**The Scarlet Macaw in Guatemala and El Salvador:
2008 Status and Future Possibilities**

## EXECUTIVE SUMMARY

The following proceedings are the outcome of a workshop held in Guatemala, during March 2008, to define conservation strategies for the northern Central American subspecies of the scarlet macaw (*Ara macao cyanoptera*). Participants from Guatemala, El Salvador, and the United States gathered for five days to evaluate possibilities for improving the plight of scarlet macaws in the lowland Maya Forest area, primarily focusing on the wild population clinging to existence in Guatemala's Maya Biosphere Reserve. Throughout the workshop, however, participants also assisted colleagues from El Salvador to evaluate the best ways to realize Salvadoran aspirations to reintroduce the species, and return the scarlet macaw to their national bird list.

Among the numerous strategies discussed, participants considered the persistence of existing wild macaw habitat to be the foundation of any successful conservation effort. The logic for this is straightforward: without viable habitat, other strategies eventually aimed at *in situ* conservation make little sense. A second point of agreement was that decreasing the frequency of macaw chick poaching across the entire range of Maya Forest macaws is critical for long-term success. Again, participants concurred that the logic of introducing birds without abating the loss of wild born chicks is questionable. But in Guatemala, recent advances in reducing poaching and in stabilizing habitat loss have poised macaw conservation at a new point, one of being able to re-evaluate lessons learned and look for new, safe ways to recover the species. For this reason, a significant part of the workshop focused on evaluating captive management techniques as a tool for ensuring, and possibly expediting, species recovery.

One of the most important questions addressed by workshop participants was "under which conditions should captive management, captive breeding, and *ex situ* strategies play a role in saving wild macaws?" A second, perhaps more intriguing question was "is the release of captive-bred macaws necessary to conserve the Maya Forest macaw population?" These questions were seen in a different light in the case of El Salvador, since conservationists there are also working to conserve the threatened yellow-naped parrot (*Amazona auropalliata*), and because captive breeding and reintroduction techniques constitute the only alternative for re-establishing a Salvadoran population of scarlet macaws.

To begin defining answers, workshop participants were largely informed by three main sources. The first consisted of extensive field data available for the wild population in Guatemala (Chapter 6). The second consisted of a collaborative pool of knowledge from avian health experts and aviculturists, many with extensive experience in macaw breeding and health issues (Chapters 5, 8, and 10). Finally, the third and perhaps most important source was a detailed, albeit imperfect[1] Population Viability Analysis (Chapter 7).

[1] "Imperfect" due to the inevitable need to estimate parameters for which solid data do not exist; for example, it was necessary to estimate, among other variables: the probability of disease outbreaks as a result of introducing captive-bred birds into a wild population; the percentage of successfully breeding females in any year; first year survival in

Inputs from these three key sources, combined with subsequent collaborative analysis and dialogue, helped workshop participants develop a set of comprehensive and ambitious conservation activities relevant to scarlet macaws in the greater Maya Forest. Among some of the more relevant conclusions, we highlight the following:

- **Insuring the persistence of an adequate expanse of viable habitat is essential to maintaining a wild population over the long-term.** As mentioned previously, great advances have occurred in the last 5 years in securing existing habitat and reducing poaching in Guatemala. Nevertheless, two key caveats also emerged as a result of the workshop and other information subsequently made available. The first is that the scarlet macaw subpopulations of Mexico, Belize, and Guatemala appear to be genetically homogeneous. This implies that historically, the populations have been connected, helping to ensure that inbreeding depression does not take its toll on the population. Scientists however, do not know the degree to which the subpopulations of the three countries remain in contact. This question is particularly relevant in terms of the linkage between macaws in Guatemala and those in Belize. As such, the relatively recent improvement in conditions for scarlet macaws in Guatemala probably does not hold true for those in Mexico[2] and Belize. Thus, a conservative approach to the conservation of the species in the lowland Maya Forest suggests an urgent need for improved protection efforts in Mexico and Belize. Second, although threats have receded somewhat in Guatemala, perhaps as much as 25% of the existing Guatemalan population is still subject to high levels of threat – including habitat loss and poaching. What's more, a recent satellite telemetry study of macaw movements in Guatemala indicated that macaws commonly move from "safe" areas into areas where threats remain high – especially after breeding season. Movements of up to 25 kilometers were detected with macaws entering into high threat zones, and apparently utilizing small areas (perhaps feeding on patchy resources) for up to a month. A similar study conducted in the lowland forests of the Peruvian Amazon by Brightsmith et al. (pers. comm.) also indicated that macaws tend to migrate seasonally out of their "home areas" for periods of a month or more. These findings help remind conservationists that while recent improvements in protection have served Guatemalan macaws well, more research should be conducted to better understand the threats on the species within the greater Maya Forest, as well as the dynamics of macaw habitat requirements over time. Finally, new information may eventually lead to the refinement and expansion of protection strategies currently underway in Guatemala, thereby highlighting the importance of continuing with investments in protection strategies as the most important activity for ensuring the persistence of existing populations.
- **Maya Forest macaw populations have decreased dramatically over the last 30 years, and the current population is far below the estimated carrying capacity of the habitat.** Despite the loss of habitat and the caveats previously mentioned, a preliminary and extremely conservative macaw habitat model developed for the lowland Maya Forest indicated that scarlet macaws could likely increase their population by 76% (from 399 to 702), or perhaps

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the wild; and other key parameters. Despite the use of these "best guesses", the PVA was very helpful in evaluating the impact of any particular variable.

[2] Unfortunately, recent information on the state of macaws in Mexico was not available for the workshop.

far more[3] without surpassing their carrying capacity. Given the model's prediction of adequate habitat for more macaws than the number currently existing in the wild, we assume that extremely high levels of chick poaching in the past have taken a big toll on the population. As a result, if poaching can be reduced, a strong potential exists to improve macaw population viability in all three countries and propel a significant increase in the wild population. Workshop participants agreed that a multifaceted strategy should be pursued based on continuing to improve habitat management, and testing interventions designed to increase recruitment into the wild population. One clear need identified was the urgency of linking Guatemalan efforts to conservation practitioners and scientists working in Mexico and Belize.

- **The introduction of captive-bred juveniles to reinforce the existing wild population can have a positive effect on population recovery, and adequate protocols exist for minimizing the threat of introducing exogenous diseases into wild populations.** This statement is based on the key assumption that introduced macaws will eventually interbreed with wild born macaws. The best available estimate of the risk of introducing captive bred macaws indicated that a significant health risk was detected only when a large number (24+) of macaws was introduced each year. Given that the cost of introducing such a large number of macaws would be prohibitive, this possibility was discounted. If the release of captive-bred macaws is tested in the future, it is more likely that "soft releases" or "precision" releases" of smaller numbers will provide the best starting point for evaluating the efficacy of introduction. However, another key question was also considered: "does the cost/benefit ratio of introducing captive-bred juveniles outweigh the ratio of improving management at sites where macaws are currently exposed to threats?" In Guatemala, the response to this question is that the remaining unprotected population resides in areas so plagued by lawlessness that viable protection efforts are not currently feasible. Separate evaluations of the feasibility of improving management should be conducted in Belize and Mexico.
- **Experimentation with the diverse strategies for augmenting the wild population should be tested, compared, and documented to ensure a wider impact in the psittacine conservation community.** The introduction of captive-bred macaws was one of many possible interventions identified that could increase the number of wild ranging macaws. Yet other interventions such as improvements in field research, wild nest management, the management of wild hatched chicks, and the mitigation of natural predation were also considered. Many of these interventions have been tested successfully in other sites, such as Peru, Puerto Rico, and Costa Rica, among others. Participants in the workshop agreed that a diverse set of strategies would likely provide the best results for our shared goal of seeing wild ranging macaws recover as quickly as possible. The proceedings therefore detail a wide range of strategies that may offer positive results for the persistence of the species if the current amount of high quality, existing habitat can remain protected.
- **Social support for scarlet macaw persistence is fundamental if they are to survive into the future.** One final outcome of the workshop was that a broad alliance of actors is now engaged to strengthen macaw conservation in the Maya Forest. A strong potential exists for

[3] The Population Viability Analysis presented in Chapter 7 estimated carrying capacity (K) to be 1200 birds in the tri-national area, probably a more realistic assessment. A lack of adequate natural history information has precluded a more precise estimation of current carrying capacity across the range, but we strongly believe that they are not limited by food resources or the availability of nesting sites.

continuing this alliance, such that diverse strategies advance across Maya Forest sites with information being shared to the benefit of all practitioners. Possibilities include, among other actions, the eventual reintroduction of a "managed population" into El Salvador, improved threat mitigation and monitoring in Belize, Mexico, and Guatemala, and experimentation with nest management and predator mitigation in Guatemala. And yet another possibility is the introduction of captive–bred macaws into the wild. One often overlooked, clear benefit of testing and refining introduction methods in Guatemala was also identified, being the massive social support likely to emerge as the result of such a process. Any effort to introduce captive-bred macaws into Guatemala would imply a collaborative effort between aviaries, government, local communities, NGO's, researchers, and leading donor organizations. A high profile effort of this nature would likely help focus public opinion on the plight of the species, and galvanize resolve to protect macaw habitat for the future. This intangible benefit should not be underestimated when considering the costs and benefits of testing such strategies in the future.

The following summaries of the chapters of these proceedings will help the reader to better understand the contribution of each section to the development of an updated strategy for the conservation of the macaws of the Maya Forest. For more detailed information, we urge the reader to consult the individual chapters of these proceedings. Chapter 1 provides a general introduction to our joint endeavors seen through the lens of the current state of macaw conservation. Chapter 2 consists of the workshop agenda, and Chapter 3 summarizes the specific goals of the workshop. Chapter 4 details the potential for the reintroduction of scarlet macaws in El Salvador, and Chapter 5 recounts information obtained during visits to two Guatemalan aviaries with scarlet macaws, Aviario Mariana and ARCAS. Chapter 6 reviews the state of the scarlet macaw in Guatemala's Maya Biosphere Reserve, and Chapter 7 provides a detailed population viability analysis (PVA) of the extant Maya Forest scarlet macaw population. Chapter 8 addresses best management practices for mitigating the threat of disease in the context of psittacine (re)introduction projects, and Chapter 9 reviews *in situ* management considerations. Chapter 10 provides detailed recommendations on the best management practices during the liberation of captive-bred and fostered macaws. Chapter 11 describes the diverse range of possibilities for macaw-related conservation activities, including research, protection, development of social support, and population enhancement, among other possible activities. Chapter 12 concludes with a set of activities selected by Guatemalan partners that will be implemented during the next two nesting seasons (2009, 2010) as an outcome of this workshop. Finally, the Appendix on recent findings on the genetic characteristics of scarlet macaws in Mexico, Guatemala, and Belize provides important guidelines, highlighting the need to expand activities to include conservation partners in Belize and Mexico.

## CHAPTER SUMMARIES

### Chapter 1: Introduction

**Chapter 2: Workshop Agenda**

**Chapter 3: Workshop Introduction**

Since 2002, the Wildlife Conservation Society has been working to conserve the last remaining population of scarlet macaws (*Ara macao cyanoptera*) in the country of Guatemala. After six years of engagement, WCS is now working to build a broad alliance with local, national, and international institutions to increase the number of wild flying macaws in Guatemala's last safe haven for the species, the Maya Biosphere Reserve (MBR). As part of this ambitious goal, with the help of national and international partners we convened this workshop to evaluate the viability of a pilot program to reinforce[4] scarlet macaw populations in the Maya Biosphere Reserve. We also hope to compare this intervention with other interventions that may contribute to the recovery of the species, and build alliances that permit greater collaborations on all aspects of scarlet macaw conservation in Guatemala.

Workshop objectives included: gathering experts to evaluate and develop a protocol for reinforcing the scarlet macaw population in the Maya Biosphere Reserve; defining a consensus on minimal health criteria for the release of captive-bred juveniles; visiting national aviaries to evaluate their potential for contribution to a captive breeding program; visiting a macaw nesting site; and developing a network of researchers and institutions willing to help strengthen Maya Forest psittacine conservation efforts.

**Chapter 4: Psittacine Conservation in El Salvador**

In 2007, SalvaNATURA began a study to assess the feasibility of reintroduction of Scarlet Macaws (*Ara macao*) to El Salvador, initially funded for three years. The ultimate goal is to establish a wild, self-sustaining population of the Scarlet Macaw. The project area is approximately 300 $km^2$ in the Department of Ahuachapán, southwestern El Salvador—the El Imposible National Park to Barra de Santiago Corridor. Initial objectives are to evaluate if the reintroduction site is within the historic distribution of the species, if there is sufficient habitat to support a macaw population, if the causes of the macaw's extirpation have been identified and addressed, and what may be the potential impacts of the reintroduction on local biodiversity. We will assess macaw stock for reintroduction based on best available phylogenetic data for *A. macao*, and genetics, availability, and quality of stock in existing breeding facilities. We are generally following guidelines of the IUCN Reintroduction Specialist Group to insure well-planned, thorough preliminary evaluations which, with our anticipated support of the project from local communities, will facilitate government authorization and have the best chance of reintroduction success.

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[4] According to the "Guidelines for Re-introductions" of the IUCN/Species Survival Commission's Re-introduction Specialist Group (1998), four strategies for *in-situ* population augmentation exist: *"**1) Re-introduction:** an attempt to establish a species in an area that was once part of its historical range, but from which it has been extirpated or become extinct (Re-establishment is a synonym, but implies that the re-introduction has been successful); **2) Translocation**: deliberate and mediated movement of wild individuals or populations from one part of their range to another; **3) Reinforcement/Supplementation:** addition of individuals to an existing populations of conspecifics; and **4) Conservation/Benign Introductions:** an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area. This is a feasible conservation tool only when there is no remaining area left within a species' historical range".*

As part of an evaluation of the species' historic distribution, we conducted an initial assessment of the status of extant coastal Pacific Scarlet Macaws in Nicaragua and Honduras which are the closest in proximity (~250 km) and habitat to conditions for macaws that once occurred in El Salvador and for which there was little information. In April 2008, we made an expedition to the Cosigüina Peninsula, Nicaragua and Isla Zacate Grande, Honduras which were reported to have a population or flock of free-living Scarlet Macaws. Our field observations confirmed that Scarlet Macaws still exist in the wild in the Cosigüina Volcán Nature Reserve, Nicaragua, and we roughly estimated the population to be 20 to 50 birds. The small population size and reports of ongoing poaching of both chicks and adults suggests that the population's continued existence is extremely threatened. Reintroduction of Scarlet Macaws at Isla Zacate Grande Biological Station, Honduras began in about 1996-97 when an interested private party was given 4 confiscated chicks; a few years later they received and released another 5 macaws (adults and chicks), also confiscations of unknown origin. The released birds are provided daily supplemental food and they also feed on wild fruits. Although the project has not been formally documented, nesting has been observed in artificial nests and natural cavities, and there are now believed to be ~20 free-flying macaws. Some of these birds range outside the reserve to nearby communities and the adjacent island of Amapala. Isla Zacate Grande is only ~35 km (over-water) from the Cosigüina Peninsula, an overland flight distance within documented range for Scarlet Macaws, and therefore contact between the reintroduced Zacate Grande flock and wild Cosigüina birds is within the realm of possibility.

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. In April 2008, monitoring began of over 2000 individually-marked trees in sampling sites in forested lands distributed among 3 elevation zones (0 - 600 m). Tree species were selected based on their potential to serve as food resources for macaws; the marked trees are observed monthly to document timing of fruiting and abundance of fruit. We will use these data, interpreted with respect to tree species' density and extent of forest, to estimate potential food resources for Scarlet Macaws throughout the study area and throughout the annual cycle.

We chose the Yellow-naped Parrot (YNPA; *Amazona auropalliata*) 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 there is high likelihood for resource overlap—and potentially competition—with Scarlet Macaws. 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. 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.

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 challenge. We are working with key players in environmental education from the local community, protected areas, and government to gain a better understanding of the state and needs of environmental education in the rural areas, and determine the best means to strengthen and incorporate themes relevant to psittacine conservation and macaw reintroduction into existing programs.

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. 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. Acceptability of likely sources of birds for reintroduction relative to health, genetics, and personal histories will be evaluated. We will then present our final analysis to the Ministry of the Environment and Natural Resources for their approval, followed by confirmation of a source of birds for reintroduction and procurement of necessary national and international permits.

**Chapter 5: Breeding Aviaries and Genetic Considerations**

One of the conservation interventions being considered for the Maya Forest macaws is captive breeding and release of juveniles to strengthen the wild population (Guatemala) or to reintroduce the species to a country from which it has been extirpated (El Salvador). Two breeding aviaries exist in Guatemala but apparently none exist in El Salvador. The facilities in Guatemala are Aviarios Mariana in the southwestern part of Guatemala near the border with El Salvador and the ARCAS Rescue Center near Flores, in the Department of Petén.

Aviarios Mariana contains 219 scarlet macaws. It was founded in 1983 by Nini de Berger and over the ensuing 25 years has bred a total of 115 F1 and F2 generation birds. No breeding has taken place since 2002, due to lack of space for additional birds. Work by Kari Schmidt of Columbia University indicates most of the birds have the same genetic signatures as wild macaws in the Maya Biosphere Reserve, although some F1 and F2 individuals are descended from a founder imported from Panama. This aviary has the potential to begin breeding again and produce significant numbers of juveniles (6-12 per year) for a release program, although probably only after 3-5 years. Genetically suitable pairs would need to be established.

The ARCAS Wildlife Rescue Center has 54 scarlet macaws, but many are not readily suitable for breeding. Most originate from the Petén region of Guatemala and are likely to be genetically suitable for providing juveniles for release. ARCAS has set up 4 pairs for breeding and have had some success in producing chicks. They plan to set up additional breeding pairs.

With these two aviaries the possibility definitely exists for a long term (e.g., 10 year) captive breeding program. To implement such a program, a number of steps would need to be taken. The birds would need to be tested to verify no serious disease exists. Biosecurity procedures would need to be established to ensure no diseases enter the breeding population. In the case of ARCAS, the macaws in the breeding program would need to be kept isolated from any new psittacines received. Additional genetic analysis by Kari Schmidt would need to be examined so that genetically suitable pairings (both pair members possessing only northern Central American genetic profiles) could be verified or established in the aviaries. A few additional flight cages would need to be constructed to allow flocking and socialization of the juveniles intended for release. While a number of steps need to be taken before using juveniles from one or both aviaries for population augmentation in the Petén, a captive breeding for release program is quite feasible.

**Chapter 6: WCS Guatemala Scarlet Macaw Conservation Program**

The Wildlife Conservation Society's Guatemala Program is focused on the conservation of the eastern Maya Biosphere Reserve (MBR), in the northern half of the Guatemalan Department of Petén. The MBR was established by the Guatemalan government in 1990 and is part of the largest tract of intact tropical forests remaining in Central America, the tri-national *Selva Maya* of Belize, Mexico, and Guatemala. Unfortunately, the reserve faces many threats; in particular, illegal colonization, illegal conversion of land to ranching and agricultural activities (often fueled by money from the illegal drug trade), uncontrolled fire, unsustainable natural resource extraction, looting of archaeological sites, and weak governance.

WCS engagement in scarlet macaw conservation issues began in 2002, when WCS began efforts to monitor nesting success and identify the nesting distribution of the species across the reserve. Since that time, four main threats affect the Guatemalan scarlet macaw population have been identified: habitat destruction, poaching, natural predation, and competition for nesting cavities.

The distribution of active macaw nests is concentrated in the eastern section of the Laguna del Tigre ecosystem, including the national park of the same name, an adjacent Biological Corridor located within the reserve's Multiple Use Zone, and community managed forest concessions. A small nesting subpopulation occurs outside of the extreme southwestern part of the reserve at Pipiles. A total of 29 active nests were reported for the 2008 nesting season in Guatemala, a slight decrease from the 31 nests reported during 2007.

A preliminary model of macaw habitat in the lowland Maya Forest areas of Belize, Guatemala, and Mexico has been developed based on the distribution of known nests, habitat type, and the availability of surface water. The model currently predicts a carrying capacity (K) of 702 macaws in all three countries, and a current population of 399. Per country estimates for the current number of wild macaws is 103 in Belize, 159 in Guatemala, and 137 in Mexico. The model also predicts that the greatest positive impact on the population can be obtained by consolidating protection and management efforts at the site of El Perú in Guatemala, and in the Maya Mountains of Belize.

WCS Guatemala has been monitoring nesting success at 7 sites across northern Guatemala, including El Perú, Peñon de Buena Vista, El Burral, La Corona, AFISAP, La Colorada, and Pipiles. In 2007, 29% of all chicks in wild nests fledged, and in 2008 50% of chicks fledged. The rate of fledging success varies widely among sites where adequate monitoring occurs, ranging from 0-100% in 2008 (Peñon de Buena Vista and AFISAP, respectively). Reasons for this include natural predation by forest falcons, and human impacts at unguarded sites.

**Chapter7: Vortex modeling**

A population viability analysis (PVA) for the northern subspecies of scarlet macaw (*Ara macao cyanoptera*) was conducted in association with a workshop to evaluate the feasibility of augmenting the existing population in Guatemala with captive produced birds. The following report presents the results of 31 scenarios created using Vortex v9.72. The baseline scenario assumes a single population of 354 across Mexico, Guatemala and Belize with an unstable age distribution (biased towards older birds), equal sex ratios, age at first breeding at six years and maximum age of reproduction at 25 years, an average of 30% of breeding age females successfully breeding (across all regions), 76% of successful nests producing one chick, 23% of successful nests producing two chicks, 1% of successful nests producing three chicks, a 1% frequency of a catastrophic disease (one event every 100 years), no inbreeding, no change in carrying capacity (K = 1200) and no supplementation. Modifications of the baseline scenario examined the effects of population size, age structure, metapopulation structure, life history characters, reproductive success, changes in disease risk and carrying capacity, and population augmentation. Further information on scenarios and justification of all values are contained in Chapter 7.

The baseline model suggests that scarlet macaw populations are probably—at best—holding their own and have a probability of extinction of at least 10% within the next 100 years. The current near-zero projected population growth rate is probably largely a result of recent efforts by CONAP (with support from WCS and local partners) that have reduced poaching rates in parts of Guatemala. Prior to 2001 it is likely that the population was experiencing a significant rate of decline. The major factor influencing population growth rates and trajectories is the percentage of females that breed successfully. In a stochastic model that accounts for environmental variation and random events, an average annual success rate of roughly 37% is necessary to maintain a stable population.

Guatemala is believed to have a success rate of 40% under current management activities, but success rates in Mexico are almost certainly lower and rates in Belize are in question. Although genetic data suggest that a single population model is appropriate, we recommend using a three-population model because of the likelihood of a source/sink dynamic between countries with different levels of reproductive success. At present, Guatemala is the only documented source population and movement of birds from Guatemala into sink populations in other areas has the potential to prevent recovery in Guatemala and possibly even deplete it. Because of the relatively small difference between the level of breeding success needed for population stability (37%) and the level of breeding success achieved by protected nests (52%) even moderate levels of poaching could result in population declines. Therefore, acquiring more accurate data on poaching rates—the primary factor reducing breeding success—in Mexico, Belize, and other parts of Guatemala is essential for predicting the future of the local and global populations of this subspecies.

Because of the recent history of severe poaching that has reduced recruitment into the population, it is likely that the current population has an unstable age structure with many older birds. If this is true, then the population could decrease over the next five to ten years. This is a demographic artifact resulting from previous poaching and would occur regardless of current nest protection efforts but any decrease in nest protection efforts would exacerbate this trend. Results suggest that *in situ* management actions that address breeding success should have the greatest conservation impact and further, that at least some level of *in situ* management is necessary for the population to recover. Average levels of breeding success achieved at protected nests in Guatemala (52%) produced sufficiently robust growth rates that other management actions (including other *in situ* actions such as those that attempt to reduce natural sources of mortality or increase the number of fledglings per nest) may not be necessary. Continued data collection on causes of nest failures will help to understand the relative importance of non-anthropogenic factors affecting breeding success.

The primary questions surrounding the issue of *ex situ* management (population augmentation) are: 1) what is the risk, and 2) what is the need. Generally speaking, the risk of disease introduction is probably low and manageable, but it is important to note that the benefits of population augmentation could be negated and population status could worsen if proper biosecurity is not observed during reintroduction. Population augmentation has the potential to minimize a short term population decrease and to increase population size if the current assumptions of an unstable age structure and a population growth rate near zero are valid; if the population is performing significantly better or significantly worse, population augmentation at the level that is suggested as feasible (a maximum of 18 birds per year) would have little impact.

Working with partners in Mexico and Belize to evaluate poaching levels and breeding success in advance of, or in concert with, any attempts at reintroduction, will be important in part because these data are needed for determining the utility of reintroduction, but also because connectivity among populations means that these countries will likely share both the benefits and the risks associated with reintroduction efforts. Finally, it is important to note that population augmentation is strictly a short term solution and does not address the cause of decline nor ultimately prevent it. Introductions in Guatemala could buy additional security for a fragile population, but will have little meaning if released individuals simply disappear into unmanaged sink populations elsewhere.

**Chapter 8: Disease Issues and Testing Recommendations**

Introducing animals from outside into a population always carries with it some risk of introducing disease. Some diseases can be disastrous. Before captive bred scarlet macaws are introduced into Guatemala or El Salvador, they must be verified as uninfected with serious psittacine diseases. An avian virologist and veterinarian from the Schubot Exotic Bird Health Center/US Department of Agriculture and a zoo veterinarian from the Wildlife Conservation Society in New York led a discussion that identified the serious diseases for which testing needs to be performed. In most cases PCR testing must be used and not serology testing. PCR testing must be performed for polyoma, Pacheco's disease (avian herpes), psttacine beak and feather disease (PBFD), and, when available, psittacine dilatation disease (PDD). PCR testing for Chlamydophyla/chlamydia is recommended. Serology testing until negative results are obtained should be considered for Exotic Newcastles's Disease (END), and *Salmonella pullorum* because these diseases may have been transmitted from domestic poultry. Of course, if multiple serology tests are all positive, the bird should be further examined.

**Chapter 9: Scarlet Macaw *In-situ* Management**

On March 12-13, workshop participants visited the Maya Biosphere Reserve scarlet macaw nesting site of El Perú to familiarize themselves with the natural conditions, visit the modest WCS Guatemala facilities, and evaluate the possibilities of promoting a macaw reinforcement project in the area. During the January – August breeding season, WCS field personnel locate nests and monitor scarlet macaw breeding success in the area, and use El Perú as a springboard for monitoring further north at the site of El Burral.

After traveling into the site, WCS personnel provided presentations on their scarlet macaw environmental education program, followed by presentations on nest monitoring, anti-poaching activities, and other field activities. Subsequently, the group discussed ways to increase the number of chicks fledging from wild nests. Dr. Don Brightsmith shared his observations from the Tambopata macaw research project in the Amazonian lowlands of Peru, highlighting the relevance of their efforts to evaluate chick nutrition and growth. Finally, Dr. Darryl Styles detailed important information from the avicultural perspective, focusing on macaw chick growth rates and feeding among other aspects relevant to monitoring and husbandry. The final day, participants visited wild nests and a tower observatory that holds potential for developing a point count system to evaluate macaw population trends over time.

The main product of this section of the workshop consisted of listing possible intervention for increasing the number of chicks successfully fledging from wild nests at the El Perú nesting site. Interventions discussed in more detail within Chapter 9 include: supplemental feeding of chicks; pulling, feeding, and replacing chicks, rearing chicks for replacement at fledging; releasing juveniles at fledging at a wild nest ("precision releases"); double-clutching; fostering chicks; and fostering eggs.

**Chapter 10: Reintroduction, Release, and Population Management**

Presentations were given and discussions held on natural scarlet macaw behaviors and how this knowledge should be used in captive breeding of the species and ensuring proper preparation of young birds for release into the wild. Most psittacines and certainly scarlet macaws are highly social creatures, living in flocks or enlarged family groups outside the breeding season. Sexually immature juveniles live entirely in a flock until they reach reproductive age and select a mate. During the breeding season, sexually mature pairs separate from the flock to reproduce and are territorial and aggressive towards other members of their species until their chicks fledge. After fledging, chicks spend some months with their parents and later join the parental flock or choose a new flock.

This natural cycle should optimally be simulated in captive breeding of adults and socialization of juveniles for either captive breeding or release into the wild. The findings suggest parent rearing of chicks when possible. After fledging or upon being separated from the parents, juveniles should be allowed to socialize and mature in mixed-age flight cages containing well-adjusted older birds and, if available, wild-caught adults. Fledglings are not suitable for release into the wild. The optimum age for releasing scarlet macaws is likely to be 1 to 3 or 4 years of age. Before being released, the release cohort should spend time together in a flocking cage where they learn to feel as part of the flock, since research has shown better survival when released macaws are attached to a flock of conspecifics. Breeding birds are optimally separated into individual breeding flight cages during the breeding season and placed together in adult or mixed-age flight cages during the non-breeding season.

All releases of macaws and probably of most psittacines should be "soft releases" where the individuals are maintained and acclimated to the release area in pre-release cages for a period of time (periods of weeks to months) and are provided supplemental food and water for some period after release. Protocols were outlined for soft releases of flocks of scarlet macaws and for "precision releases" of small numbers of birds in the vicinity of just-fledged juveniles and their parents. Attempts should be made to retrieve any individuals that do not seem to be able to adapt to the wild environment.

Some environments are so human-modified and human-occupied that no truly wild release is possible. In these cases a modified version of the standard soft release protocol is recommended, a so-called "semi-wild" or "managed release." The members of the target species are released via a soft release into a safe site and are encouraged or trained to use the safe region as a home base while being free to range elsewhere in the landscape. The birds are then continuously managed through provision of safe roosting sites, possibly provision of nest boxes with control of human poaching, natural predation, and bee and parasite infestations as needed, and possibly long term provision of food and planting of food plants. Because the existence of truly wild areas without serious deleterious human impact are so rare, many populations of mammals and birds, including macaws and other psittacines, may only continue to persist if they are managed to this objective.

**Chapter 11: Potential Future Scarlet Macaw Program Activities in Guatemala and El Salvador**

Participants prepared detailed lists of potential useful future activities for scarlet macaw conservation in each of the two countries without rejecting activities because of issues of feasibility. The activities were grouped for Guatemala under headings of: Conservation, Monitoring and Applied Research, Natural History Research, Ex-situ Management, and Population Augmentation Projects. For El Salvador the groupings were: Monitoring and Applied Research, Conservation/Education, Ex-situ Management, Reintroduction Strategy, Law Enforcement, Conservation-Based Economic Activities, and Permitting

**Chapter 12: Workshop Accomplishments and Future Directions in Guatemala**

The wide-ranging backgrounds of the participants were summarized, the significant accomplishments of the workshop were described and a multi-year work plan for Guatemala was presented. Because the El Salvador program is so recent, a similar work plan for that project is still being designed.