ORNITOLOGIA NEOTROPICAL 19 (Suppl.): 113–122, 2008

BEHAVIORAL MONITORING OF BLUE-AND-YELLOW MACAWS (*ARA ARARAUNA*) REINTRODUCED TO THE NARIVA SWAMP, TRINIDAD

Bernadette L. Plair[1], Kristine Kuchinski[2], Joseph Ryan[3], Selene Warren[3], Karen Pilgrim[4], David Boodoo[5], Sham Ramsubage[5], Audho Ramadhar[5], Motilal Lal[5], Bhim Rampaul[5], & Natasha Mohammed[6]

[1]Cincinnati Zoo and Botanical Garden, 3400 Vine Street, Cincinnati, Ohio 45220, USA.
E-mail: bernadette.plair@cincinnatizoo.org

[2]Florida Avian Advisors, 4508 26th Street, Gainesville, Florida 32641, USA

[3]Ministry of Agriculture, Land and Marine Resources, #80 Abercromby Street, Port-of-Spain, Trinidad & Tobago, W.I.

[4]171 Century Palm Gardens, D'urban Backlands, Georgetown, Guyana.

[5]Forestry Division, Ministry of Public Utilities and the Environment, Long Circular Road, St. James, Trinidad & Tobago, W.I.

[6]University of the West Indies, Department of Natural Sciences, St. Augustine, Trinidad & Tobago, W.I.

Resumen. – Seguimiento del comportamiento de Guacamayas azules y amarillas (*Ara ararauna*) reintroducidas en el humedal Nariva, Trinidad. – La Guacamaya azul y amarilla (*Ara ararauna*), originalmente nativa de la isla de Trinidad, fue extirpada a comienzos de la década de 1960, principalmente debido al saqueo de nidos para el comercio de mascotas. Entre 1999 y 2004, el Zoológico y Jardín Botánico de Cincinnati, el Ministerio de Ambiente de Trinidad y el Centro para el Rescate de Especies Amenazadas de Trinidad y Tobago (CRESTT) desplazaron aves silvestres de Guyana a Trinidad. Durante el período de aclimatación, previo a la liberación, se monitoreó en una jaula de vuelo la capacidad de vuelo de las primeras 14 aves como el principal criterio para la liberación. Nueve de las 14 aves liberadas (64%) sobrevivieron y produjeron 12 pichones en tres períodos reproductivos. Tres años después, 20 aves adicionales capturadas de estado silvestre fueron importadas y el criterio para su liberación fue expandido. Pobladores locales entrenados realizaron cuidadosas observaciones diarias detallando el comportamiento en cautiverio usando etogramas. En adición a la adecuación para el vuelo, notaron qué aves fueron agresivas o formaron parejas, cuáles estuvieron juntas, y qué renglones alimenticios silvestres consumieron. Hubo un 100% de supervivencia de las primeras 12 aves listas para el vuelo liberadas de este segundo grupo. Las parejas y grupos sociales que fueron reintroducidos permanecieron juntos y exhibieron comportamientos que indican una estructura social saludable. Posteriormente, cinco aves adicionales fueron liberadas y se integraron con miembros de la bandada original, y también tuvieron una supervivencia de 100%. Otros catorce pichones adicionales se produjeron en tres períodos reproductivos. Este estudio sugiere que la liberación de aves en parejas y grupos sociales compatibles podría mejorar sus probabilidades de supervivencia en la naturaleza.

Abstract. – The Blue-and-yellow Macaw (*Ara ararauna*), once native to the island of Trinidad, was extirpated in the early 1960's, primarily due to nest poaching for the pet trade. Between 1999 and 2004, the Cincinnati Zoo and Botanical Garden, Trinidad's Ministry of Environment and the Centre for the Rescue of Endangered Species of Trinidad and Tobago (CRESTT) translocated wild-caught birds from Guyana to Trinidad. During acclimation in a pre-release flight cage, the flight-readiness of the first 14 birds was monitored as the main criterion for release. Nine of the 14 birds released (64%) survived and produced 12 chicks in three nesting seasons. Three years later 20 additional wild-caught birds were imported and the criterion for their release was expanded. Trained villagers spent time each day carefully detailing the behavior of the macaws using an ethogram. In addition to flight-readiness, they noted which birds were aggressive or formed bonded pairs, which other birds stayed together and what native foods they ate. There was 100% survival of the first 12 flight-ready birds released from the second flock. Bonded pairs and social groups that were released stayed together, and exhibited behaviors indicating healthy social structure. When five additional birds were released, they integrated with members of the original flock, and also had 100% survival. Fourteen additional chicks were produced in three more nesting seasons. This study suggests that releasing birds in pairs and socially compatible groups might enhance their chances of survival in the wild. *Accepted 28 November 2007.*

Key words: Behavior, bonded pairs, social groups, survival, reintroduction, *Ara ararauna*, Blue-and-yellow Macaw, Trinidad.

INTRODUCTION

Reintroduction and supplementation have developed as important conservation techniques for the management of threatened species over the past twenty years (Olney *et al.* 1994, Serena 1994). Parrots are of particular interest in the application of these techniques because trade has built up significant captive populations even as the wild populations decline. Releasing captive-reared individuals to supplement existing populations or to reintroduce new populations has become a key component of many endangered species recovery efforts (Snyder *et al.* 1994, Sanz & Grajal 1998, Brightsmith *et al.* 2005). Since ways to maximize and maintain post-release survival are constantly being evaluated, behavioral monitoring during pre-release acclimation may be another important tool in determining suitable release candidates, and increasing post-release survival and breeding success in the wild.

The Blue-and-yellow Macaw (*Ara ararauna*) is found in eastern Panama, Guyana, western Colombia, western Ecuador and most other areas of the Amazon Basin (Juniper & Parr 1998). Collar (1997) lists the species as apparently extinct in Trinidad and extinct in many areas in Ecuador, Colombia and Brazil. Extirpation of the species in Trinidad was primarily due to nest poaching of the chicks for the pet trade. In 1999, the Cincinnati Zoo & Botanical Garden along with the Trinidad & Tobago's Forestry Division Wildlife Section agreed to initiate a reintroduction project.

Strategies used for the release of wild and captive raised parrots include separating bonded pairs and releasing their mates (Clubb & Clubb 1992, Wille 1992), releasing bonded pairs, releasing small groups of captive-bred birds (Collazo *et al.* 2003, Brightsmith *et al.* 2005, White *et al.* 2005), and hand-rearing and releasing eggs or young taken from wild nests (Nycander *et al.* 1995). Survival and reproductive rates of birds from these releases had varying degrees of success. Although several factors contributed to the overall results of these efforts, the trend suggests that social groupings prior to release may play an important role in the birds' survival and adaptation to their new habitat. This study reports on the survival and reproduction of two groups of Blue-and-yellow Macaws released on the

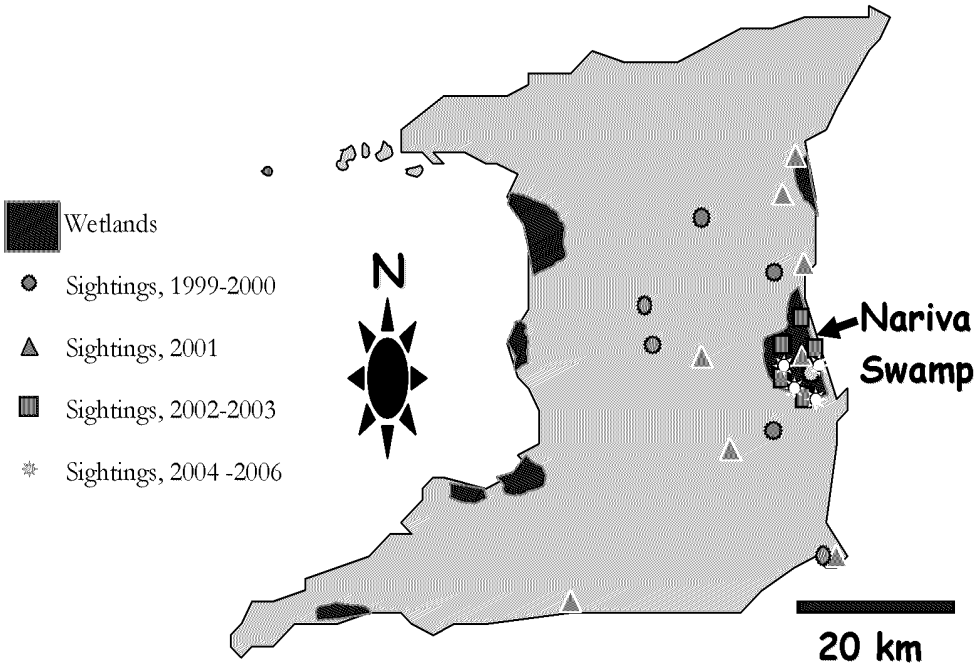

FIG. 1. Sightings of Blue-and-yellow Macaws released on the island of Trinidad. The Nariva swamp on the eastern side of the island is where the birds were released, and this swamp represents the entire historic range of the species on Trinidad.

island of Trinidad. It also analyzes the potential roles of opportunistic and systematic behavioral monitoring of social interactions during pre-release acclimation and its effect on survival, adaptation and breeding success of the birds released in the wild.

METHODS

The 6234 ha Nariva Swamp (10° 23' N 61°04' W; Fig. 1) is a permanent brackish lagoon on the eastern coast of Trinidad with an extensive complex of freshwater swamp forests, permanent herbaceous swamp and mangrove forest, separated from the Atlantic Ocean by two parallel sandbars and a large area of seasonally flooded marshes (elevation 0–10 m a.s.l.). The swamp became a protected wetland under the Ramsar Convention in 1993, and the 1544 ha Bush Bush Wildlife Sanctuary, established in 1968 (Bacon & ffrench 1972), remains a protected area under the Forest Act of Trinidad and Tobago requiring Government permits for visitor entry, fishing and hunting.

The palm swamp forest has an open canopy of royal palms (*Roystonea oleracea*), with a density of 380 trees per ha, up to 26-m tall and over 10 cm in diameter at breast height (dbh). Royal palms comprised 56% of individuals with peak ripe fruit availability from August to November during the rainy season (Bonadie 1998). Moriche palms (*Mauritia sertigera*), with a density of 344 trees per ha, up to 22-m tall and =10 cm in dbh, contributed 43% of individuals with peak ripe fruit availability from September to May. Both palms are a very important source of food and nest-

ing sites for parrots and macaws in the Nariva Swamp (Bonadie & Bacon 2000). Three psittacine species still occupy the Nariva Swamp, the Red-bellied Macaw (*Ara manilata*), the Orange-winged Parrot (*Amazona amazonica*), and the Green-rumped Parrotlets (*Forpus passerinus*) (Bonadie & Bacon 2000).

Aerial and ground surveys conducted in the Nariva Swamp by the first author and Trinidad Forestry officers in 1999 and 2003 determined that there were suitable food sources and potential nesting sites to support a population of Blue-and-yellow Macaws. In October 1999, 18 wild-caught Blue-and-yellow Macaws were legally imported from Guyana to Trinidad. The birds were trapped by licensed dealers in Guyana in August 1999. Laparoscopic sexing was used to identify nine males and nine females between 1 and 4 years of age for reintroduction to Trinidad. Transponder chips inserted into the chest muscles of each bird provided a method of permanent identification while a small band around the right or left leg identified males from females.

Following guidelines established by the Trinidad and Tobago government, the birds were quarantined in Guyana for a period of at least 28 days, under veterinary supervision. They were certified free of endoparasites and ectoparasites prior to importation into Trinidad and tested negative for psittacosis/ornithosis, avian influenza, and Newcastle's disease. To reduce the stress of relocation, the birds were fed a high carbohydrate diet, supplemented with sunflower seeds and vitamins. Upon entry into Trinidad, the birds were further quarantined at the government's Wildlife Section for 21 days.

The macaws to be released were acclimated for 4 weeks from November to December 1999 in a 5.5 m x 7.3 m x 6.4 m pre-release flight cage in the protected Bush Bush Wildlife Sanctuary where they were to be released. During this period, their diet consisted of commercial dog chow supplemented with natural fruits and seeds found in the Nariva Swamp e.g., *M. sertigera*, *R. oleracea*, *Hura crepitans* (Euphorbiaceae), *Sterculia caribaea* (Sterculiaceae), *Spondias mombin* (Anacardiaceae), *Rollinia exsucca* (Annonaceae), *Maximiliana elegans* (Palmae) and *Manilkara bidentata* (Sapotacea). Trained villagers from a nearby community fed and observed the birds for flight capability during the pre-release phase. There was minimal human contact outside of feeding the birds. Three days prior to release, some pair bonding was observed by Cincinnati Zoo personnel but no systematic behavioral data were collected on the birds during the acclimation period.

Government veterinarians performed health assessments on the macaws for overall fitness and birds were selected for release based on the re-growth of their primary feathers and their flight capability. The number of birds released reported by Oehler *et al.* 2001 differs slightly from the account reported here but both refer to the same reintroduction. BLP was present and recorded the data on the birds that were released in December 1999 and January 2000. The macaws were released as follows: four males on 15 December 1999, three males and five females on 13 January 2000, and one male and one female on 15 March 2000. One of five males selected for release on 15 December 1999 did not leave the release site and was returned to the flight cage on the same day. This bird was later released in March 2000. Four of the18 birds did not re-grow their primary feathers and were never released. Supplemental food was made available to the released birds for one week following their release. Trained villagers monitored the survival, flight patterns, feeding and nesting behavior of the released birds 3 to 4 days per week, from January to June each year from 2001 to 2003.

In September 2003, a second group of 20 wild-caught macaws (12 females and 8 males)

sexed via laparoscopy was imported from Guyana. The group consisted of four mature females (> 3 years old), four adolescent females (2 years old), four immature females (1 year old), two mature males, one adolescent male and five immature males. Following the same guidelines established by the Trinidad Government in 1999, the birds were quarantined and tested prior to their importation to Trinidad. Upon entry into Trinidad in September 2003, the birds were transferred directly to the release site in Bush Bush Wildlife Sanctuary and acclimated for 3 months in a large 18.3 m x 8.5 m x 6.1 m pre-release flight cage. Cage dimensions were increased from the original flight cage to provide the birds more space to strengthen their flight muscles and to develop social interactions. The birds were fed diets of natural fruits and seeds from the surrounding area, as well as sunflower seeds and seasonal local beans and fruit. A protein enriched plumage enhancer, Nekton Bio (Nekton Products, Germany), was added to their diet to facilitate re-growth of the cut primary feathers.

Prior to the release of this second group, the social behavior of the birds was documented in contrast to the first group of birds released in 1999-2000. The birds were observed for one hour each morning and afternoon, weather permitting. Specified behaviors were recorded based on instantaneous scans of the whole group of birds every 5 min during each 1-h observation period. Behaviors recorded included self-preening, allo-preening, aggressive pecking at another bird, sitting on a perch alone, sitting on a perch as a pair, sitting on a perch as a group, flying from one end of the cage to the other, flying to another perch, biting the perch, eating sunflower seeds, eating native foods, drinking and vocalizing.

In December 2003, three bonded pairs and a group of three birds including two females and a male were chosen for release. In addition, three individual females that showed no particular affinity to each other but integrated well with the group were selected for release. All showed strong flight capability and had re-grown their primary feathers. Of the remaining eight birds, three had re-grown their primary feathers but these birds displayed aggressive tendencies towards some of the birds chosen for release and they were not released with the group of twelve. Supplemental food was provided for 3 days following the release. The birds were released in December when both *Roystonea* and *Mauritia* palm fruit were available.

Following the December 2003 release, data on the eight birds remaining in captivity were not collected daily. The birds were observed weekly for additional pair bonding, socialization and flight readiness. In June 2004, two male and three female macaws were released. There was no pair bonding or serious aggression among these five birds. Of the three birds not released, one male died due to an infected wing follicle and the remaining pair of birds had poor re-growth of their primary feathers.

RESULTS

There was 50% survival of the four male macaws released in December 1999. For 2 days after the release, the 4 males were observed at the flight cage eating the supplemental food. Up to one week later, vocalizations of the released birds were heard in the area of the flight cage but they did not return to the cage or the supplemental food. Five days later, two males were observed actively foraging in an area 13 to 14 km from the release site. Less than 3 weeks later, two males were spotted in the southwestern region of the Nariva Swamp, about 9 km from the release site. The other two males were not seen or heard anymore.

There was 100% survival of the eight

birds released in January 2000 for at least 4 weeks post-release. Among them were two bonded pairs, one female that was bonded to a non-flighted male and three unpaired birds. Following the release, two pairs of macaws were observed above the forest canopy, flying distances of approximately 10 km within 24 h of the release. For 4 days following the release a female and a male returned to the enclosure for supplemental feeding, and to perch in close proximity to individual birds remaining in the flight cage.

Two weeks after the release, one female macaw found perched outside a private aviary on the southeastern corner of the island, some 26 km away, was captured, kept isolated and released on the day after her return. For one month after the release, sightings of pairs of macaws were reported as far as 27 km north and 24 km northwest of the release site. Frequently, two unpaired macaws were observed feeding on *Mauritia* palm fruit in an area approximately 16 km north of the release site.

In February 2000, villagers in the areas bordering the Swamp were still seeing 10 of the 12 released birds. The deteriorated body of a male macaw identified by its leg band to be one that was released in December 1999 was found on 2 May 2000 by a farmer in a village, 14 km from the release site. Nine out of 14 birds (64%) released between December 1999 and March 2000 continued to be sighted between May 2000 and December 2003. Four birds remained of unknown status.

During the first year, the nine surviving birds explored areas well beyond the boundaries of the Nariva Swamp. Three pairs established a range that encompassed the swamp and areas 27 km north, 24 km northwest, and 20 km west of Nariva. Three macaws flew south near the private aviary and established a range between the southeastern and south-central coasts of the island between 26 and 40 km from the release area. From January to June of 2001, the three pairs of macaws were routinely seen in a flight pattern that terminated in an area dominated by thick *Mauritia* palms, 4 to 5 km from the release site. The three macaws that occupied the southeastern and south-central range in 2000 and 2001 integrated with the three pairs of macaws within the Nariva Swamp in February 2002.

There was 100% survival of the eight female and four male macaws released in December 2003. For 2 to 3days after the release, all 12 birds returned in pairs or groups to the flight cage. Several perched on top of the cage, eating supplemental food and interacting with the eight remaining birds in the flight cage. When supplemental feeding was ceased after 3 days they dispersed, flying distances up to15 km, but returning in pairs or groups to areas around the pre-release cage.

Village monitors from communities around the Nariva Swamp noticed an increase of two or more birds normally observed in their particular range following the December 2003 release. This suggests that the newly released birds were integrating with the established flock. Birds from the first translocation returned with the newly released birds to the release site. A banded female with a juvenile bird (identified by its short tail) was observed perched on a tree close to the pre-release cage about 3 weeks after the December 2003 release. This bird appeared to be the offspring of parents from the first reintroduction. Between January and June 2004, some of the released birds continued to visit and perch on trees above and around the pre-release cage which still housed the eight remaining birds. There were approximately 26 birds in the wild prior to the December 2003 release. With the survival of all 12 birds released in December 2003, the total population increased to 38 birds (Table 1).

The five macaws released in June 2004 also had 100% survival. The three female and

TABLE 1. Survival and reproduction of wild caught Blue-and-yellow Macaws released in the Nariva Swamp, Trinidad.

Year	Number of birds released	Percent surviving	Number surviving male/female	Number of pairs established	Number of young produced	Number of eggs lost	Total population
1999	4	50	2/0	0	0		2
2000	10	70	5/4	2	0		9
2001	0		5/4	3	5		14
2002	0		5/4	4	3	3	17
2003	12	100	9/12	4	4		33
2004	5	100	11/15	7	5		43
2005	0		11/15	7	3	2	46
2006	0		11/15	8	6		52
Total	31	84	11/15	8	26	5	52

two male macaws did not return to the empty pre-release cage on the days following their release. Those birds integrated with the macaws already established in the area. The population in the wild increased to 43 birds. None of the birds from the groups released in December 2003 and June 2004 explored beyond the boundaries of the Nariva Swamp as did the original flocks. In 2006, monitors within the swamp recorded the flight patterns of eight pairs in areas between 8 km and 15 km from the release site. Two pairs were frequently seen within 4 km of the release site. Overall, 84% of the birds released between 1999 and 2004 have survived.

In Trinidad, the Blue-and-yellow Macaws nest during April and May (Forshaw 1989). No nesting was observed following the releases between December 1999 and March 2000. During the 2001 nesting season, three pairs produced five chicks. Nest sites were not located and monitored but, in September 2001, six adults and five young were observed feeding together on fruiting *Cordia alliodora*. Four pairs produced three chicks in 2002 and four in 2003. Three eggs were lost in April 2002 when a nest tree was deliberately cut down by poachers in search of chicks. Nesting success continued with five chicks produced by seven pairs in 2004, and three chicks in 2005. Two eggs were lost presumably to nest predation in 2005 when shells were found at the base of a nest site tree. Eight pairs fledged six chicks in 2006, bringing the total population to 52 birds, consisting of 26 adults and 26 chicks (Table 1).

DISCUSSION

This study shows that Blue-and-yellow Macaws translocated into their historic range can survive and reproduce successfully in the wild. Several factors may have contributed to this success: 1) The use of wild caught birds for translocation (Snyder *et al.* 1994, Wiley *et al.* 1992); 2) Releasing birds within their historical range (Sanz & Grajal 1998); 3) The existing habitat had sufficient food and nesting sites for the birds (IUCN/SSC 1995); 4) Competition for food and nesting sites was apparently low (Griffith *et al.* 1989); and 5) The threat of predation was minimal (Butler 1992).

A key factor in gaining high survival of birds reintroduced to the wild is the establishment of a pioneer group. When the first group of translocated Blue-and-yellow Macaws was released within the Nariva

Swamp, the birds explored up to 40 km beyond their historic range during the first year. The single sexed group of four macaws experienced 50% mortality within one week after release. A mixed group of eight macaws released a month later survived for at least 4 weeks after their release and two months later another pair was released. Nine of the 14 birds (64%) released over the 4 month period are still alive. Birds released from a second translocation 2 years later did not explore beyond the boundaries established by the pioneer group but instead integrated with the wild group. All the released birds from the second translocation are still alive. Birds released after the pioneer group was established had a higher overall rate of survival than birds from the first release.

Social factors apparently play an important role in post-release survival. During the acclimation period, birds form bonded pairs or social groups which influence their behavior when released. One of five males selected for release from the first translocation did not leave the area and was returned to the flight cage. After the second release of two bonded pairs and four individual birds, one male and a female visited the cage for 4 days to be in proximity of birds within the cage. After the second translocation of Blue and Yellow Macaws, three bonded pairs and six individual birds all returned to the fight cage to interact with birds within the enclosure. In contrast, when five additional birds were released in 2004, they did not return to the empty flight cage. Similar results were found for Scarlet Macaws (*Ara macao*) released in Costa Rica. Many of the first released parrots flew away from the release site and never returned. After the core flock was established, released birds that flew off returned and were accompanied by established birds (Brightsmith *et al.* 2005). With Hispanolan Parrots (*Ara tricolor*), the presence of formerly released birds encouraged birds from recent releases to integrate into the flock (Callazo *et al.* 2003).

One way of maintaining social interactions among released birds is providing supplemental feeding. This was a key factor in the success of some reintroductions (Casimir *et al.* 2001, Brightsmith 2005). In this study, supplemental feeding was provided on a limited basis. Observations suggest that birds returned to the cage, not solely for supplemental food, but also if they had previous social contact with the individuals within the cage. In the first releases, birds returned to the flight cage for food up to 4 days after release. When supplemental food was discontinued, they did not return to the cage. During the acclimation of birds from the second translocation, none of the birds already established in the wild visited the pre-release cage. In contrast, the first group of released macaws from the second translocation continued to return to the flight cage where birds were housed even after supplemental feeding was ceased. They were sometimes accompanied by birds from the established flock. After the release of the second group, the birds did not return as there were no macaws in the cage or supplemental food provided.

Blue-and-yellow Macaws have reproduced at a high rate in the Nariva Swamp. The birds nested in hollow *Roystonea* and *Mauritia* palms, as well as in hard wood trees (Plair unpubl.). There was little or no competition for nest sites with the Red-bellied Macaws that also occupy the swamp since nest site criteria differed for each species. In contrast, reproductive success has been minimal for captive raised Scarlet Macaws in Costa Rica but, at Tambopata, Peru, hand-raised macaws reproduced successfully with wild mates (Brightsmith *et al.* 2005). Using wild caught birds for translocation and lack of competition for nest sites may have aided in the high reproductive rate achieved in Trinidad.

Raptor predation has plagued reintroductions of smaller Psittacines like Puerto Rican

(*Amazona vittata*) and Thick-billed Parrots (*Rhynchopsitta pachyrhyncha*) (Snyder *et al.* 1994, USFWS 2002, White *et al.* 2005). Large macaws may avoid high rates of raptor predation due to the fact that there are relatively few avian predators large enough to capture adult macaws and these occur at naturally low densities (Willis & Eisenmann 1979, Terborgh *et al.* 1990, Thiolly 1994, Brightsmith *et al.* 2005). In Trinidad, there are no serious threats from raptor predation and loss of eggs and chicks may be mainly due to poaching by humans. Using trained villagers from communities bordering the Nariva Swamp to monitor and protect the birds and promoting increased public awareness through conservation education has mitigated the effect of nest site poaching of macaws (Butler 1992).

Although early releases of captive-raised parrots had little success in the wild (Snyder *et al.* 1987, Snyder *et al.* 1994, Meyers & Arendt 1996), recent reintroduction efforts of wild and captive-raised parrots were more successful (Sanz & Grajal 1998, Collazo *et al.* 2003). In this study we have found that, in addition to the many other factors that play a role in the success of parrot translocation, systematic monitoring of social interactions during the pre-release acclimation may prove helpful in determining which birds can be released together. Releasing birds in pairs or groups may help them survive, adapt to their new habitat, and reproduce more successfully in the wild.

ACKNOWLEDGMENTS

I am grateful to Donald Brightsmith for the invitation to contribute this paper and for providing me with valuable insights from his work with large macaws in Peru. The Cincinnati Zoo and Botanical Garden provided continued financial support of this project over the past several years. The Forestry Division, Ministry of Public Utilities and the Environment, Trinidad & Tobago and the Centre for the Rescue of Endangered Species of Trinidad and Tobago provided valuable assistance during our work in the Nariva Swamp. We are very grateful to the local villagers who assisted team leaders in monitoring the macaws and collecting field data. We also extend our gratitude to Talisman Petroleum Ltd., BHP Billiton, British Gas of Trinidad & Tobago, The Cleveland Zoological Society and many private donors including bird clubs in the Greater Cincinnati, Miami Valley and Central Indiana area of the USA, for their generous financial support. Emily Martin, Christine Lanser, Donald Brightsmith, Thomas White, and an anonymous reviewer provided helpful comments on the initial draft of this manuscript.

REFERENCES

Bacon, P. R., & R. P. ffrench. 1972. The wildlife sanctuaries of Trinidad & Tobago. Trinidad & Tobago Wildlife Conservation Committee, Ministry of Agriculture, Lands and Fisheries, Port-of-Spain, Trinidad & Tobago, W.I.

Bonadie, W. A., 1998. The ecology of *Roystonea oleracea* palm swamp forest in the Nariva Swamp (Trinidad). Wetlands. 18: 249–255.

Bonadie, W. A., & P. R. Bacon. 1999. The structure and ecology of *Mauritia sertigera* palm swamp forest in Nariva Swamp (Trinidad). Trop. Ecol. 40: 199–206.

Bonadie, W. A., & P. R. Bacon. 2000. Year-round utilization of fragmented palm swamp forest by Red-bellied Macaws *Ara manilata* and Orange-winged Parrots *Amazona amazonica* in the Nariva Swamp (Trinidad). Biol. Conserv. 95: 1–5.

Brightsmith, D. J., J. Hilburn, A. del Campo, J. Boyd, M. Frisius, R. Frisius, D Janik, & F. Guillen. 2005. The use of hand-raised psittacines for reintroduction: a case study of Scarlet Macaws *(Ara macao*) in Peru and Costa Rica. Biol. Conserv. 121: 465–472.

Butler, P. J. 1992. Parrots, pressures, people, and pride. Pp. 25-46 *in* Beissinger, S. R., & N. F.

R.Snyder (eds.). New World parrots in crisis. Smithsonian Institution Press, Washington, D.C.

Casimir, D., S. Fisher, D. Rodda, R. Nichols, A. Morris, & L. Woolaver. 2001. The release of captive-raised Echo Parakeets to the wild, 2000/2001. Unpubli. report. Mauritian Wildlife Foundation, Vacoas, Mauritius.

Clubb, K. J., & S. L. Clubb. 1992. Reintroduction of Military Macaws in Guatemala. Chapter 23 *in* Shubot, R. M., K. J. Clubb, & S. L. Clubb (eds.). Psittacine aviculture: perspectives, techniques and research. Avicultural Breeding and Research Center, Loxahatchee, Florida.

Collar, N.J. 1997. Family Psittacidae. Pp. 280-179 *in* del Hoyo, J., A. Elliot, & J. Sargatal (eds.). Handbook of the birds of the world. Volume 4: Sandgrouse to cuckoos. Lynx Edicions, Barcelona, Spain.

Collazo, J. A., T. H. White, F. J. Vilella, & S. A. Guerrero. 2003. Survival of captive-reared Hispaniolan Parrots released in Parque Nacional del Este, Dominican Republic. Condor 105: 198–207.

Forshaw, J. M. 1989. Parrots of the world. 3rd ed. Landsdowne, Melbourne, Australia.

Griffith, B., J. M. Scott, J. W. Carpenter, & C. Reed. 1989. Translocation as a species conservation tool: status and strategy. Science 245: 477–480.

IUCN/SSC. 1995. Guidelines for re-introductions. IUCN, Gland, Switzerland.

Juniper, T., & M. Parr. 1998. Parrots: A guide to parrots of the world. Yale Univ. Press, New Haven, Connecticut.

Meyers, J. M., W. J. Arendt, & G. D. Lindsey. 1996. Survival of radio-collared nestling Puerto-Rican Parrots: Wilson Bull. 108: 159–163.

Nycander, E., D. H. Blanco, K. M. Holle, A. D. Campo, C. A. Munn, J. I. Moscoso, & D. G. Ricalde. 1995. Manu and Tambopata: Nesting success and techniques for increasing reproduction in wild macaws in southeastern Peru. Pp. 423-443 *in* Abramson J., B. L. Spear, & J. B. Thomsen (eds.). The large macaws: Their care, breeding and conservation. Raintree Publications, Ft Bragg, California.

Oehler, D. A., D. Boodoo, B. Plair, K. Kuchinski, M. Campbell, G. Lutchmedial, S. Ramsubage, E. J. Maruska, & S. Malowski, 2001. Translocation of Blue and Gold Macaw *Ara ararauna* into its historical range on Trinidad. Bird Conserv. Int. 11: 129–141.

Olney, P. J. S, G. M. Mace, & A. T.C., Feistner. 1994. Creative conservation: interactive management of wild and captive animals. Chapman & Hall, London, UK.

Sanz, V., & A. Grajal. 1998. Successful reintroduction of captive-raised Yellow-shouldered Amazon Parrots on Margarita Island, Venezuela. Conserv. Biol. 12: 430–441.

Serena, M. 1994. Reintroduction biology of Australian and New Zealand fauna. Surrey Beatty & Sons, Chipping Norton, Australia.

Snyder, N. F., J. W. Wiley, & C. B. Kepler. 1987. The Parrots of Luquillo: Natural history and conservation of the Puerto Rican Parrot. Western Foundation of Vertebrate Zoology, Los Angeles, California.

Snyder, N., S. Koenig, J. Koschmann, H. Snyder, & T. Johnson. 1994. Thick-billed Parrot releases in Arizona. Condor 96: 845–862.

Terborg, J., S. K. Robinson, T. A. Parker III, D. K. Moskovits. 1996. Structure and organization of an Amazonian forest bird community. Ecol. Monogr. 60: 213–238.

Thiolly, J. M., 1994. Structure, density and rarity in an Amazonian rainforest bird community. J. Trop. Ecol. 10: 449–481.

U.S Fish and Wildlife Service. 2002. Puerto Rican Parrot 2002 update. U.S Fish and Wildlife Service, Atlanta, Georgia.

White, T. H., J. A.Collazo, & 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, & R. S. Gnam, 1992. Reintroduction as a conservation strategy for parrots. Pp.165–200 *in* Beissinger, S. R., & N. F. R. Snyder (eds.). New World parrots in crisis. Smithsonian Institution Press, Washington, D.C.

Wille, C., 1992. Military Macaws in Guatemala. Am. Birds 46: 25–31.

Willis, E. O., E. Eisenmann, 1979. A revised list of the birds of Barro Colorado Island, Panama. Smithsonian Institution Press, Washington, D.C.