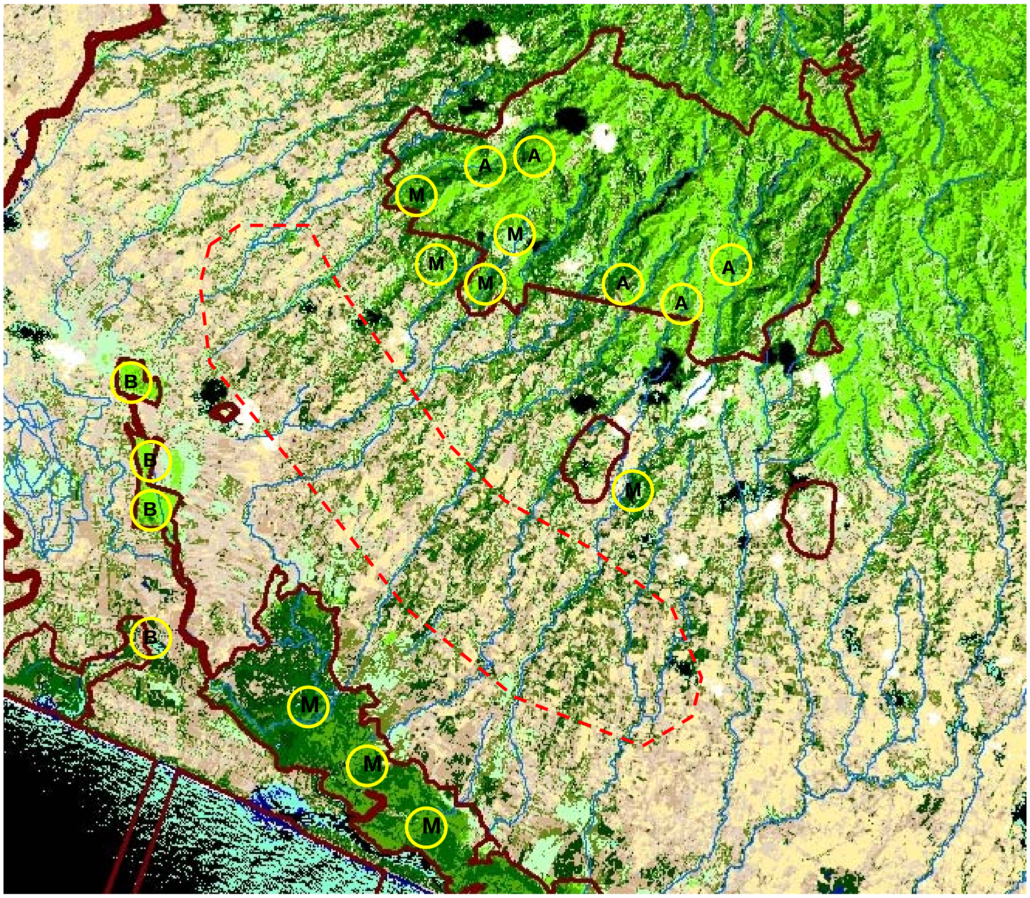
Row 3

Row 4

Row 5

Figure 4-7. Habitat in project area. **Row 1**: View of intact primary forest from overlook in El Imposible National Park & of the corridor from El Imposible to the coast; **Row 2**: Degraded forest patches, corn fields, and pasture in mid-corridor, **Row 3**: Remnant seasonally-inundated primary forest of Santa Rita Protected Area; **Row 4**: Mangroves of Barra de Santiago Protected Area; **Row 5**: Sugar cane, cattle pasture, and other agriculture surrounds the lower elevation protected areas.

A.



B.

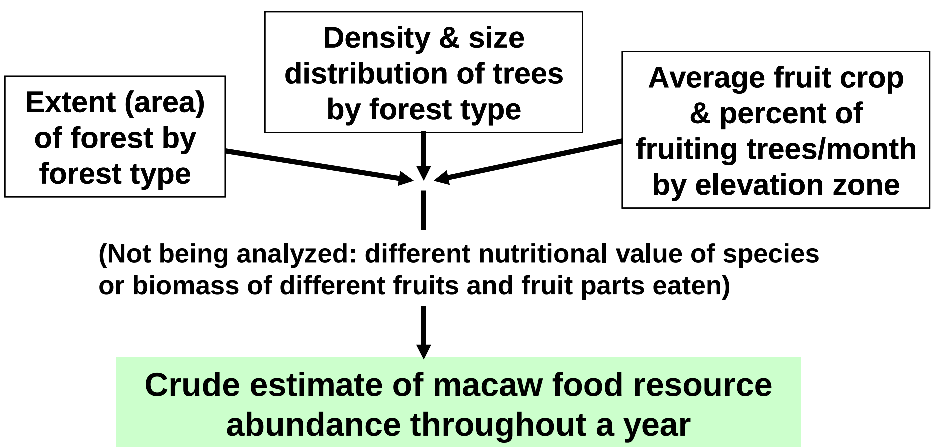


Figure 4-8. **A.** Distribution of sampling sites in different elevation zones of the project area, A= “alto” or high (400-600 m), M= “medio” or mid (200-400 m), and B= “bajo” or low (0-200 m). We have had difficulty locating sites outside protected areas in the mid to low elevation zone (red dashed line) because much of the forest exists in degraded forest patches and under private landowners who are unwilling to grant permission to work on their land.
B. Schematic of data needed to estimate macaw food resource abundance.

Figure 4-9. Visit to the Puerto Rican Recovery Program. From LEFT to RIGHT, TOP: Tom White and Robin Bjork stand at new flight cage at El Yunque; Jafet Velez-Valentin (Aviary Operations Coordinator) describes health issues in their well-equipped lab at El Yunque. CENTER: Ivan Roman Ricardo (Coordinator of Releases, Río Abajo) and Gabriela Ponce stand at the pre-release cage holding 22 Puerto Rican Parrots; Ricardo Valentin discusses diet and food storage to Janice Boyd at Río Abajo. BOTTOM: Ricardo, Janice, and Gabriela inspect breeding cages at Río Abajo; breeding cages at El Yunque are situated in forest with visual separation between them.

(YNPA) is listed in CITES, Appendix I (CITES 2002 a, b) and is being considered for inclusion on the IUCN Red List as "Vulnerable" (Snyder et al. 2000). It exists in very low numbers on the Pacific slope in Central America, critical in Mexico, low numbers in southern Guatemala in disturbed cane and cattle pastures, and reduced numbers in Salvador and Honduras (Snyder et al. 2000). Negative impacts of reintroduction could contribute to extirpation of this rare species, a concern voiced by the Ministry of the Environment at the initiation of the project. Conversely, given our plan to include education and conservation themes on Yellow-naped Parrot in our outreach/education component, we expect that the reintroduction would have a significant positive benefit for the population's long-term persistence.

We chose the Yellow-naped Parrot as an element of biodiversity in the project area to be among the most likely to exhibit effects—both positively and negatively—from the reintroduction of Scarlet Macaws. The YNPA inhabits mangroves and lowland forest patches in the project area, and we believe it has the high likelihood for resource overlap—and potentially competition—with Scarlet Macaws, especially for food resources. There is broad overlap of food species between YNPA and Scarlet Macaws; over 50% of the tree species on our list of potential food resources for Scarlet Macaws are documented food items of YNPA in the project area (Herrera and Herrera 2008). The birds nest in cavities of large old mangrove trees which have been heavily logged out, and the population is thought to be reproductively limited by insufficient nes–limited (Herrera and Herrera 2008). Beginning in December 2008, we will initiate research on the population (population size, diet, habitat use), erect artificial nests and monitor reproductive activities in natural and artificial nests, and include the species in our education outreach. If birds are captured for a telemetry study (pending), we plan to conduct health evaluations. From what we know about the needs of Scarlet Macaws and what we learn about those of YNPA, we can assess potential impacts of the reintroduction and monitor for predicted impacts if the reintroduction proceeds.

4.2.5 Site Determination

We will identify potential locations for reintroduction facilities considering availability of macaw food resources and forest connectivity throughout the corridor, security issues, land tenure and availability, human density, and educational opportunities. From this evaluation, a site-specific strategy will be defined. More than one site-strategy may be possible (Chapter 10, *Release, reintroduction, population management*), e.g. a remote *in-situ* pre-release facility with young, well-socialized birds and minimal human presence and a park/education facility with semi-tame park birds (older, captive-kept adults) encouraged to remain in the vicinity, even nest, and which require long-term maintenance.

4.2.6 Environmental Education

Critical to the success of this project is the securing of local community support and participation in the project. Public outreach and grade school education is the primary means by which we will approach this task. An effective program must address underlying problems that led to the extirpation of the species, namely poaching and habitat degradation. Poaching is likely the current overriding threat to the continued existence of the Yellow-naped Parrot population. Clearly, poaching is also a threat to reintroduced macaws; even if released within the boundaries of a protected area, birds will easily range outside these boundaries and come into contact with humans. We see a need for a holistic education outreach program that works to influence attitudes toward conservation of psittacines. Included will be education on national laws with respect to poaching and habitat alteration, however effective law enforcement is a necessary element of success on this front. Given the inadequate state of Salvadoran law enforcement on crimes involving wildlife, we plan to encourage and support stronger enforcement and consider including a component for education of law enforcement staff.

There are various ongoing environmental education (EE) initiatives in the project area (Fig. 4-10), and we believe that collaborating with and supporting existing efforts, both facilitates our agenda and benefits the communities. We organized a workshop to unite key actors in EE from the local community, protected areas, and government to (1) present the objectives and status of our reintroduction project, (2) facilitate communication among practioners, (3) gain a better understanding of the state and needs of EE in the urban and rural zones in the region, and (4) develop a proposal for an integrated EE program. The workshop, "*Taller de consulta previo a la elaboración del programa de educación ambiental en el Corredor Biológico El Imposible-Barra de Santiago, El Salvador*" was held in San Salvador on 10 April 2008 (Fig. 4-11). The highly-

Figure 4-10. Environmental education programs in project area. TOP: Santa Rita educators are also park guards who give presentations in the schools surrounding the protected area and bring kids to the park. They also have a reforestation program in the corridor which separates their 2 small protected forests. BOTTOM: The NGO, AMBAS, co-manages Barra de Santiago with the Ministry of the Environment (MARN) and recently constructed a new community education center; SalvaNATURA has an active education program in El Imposible National Park.

participatory format of the workshop was defined and facilitated by Lic. Marta Lilian Quezada, Specialist in Environmental Education and Communication, who is currently directing the USAID/SalvaNATURA EE program in the region. A report summarizing the results of the workshop was produced. Public dissemination of information in the project area, specifically on the reintroduction project, is planned for Winter 2008.

Figure 4-11. We organized a workshop in April 2008 to unite key actors involved in environmental education in the project area, including members of local community organizations, protected areas, and other professionals. LEFT: Round-table discussions in subgroups addressed topics such as local perceptions about biodiversity and knowledge of laws; a representative from each subgroup then presented a summary of their discussions to the full group. Dr. Oliver Komar, Director of SalvaNATURA's Conservation Science Department, is in the red shirt. MIDDLE: Another activity involved a prioritization of threats to biodiversity by first compiling a list of threats, followed by marking of the 3 highest priority threats (with green and red dots) by each participant. RIGHT: A report summarizing the results of the workshop was produced and distributed to all participants by email or hand-delivery of hard copies to those without internet access; the extra effort made (hand-delivery) to insure that all participants received a copy of the results was greatly appreciated and is an important aspect of communication and education to consider.

4.3 Next Phase

The next phase of the project will involve defining a reintroduction strategy or strategies for El Salvador based on our habitat evaluation and the availability of birds. Acceptability of likely sources of birds for reintroduction relative to health, genetics, and personal histories will be evaluated, and optimal strategies and costs will be outlined, including 1) age/gender of birds and procedure of reintroduction, 2) infrastructure requirements, 3) staffing requirements, 4) source of birds and means of their procurement from source to our facility, 5) maintenance of captive and released birds (food, security procedures), and 6) monitoring of birds from pre- through post-release (e.g. behavior, bird counts at feeding stations, radio tracking). We will then present our final analysis to the Ministry of the Environment for their approval, followed by identification of source birds and procurement of necessary national and international permits.

ACKNOWLEDGEMENTS

SalvaNATURA gratefully acknowledges Joe and Cornelia Bruderer-Schwab for their generous support of this project, without which the project would not be possible. Excellent field work has been conducted by biologist Xiomara Henríquez and Heriberto Rivera. We acknowledge the invaluable technical support provided by Dr. Janice Boyd. Janice is a wealth of knowledge and passion for reintroduction and conservation of psittacines. We thank Roan Balas McNab for his support of our project and his relentless defense of the Maya Biosphere Reserve (MBR), the most important stronghold for wild Scarlet Macaws in northern Central America.

LITERATURE CITED

Brightsmith, D. 2000. Nest box design and use. Unpublished report.

Brightsmith, D., J. Hilburn, A. del Campo, J. Boyd, M. Frisius, R. Frisius, D. Janik, and F. Guillen. 2005. The use of hand-raised Psittacines for reintroduction: a case study of scarlet macaws (*Ara macao*) in Peru and Costa Rica. Biological Conservation 121: 465-472.

Camacho and S. Martínez. 2006. Caracterización y evaluación de seis sectores de avistamiento de lapa roja (*Ara macao*) en la Reserva Natural Volcán Cosigüina. Undergraduate thesis, Universidad Nacional Autónoma de Nicaragua UNAN, León, Nicaragua.

Centeno, N.E.V., R.F.V. Monzón, P.H.M.Sloot, F.J.D. Olivares, D. Vreugdenhil, D. Graham. 2000. *Mapeao de la vegetación Natural de los Ecosistemas Terrestres y Acuaticos de Centro America*.Banco Mundial, Gobierno de Holanda, CCAD a traves del Ministerio de Medio Ambiente y Recursos Naturales, San Salvador, El Salvador. Sept 2000. 141 Pp.

CITES 2002a. Transfer the Yellow-naped Amazon (Amazona auropalliata) from Appendix II to Appendix I. Proponet: Costa Rica. Ref. CoP 12 Prop. 16. Council of Representatives of CITES Scientific Authorities of Costa Rica, 12th Meeting of the Conference of Parties, Santiago, Chile.

CITES 2002b. Additional information to the proposal 12.16 to transfer the Yellow-naped Amazon (*Amazona auropalliata*) from Appendix II to Appendix I (Costa Rica), Council of Representatives of CITES Scientific Authorities of Costa Rica, 12th Meeting of the Conference of Parties, Santiago, Chile.

Dickey, D.R. and A.J. van Rossem. 1938. The Birds of El Salvador. Field Museum of Natural History, Chicago, IL. Pp. 200-201.

Escalante Arce, Pedro. 1992. Códice Sonsonate. Crónicas Hispánicas, Dirección de Publicaciones -CONCULTURA- Patronato Pro Patrimonio Cultural, San Salvador.

ERDAS. 2003. ERDAS IMAGINE 8.7. Leica Geosystems Geospatial Imaging, Atlanta, GA.

ESRI (Environmental Systems Research Institute). 2005. ArcMap 9.1. Redlands, CA.

Frontier Nicaragua. 2004. Biodiversity Assessment of Volcán Cosiguina Nature Reserve. Muurmans M., A. Farmer, and E. Fanning (Eds.) Frontier Environmental Research Report 1. Society for Environmental Exploration UK, UNAN-León, Fundación LIDER.

Herrera, N. and A.D. Herrera. 2008. Biología reproductive de la lora nuca amarilla (*Amazona auropalliata*) en El Salvador. Mesoamericana.

Howell, S,N.G. and S. Webb. 1995. *A Guide to the Birds of Mexico and Northern Central America*. Oxford.

IUCN. 2001. Periodic review of animal taxa in the Appendices [Resolution Conf. 9.1 (Rev)]. Seventeenth meeting of the Animals Committee, Hanoi (Viet Nam), 30 July-3 August 2001.

IUCN/SSC. 1995. IUCN/SSC Guidelines For Re-Introductions. Prepared by the SSC Re-introduction Specialist Group. Approved by the 41st Meeting of the IUCN Council, Gland Switzerland, May 1995.

Land, H.C. 1970. Birds of Guatemala. International Committee for Bird Preservation, Livingston Publishing Company, Wynnewood, Pennsylvania. Pp123-124.

Matuzak, G.D., M.B. Bezy, and D.J. Brightsmith. 2008. Foraging ecology of parrots in a modified landscape: seasonal trends and introduced species. The Wilson Journal of Ornithology, 120(2): 353-365.

Monroe, B.L, Jr. 1968. A Distributional Survey of the Birds of Honduras. Ornith. Monographs (7):138-139.

Morales, R., O. Molina, and G. Miss. 2001. Uso de habitat y patrones migratorios de la guacamaya roja *Ara macao cyanoptera* en el Parque Nacional Sierra del Lacandón, La Libertad, Petén, 2000-2001. Fundación Defensores de la Naturaleza/CONAP. 83 Pp.

Myers, M.C. and C. Vaughn. 2004. Movement and behavior of scarlet macaws (Ara macao) during the post-fledging dependence period: implications for in situ versus ex situ management. Biol. Cons. 118: 411-420.

Peréz, E.S. 1998. Evaluación del hábitat disponible para la Guacamaya Roja (Ara macao) en Péten, Guatemala. Tesis para grado de licenciado, Universidad de San Carlos de Guatemala, Guatemala, Abril 1998.

Ponce-Santizo, G. 2004. Dispersión de semillas por Mono araña (*Ateles geoffroyi*), Saraguate negro (*Alouatta pigra*) y escarabajos coprófagos en el Parque Nacional Tikal, Guatemala. Tesis de Licenciatura. Universidad del Valle de Guatemala. 107pp.

Renton, K. 2000. Scarlet Macaw. Pp.253-257, In R.P. Reading and B. Miller, Eds. *Endangered Animals: A Reference Guide to Conflicting Issues*. Greenwood Press, Westport, CT.

Renton, K. 2006. Diet of adult and nestling Scarlet Macaws in southwest Belize, Central America. Biotropica 38(2): 280-283.

Snyder, N. McGowan, P. Gilardi, J. and Grajal, A. (Eds.). 2000. *Parrots: Status, Survey, and Conservation Action Plan 2000-2004*. IUCN, Gland, Switzerland and Cambridge, UK.

Thurber, W.A., J.F. Serrano, A. Sermeno, and M. Benitez. 1987. Status of Uncommon and Previously Unreported Birds of El Salvador. Proceedings of the Western Foundation of Vertebrate Zoology: 3: 109-293.

Vaughn, C. 1983. Potential habitat for endangered species in Costa Rica. Universidad Nacional, Heredia, Costa Rica. 49 Pp.

Vaughn, C., N. Nemeth, and L. Marineros. 2003. Ecology and management of natural and artificial Scarlet Macaw (*Ara macao*) nest cavities in Costa Rica. Ornithologia Neotropical 14: 381-396.

Vaughn, C., N. Nemeth, L. Marineros. 2006. Scarlet Macaw, *Ara macao*, (Psittaciformes: Psittacidae) diet in Central Pacific Costa Rica. Rev. Biol. Trop. 54(3): 919-926.

Weidenfeld, D.A. 1994. A new subspecies of Scarlet Macaw and its status and conservation. Ornitologia Neotropical 5:99-104.

White, T.H., J.A. Collazo, and F.J. Vilella. 2005. Survival of captive-reared Puerto Rican Parrots released in the Caribbean National Forest. Condor 107:424-432.

Wiley, J.W., N.F.R. Snyder, and R.S. Gnam. 1992. Reintroduction as a conservation strategy for parrots. *New World Parrots in Crisis: Solutions from Conservation Biology*: 165-200. Beissinger S.R. and Snyder, N.F.R. (Eds). Washington, DC, Smithsonian Institution Press.

Appendix 4-A. Summary of the reintroduction guidelines defined by the International Union for the Conservation of Nature/Species Specialist Commission/Reintroduction Specialist Group (IUCN/SSC 1995).

AIMS AND OBJECTIVES

Aims: The principal aim of reintroduction should be to establish a viable, free-ranging population in the wild, of a species, subspecies or race, which has become globally or locally extinct, or extirpated, in the wild. It should be reintroduced within the species' former natural habitat and range and should require minimal long-term management.

MULTIDISCIPLINARY APPROACH

A reintroduction requires a multidisciplinary approach involving a team of persons drawn from a variety of backgrounds. As well as governmental personnel, they may include persons from governmental natural resource management agencies; non-governmental organizations; funding bodies; universities; veterinarian institutions; zoos, with a full range of suitable expertise. Team leaders should be responsible for coordination between the various bodies and provision should be made for publicity and public education about the project

PRE-PROJECT ACTIVITIES

A. Feasibility study and background research:

- An assessment of the taxonomic status of individuals to be reintroduced. They should preferable be of the same subspecies as those which were extirpated. An investigation of historical information about the loss and fate of individuals from the reintroduction area, as well as molecular genetic studies, should be undertaken in case of doubts as to individuals' taxonomic status.
- Detailed studies should be made of the status and biology of wild populations to determine the species' critical needs. This includes descriptions of habitat preferences, intraspecific variation and adaptations to local ecological conditions, social behavior, group composition, home range size, shelter and food requirements, foraging and feeding behavior, predators and disease. Overall, a firm knowledge of the natural history of the species in question is crucial to the entire reintroduction scheme.

B. Previous Reintroductions

- Thorough research into previous reintroductions of the same or similar species and wide-ranging contacts with persons having relevant expertise should be conducted prior to and while developing reintroduction protocol.

C. Choice of release site and type

- Site should be within the historic range and natural habitat of the species. The reintroduction area should have assured, long-term protection.

D. Evaluation of the reintroduction site

- Availability of suitable habitat: reintroductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the forseeable future. The area should have sufficient carrying capacity to sustain growth of the reintroduced population and support a viable (self-sustaining) population in the long run.
- Identification and elimination, or reduction to a sufficient level, of previous causes of decline. Where the release site has undergone substantial degradation caused by human activity, a habitat restoration program should be initiated before the reintroduction is carried out.

E. Availability of suitable release stock

- If captive or artificially propagated stock is to be used, it must be from a population which as been soundly managed both demographically and genetically, according to the principles of contemporary conservation biology.
- Prospective release stock must be subjected to a thorough veterinary screening process before shipment from original source.

F. Release of captive stock

- Most species of mammal and birds rely heavily on individual experience and learning as juveniles for their survival; they should be given the opportunity to acquire the necessary information to enable survival in the wild, through training in their captive environment; a captive bred individual's probability of survival should approximate that of a wild counterpart.

Appendix 4-A, continued.

SOCIO-ECONOMIC AND LEGAL REQUIREMENTS

- Reintroductions are generally long-term projects that require the commitment of long-term financial and political support.
- Socio-economic studies should be made to assess impacts, costs and benefits of the re-introduction program to local human populations.
- A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long term protection of the re-introduced population, especially if the cause of species' decline was due to human factors (e.g. over-hunting, over-collection, loss or alteration of habitat). The programme should be fully understood, accepted and supported by local communities.
- Where the security of the reintroduced population is at risk from human activities, measures should be taken to minimize these in the reintroduction area. If these measures are inadequate, the reintroduction should be abandoned or alternative release areas sought.
- The policy of the country to reintroductions and to the species concerned should be assessed. This might include checking existing provincial, national and international legislation and regulations, and provision of new measures and required permits as necessary.
- Reintroduction must take place with the full permission and involvement of all relevant government agencies of the recipient or host country.

PLANNING, PREPARATION AND RELEASE STAGES

- Approval of relevant government agencies and land owners, and coordination with national and international conservation organizations.
- Construction of a multidisciplinary team with access to expert technical advice for all phases of the program.
- Identification of short- and long-term success indicators and prediction of programme duration, in context of agreed aims and objectives.
- Securing adequate funding for all program phases.
- Design of pre- and post- release monitoring program so that each reintroduction is a carefully designed experiment, with the capability to test methodology with scientifically collected data.
- Appropriate health and genetic screening of release stock, including stock that is a gift between governments. Health screening of closely related species in the reintroduction area.

Appendix 4-B. Information on known natural food resources of Scarlet Macaws in Guatemala, Belize, and Costa Rica complied from **1**: Peréz 1998, **2**: Renton 2006, **3**: Vaughn et al. 2006, and **4**: Matuzak, unpubl. data. Letters in column 1 refer to additional sources of data and references in Perez 1998, a: Rodas 1997-Guatemala, b: Ramirez 1997-Guatemala, and c: Marineros and Vaughn 1995-Costa Rica).

1	2	3	4	FAMILY	SCIENTIFIC NAME
		X		ACANTHACEAE	*Bravaisia integerrima*
		X	X	ANACARDIACEAE	*Anacardium excelsum*
		X			*Anacardium occidentalis*
			X		*Mangifera indica*
1					*Metopium brownei*
1	X	X	X		*Spondias mombin*
		X	X		*Spondias purpurea*
1					*Spondias spp.*
				ANNONACEAE	*Xylopia frutescens*
1,a				APOCYNACEAE	*Aspidosperma megalocarpon*
a					*Aspidosperma sp.*
		X			*Aspidosperma spuceanum*
1					*Aspidosperma stegomeris*
1,a		X			*Stemmadenia donnell-smithii*
			X	AVICENNIACEAE	*Avicennia germinans*
c		X	X	BIGNONIACEAE	*Tabebuia rosea*
		X		BOMBACACEAE	*Bernoullia flammea*
			X		*Bombacopsis quinata*
			X		*Ceiba aesculifolia*
c		X	X		*Ceiba pentandra*
			X		*Ochroma lagopus*
		X			*Ochroma pyramidale*
		X			*Quararibaea asterolpsis*
		X		BORAGINACEAE	*Cordia collococca*
1,a	X	X	X	BURSERACEAE	*Bursera simarouba*
1,a					*Protium copal*
a				CHRYSOBALANACEAE	*Hirtella americana*
c		X			*Licania platypus*
		X	X	COMBRETACEAE	*Terminalia catappa*
		X			*Terminalia oblonga*
	X			EUPHORBIACEAE	*Cnidoscolus spp.*
c		X			*Hura crepitans*
c		X			*Sapium jamaicense*
a,b	X				*Sebastiana longicuspis*
a,b				FABACEAE	*Acacia angustissima*
b			X		*Cassia grandis*
			X		*Delonix regia*
1		X	X		*Enterolobium cyclocarpum*
		X			*Erythrina spp.*
		X			*Hymenaea courbaril*
			X		*Inga spp.*
		X	X		*Inga vera*
		X			*Lonchocarpus acuminatus*
			X		*Lysiloma divaricatum*
		X			*Pithecellobium saman*
			X		*Pseudosamanea guachapele*
			X		*Samanea saman*

Appendix 4-B, continued.

1	5	6	7	FAMILY	SCIENTIFIC NAME
c	X	X	X	FABACEAE	*Schizolobium parahybum*
			X		*Tamarindus indica*
a				LAURACEAE	*Ocotea spp.*
			X	LYTHRACEAE	*Lagerstroemia speciosa*
	X			MARCGRAVIACEAE	*Schwartzia spp.*
1		X	X	MELIACEAE	*Cedrella odorata*
		X			*Guarea glabra*
1,a		X		MORACEAE	*Brosium alicastrum*
		X			*Brosium utile*
1,a					*Castilla elastica*
	X				*Cecropia obtusifolia*
		X			*Clarisia biflora*
a					*Coussapoa oligocephala*
		X			*Ficus insipida*
1,a,b		X	X		*Ficus spp.*
	X				*Pourouma bicolour*
		X			*Pseudolmedia oyyphyllaria*
1,a					*Pseudolmedia spuria*
		X		MYRISTICACEAE	*Virola sebifera*
1,a				MYRTACEAE	*Pimenta dioica*
			X		*Psidium guajava*
			X	PALMAE	*Cocos nucifera*
			X		*Elaeis guineesis*
1	X				*Orbignya cohune*
b					*Scheelea lundelli*
		X	X		*Scheelea rostrata*
1,a				POLYGONACEAE	*Coccoloba spp.*
a				RUBIACEAE	*Guettarda combsii*
1					*Sickingia salvadorensis*
1				SAPINDACEAE	*Blomia prisca*
1					*Talisia olivaeformis*
1,a				SAPOTACEAE	*Manilkara sapota*
1,a					*Pouteria amygdalina*
1,a					*Pouteria campechiana*
1,a					*Pouteria durlandii*
1					*Pouteria mammosa*
1					*Pouteria reticulata*
		X			*Pouteria spp.*
	X				*Sloanea tuerckheimii*
a				SIMAROUBACEAE	*Simarouba glaca*
	X			STERCULIACEAE	*Butnerria cf. catalpifolia*
	X		X		*Guazuma ulmifolia*
		X	X		*Sterculia apetala*
			X	TILIACEAE	*Luehea seemannii*
		X		VERBANACEAE	*Gmelina arborea*
		X	X		*Tectona grandis*
		X			*Vitex cooperi*
a,b					*Vitex gaumeri*

Appendix 4-C. List of tree species sampled for phenology and fruit abundance in the project area. The list was developed based on lists of known natural fruit resources of Scarlet Macaws (Appendix 4-A); tree species that occur in the project area which share characteristics with known food species (same family and similar fruit characteristics) were included in the list. There are a total of 78 species considered as potential food resources for macaws in the project area. The list also includes known food resources of spider monkeys, *Ateles geoffroyi* (Ponce-Santizo 2004).

(yellow)	species in project area that is the same species documented as food resource in published reports
(cyan)	species in project area that is within genus of species documented as food resource in published reports
(green)	common species in the project area that is within a family used by macaws/parrots as food resource

FAMILY	SCIENTIFIC NAME	COMMON NAME
ANACARDIACEAE	*Anacardium occidentalis* L.	Marañon
	Mangifera indica	Mango
	Spondias mombin L.	Jocote de pava
	Spondias radlkoferi Donn. Sm.	Jocote jobo
APOCYNACEAE	*Aspidosperma megalocarpon* Müll. Arg.	Mojella de pato
	Plumeria rubra var. acutifolia (Poir.) L.H. Bailey	Flor blanca, mayo
	Stemmadenia donnell-smithii (Rose) Woodson	Cojón de puerco, cojón
BIGNONIACEAE	*Tabebuia chrysantha* (Jacq.) G. Nicholson	Cortez negro
	Tabebuia rosea (Bertol.) A. DC.	Maquilishuat
BOMBACACEAE	*Bernoullia flammea*	
	Ceiba aesculifolia (Kunth) Britten & Baker f.	Ceibillo
	Ceiba pentandra (L.) Gaertn.	Ceiba
	Pseudobombax ellipticum (Kunth) Dugand	Shilo
BORAGINAGEAE	*Cordia alliodora*	Laurel
	Cordia collococca	Manuno
	Cordia dentata	Tiguilote
BURSERACEAE	*Bursera (roja)*	
	Bursera simarouba (L.) Sarg.	Jiote
CHRYSOBALANACEAE	*Hirtella racemosa var. hexandra* (Willd. ex Roem. & Schult.) Prance	Aceitunillo
	Licania arborea	Roble de costa
	Licania platypus	Zunza
	Licania retifolia	Mulo
CLUSIACEAE	*Calophyllum brasiliense var. rekoi* Standl.	Mario, Marillo
COMBRETACEAE	*Laguncularia racemosa*	
	Terminalia catalpa	Almendra
	Terminalia oblonga (Ruiz & Pav.) Steud.	Volador
ELEAEOCARPACEA	*Sloanea terniflora* (Sessé & Moc. ex DC.) Standl.	Terciopelo
EUPHORBIACEAE	*Hura crepitans*	
	Omphalea oleifera Hemsl.	Shirán, tambor blanco
	Sapium macrocarpum	Chilamate
FABACEAE	*Acacia hindsii* Benth.	Ixcanal
	Acacia polyphylla DC.	Zarzo
	Albizia adinocephala	Polvo de queso
	Andira inermis (W. Wright) DC.	Almendro de río

Appendix 4-C, continued.

FAMILY	SCIENTIFIC NAME	COMMON NAME
FABACEAE	*Cassia grandis*	Carao
	Delonix regia (Bojer ex Hook.) Raf.	Arbol de fuego
	Enterolobium cyclocarpum (Jacq.) Griseb.	Conacaste
	Gliricidia sepium (Jacq.) Kunth ex Walp.	Madrecacao
	Hymenaea courbaril	Copinol
	Inga calderonii Standl.	Zapato de mico
	Inga oerstedeana	Pepeto
	Inga punctata Willd.	Caspirol
	Inga sapindiodes	Pepeto
	Inga vera Willd.	Cuje de río
	Lonchocarpus minimiflorus Donn. Sm.	Chaperno negro
	Lonchocarpus phaseolifolius Benth.	Patamula
	Lonchocarpus salvadorensis Pittier	Sangre de chucho
	Lonchocarpus schiedeanus (Schltdl.) Harms	Culebro negro
	Lysiloma divaricatum (Jacq.) J.F. Macbr.	Quebracho
	Pithecellobium dulce (Roxb.) Benth.	Mangollano, guachimol
	Samanea saman (Jacq.) Merr.	Cenicero, carreto, gavilan
	Tamarindus indica	Tamarindo
MELIACEAE	*Cedrela odorata*	Cedro
	Guarea glabra Vahl	
	Swietenia macrophylla King.	Caoba
MORACEAE	*Brosimum alicastrum* Sw.	Ojushte de invierno y verano
	Castilla elastica Sessé ex Cerv.	Palo de hule
	Cecropia obtusifolia Bertol.	Guarumo
	Cecropia peltata L.	Guarumo
	Ficus goldmanii Standl.	Amate
	Ficus insipida Willd.	Amate
	Ficus maxima Mill.	Amate peludo
	Ficus ovalis (Liebm.) Miq.	Amate
	Ficus sp. (Fruto rojo pequeño, hojas como obtusifolia)	Amate
	Ficus sp. (Hojas muy anchas)	Matapalo
PALMAE	*Cocos nucifera*	Coco, Coconut
POLYGONACEAE	*Coccoloba montana* Standl.	Papaturro
SAPOTACEAE	*Pouteria compechiana* (Kunth) Baehni	Guaycume
	Manilkara chicle (Pittier) Gilly	Nispero
	Sideroxylon capiri subsp. tempisque (Pittier) T.D. Penn.	Tempisque
SIMAROUBACEAE	*Simarouba glauca DC.*	Aceituno
STERCULIACEAE	*Guazuma ulmifolia* Lam.	Caulote, tapaculo
	Sterculia apetala (Jacq.) H. Karst.	Castaño
TILIACEAE	*Luehea candida*	Tepecaulote, molinillo
TILIACEAE	*Luehea speciosa*	Tepecaulote
VERBENACEAE	*Avicennia bicolor*	Mangle
	Avicennia germinans	Mangle blanco
	Tectona grandis	Teca, Teak

Appendix 4-D. Data sheet used for reproductive phenology and fruit abundance data.

PROYECTO GUARAS: Estudio de fenologia de arboles en el Corredor El Imposible-Barra de Santiago

Sitio:____

Fecha de censos:________________________________

Hojas
S = sin hojas
T = hojas tiernas
N = hojas normales
V = hojas viejas

Flores
sí
no

Cantidad de la fruta
1-10
11-25
26-50
51-100
101-500
501-1000
1001-5000
5001-10000
>10000

% de la copa
0 = 0
1 = 1-33%
2 = 34-66%
3 = 67-100%

					Porcentaje de la fruta presente por 0.25%						
					% del arbol	**% del arbol**	**% del arbol**				
Codigo	**Especie de arbol**	**DAP**	**Hojas**	**Flor**	**tierna**	**sason**	**madura**	**Cantidad**	**% de la copa**	**En suelo?**	**Notas**

Appendix 4-E. Comparison of environmental and habitat variables between project area in El Salvador and sites in Costa Rica and Nicaragua with reintroduced or extant Scarlet Macaws (data on Costa Rica sites from [1]Brightsmith et al. 2005, [2]Myers and Vaughn 2004 and Nicaraguan site from Frontier Nicaragua 2004). The viability of flocks/populations in Costa Rica and Nicaragua is unknown. Myers and Vaughn (2004) reported that the mangrove reserve "was used by some macaws for nesting and by the majority of the population as a nocturnal roosting site."

ES project area	Area (ha)	Elevation (m)	Rainfall (mm)	Primary Forest Type	Site description
El Imposible	[3]3800	250-1425	3000	tropical dry deciduous	~25% intact forest and 75% matrix of agriculture, cattle pastures, agroforestry, primary and secondary forest, & human habitation
Santa Rita	225	lowland	1700	tropical evergreen	
Barra de Santiago	3100	coastal		mangrove	
Costa Rican sites					
[1]Curu (reintroduced)	1492	sealevel	2000	tropical dry and moist	70% natural forest, 30% human created
[1]Golfito (reintroduced)	[4]ND	sealevel	6000	tropical wet	valley of second growth forest ringed by low mountains of primary forest
[2]Carara (extant)	5500	lowland	2500-3300	tropical dry to humid transition, premontane, & tropical wet	primary and secondary forests, cattle pastures, agriculture, human habitation
Guacalillo Reserve	1100	coastal		mangrove	
Punta Leona Reserve	300	[2]ND		[4]ND	
Nicaraguan site					
Cosigüina (extant)	~13,000	0-870	700-1500	tropical dry & mangrove	primary and second growth forests, cattle pastures, agriculture, human habitation

[1]Brightsmith et al. 2005
[2]Myers and Vaughn 2004
[3]the project area covers ~half of the 3800 ha national park
[4]ND = no information found