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Abstract. Translocation is a useful tool for the conservation of endangered species, because it enables individuals to be moved between wild populations and between captivity and the wild. The use of captive-raised animals in these processes is sometimes the only option to recover a declining population, but captive-raised parrots are commonly seen as the worst candidates for release because they lose their ability to recognize predators, to find food in the wild and to socialize with conspecifics. The Blue-fronted Amazon *Amazona aestiva* is one of the most popular parrot species in captivity. Thirty-one parrots were soft released and monitored during 13 continuous months in a *Cerrado* area (savannah-like vegetation) of Minas Gerais State, southeastern Brazil. Three released parrots (10%) were confirmed to die and five (16%) disappeared soon after release and no behavioral recordings or data about their destinations were available. Ten parrots (32%) showed behaviors that suggest adaptation to the wild and 13 individuals (42%) expressed behaviors more typical of captivity. Difficulties in settling were observed for the parrots after release. One released pair, and one female paired with a wild male, reproduced. There was a tendency to decrease in all captive-related behaviors and to increase in wild-related behaviors since time after release. Supplementary food use diminished as the parrots explored natural food resources. This study indicates that confiscated captive-raised parrots can be good candidates for translocation if a training program could be applied prior to their release to reduce undesirable behaviors and the chance of re-capturing by humans. Furthermore, the use of non-endangered species in conservation programs can be useful to create protocols for the conservation programs of rare and endangered species.

Key words: Behavioral skills, captivity, conservation, Psittacidae, soft-release, reintroduction, translocation, introduction

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INTRODUCTION

Reintroduction, introduction and translocation are tools for the conservation of endangered species' populations (Seddon et al. 2012, Oliveira et al. 2014). These techniques enable individuals to be moved between different wild populations and between captivity and wild populations, resulting in genetic mixing often not possible without human assistance in a modified landscape (translocation) and for individuals to recolonize areas where the species disappeared (reintroduction). However, there are few well documented translocation studies where the methodologies are systematically described, which sometimes makes replication difficult. Furthermore, normally the mistakes made during the post-release process are not described these studies (Griffith et al. 1989, Earnhardt et al. 2014).

The use of captive-raised animals for translocation/introduction/reintroduction programs is commonly discussed, and the major concerns are that these animals can transmit diseases to a wild population, can present high levels of consanguinity (inbreeding depression can be a genetic risk for wildlife populations), and the loss of behavioral skills necessary to survive and reproduce in the wild (Griffith et al. 1989, Beck et al. 1994, Snyder et al. 1996). Therefore, it is necessary to study the process of adaptation to the wild of captive-raised individuals, because they are often the only option for conservation programs of endangered species or species extinct in the wild (Scott & Carpenter 1987, Beck et al. 1994, Clout & Merton 1998).

The Blue-fronted Amazon *Amazona aestiva* is one of the most popular parrot species kept in captivity (Seixas & Mourão 2002). It is among the species most often received by the Wild Animal Triage Centers (CETAS) in Brazil, which are responsible for receiving wild animals seized, rescued, injured or voluntarily handed in by citizens or poachers (Vilela 2012). They usually remain for years in the CETAS, in conditions often less than ideal in terms of maintaining behavioral competency, or are released into nature without any behavioral or health evaluation, and with no post-release monitoring (Marini & Filho 2005, Vilela 2012). This species is found throughout Brazil, eastern Bolivia, northern Argentina and southern Paraguay (Sick 2001), inhabiting distinct habitats, such as forests, savannahs, arid and wet areas (Schunck et al. 2011). Nestlings are poached directly from the nests, which decreases the recruitment of individuals into wild populations, and decreases the number of reproductive sites, since parrots abandon disturbed reproductive sites (Seixas & Mourão 2002). Although not considered endangered, the species was included in the "National Action Plan for the Conservation of Threatened Parrots of the Atlantic Forest" in Brazil, due to the high pressure that it suffers from the trading of wild animals (Schunck et al. 2011). Between the years of 2008 and 2010, 3395 individuals of this parrot were received by the Brazilian CETAS (2145 seized, 279 rescued, 939 voluntarily handed in by citizens or poachers and 32 undefined), which corresponds to 2.37% of the total received birds and 24% of the total received Psittacidae) (Vilela 2012).

In nature, Blue-fronted Amazons are normally found in pairs or in groups of up to 50 individuals (Sick 2001). They spend most of the day perching in trees, foraging and eating fruits (Nunes & Santos Junior 2011). These parrots roost communally at night (Sick 2001). They form monogamous pairs during the breeding season, and the pairs usually stay together for life (Sick 2001). Nests are built in tree hollows and rocky walls (Berkunsky & Reboreda 2009, Berkunsky et al. 2017). In this species homosexual pairs have never been reported in the scientific literature, in nature or in captivity. The most common behaviors exhibited by wild Blue-fronted Amazons are feeding (parrots can hold the food item with one of its feet), vocalizations (especially when they are flying), agonistic social behaviors (shivering the feathers of neck and head, up-and-down the body while hissing towards the other individual, raising the feet towards other individuals), positive social interactions (allo-preening, regurgitating food for other individuals), movement, inactivity, reproductive behaviors, etc. (Sick 2001, Berkunsky et al. 2016, Berkunsky et al. 2016, 2017). In captive populations, abnormal behaviors such as feather pecking, pacing and other stereotypic behaviors can be observed (Andrade & Azevedo 2011). Furthermore, in captivity, these parrots can imitate the human voice, making it an attractive pet species and this is the one of the factors causing its decline in nature (Sick 2001).

Thus, there is an urgent need for research focused on post-release monitoring for these parrots to evaluate how they behave and survive when released back to the wild, highlighting failures in the processes that could be improved upon in future translocation programs. Using non-endangered species as a model species, we can develop and improve protocols that can be used in conservation programs of endangered species.

The goals of the present study were to evaluate techniques of management and monitoring employed in the translocation of a group of captive-raised Blue-fronted Amazons.

METHODS

Study area and selected parrots

The study was conducted in a private farm located in the metropolitan region of Belo Horizonte city, Minas Gerais State (MG), southeastern Brazil. The site and its surroundings presented a mix of *Cerrado* (savannah-like vegetation) and pasture lands, distributed in farms, small urban areas and one State Park. In the release site there is a high rocky wall that wild Blue-fronted Amazons use as a roost site during the night. Release of the parrots was authorized by the Brazilian Institute of Environment and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis — IBAMA) under the license n° 170/2012 with the release site register: IBAMA-ASAS 005/2010.

Thirty-one Blue-fronted Amazon parrots (17 males and 14 females) were selected in the CETAS of Belo Horizonte after general health exams. The parrots' origin (wild caught, captive-raised, etc.) was unknown, but all individuals lived for at least three years in captivity before being released into the wild. All parrots were painted on the chest with a nontoxic Expo® low odor dry-erase blue marker (right side for females and left side for males), received a microchip and two leg bands: an aluminum colored leg band and a stainless steel leg band, with an identification number and the IBAMA's telephone number. Six parrots also received a VHF signal transmitter radio collar, model TXE304CP, Telenax Company® (radio weight: 14.5g – 3% of the parrots' weight). Parrots were marked immediately after they were transferred to the acclimatization aviaries.

Acclimatization aviaries and soft release

After a quarantine period, the parrots were transferred to two acclimatization aviaries located at the release site with 12 m length, 4 m width and 3.5 m height, placed 2 m distant from each other, away from human interferences and surrounded by natural habitat. The aviaries had six fixed perches, placed far from each other and food was positioned far from the cage's wire to encourage birds to fly. Pre-release training was provided to the birds (parrots were trained against predators, i.e. models of predators were associated to an aversive stimulus — persecution with a net — by a classical conditioning technique; for more details, see Azevedo et al. 2017, Lopes et al. 2017). Water was provided *ad libitum* and the food, a mixture of industrialized food for parrots (Megazoo®), sunflower seeds and fruits of the season, was provided every day at 08:00 AM. Occasionally, native fruits and seeds found in the release area were provided. Birds were assessed monthly to evaluate flight, landing, and foraging abilities. Flight ability was evaluated by observing birds flying through the aviary; landing ability was evaluated by observing the birds landing on the perches in the aviary and on the aviary's mesh; foraging ability was evaluated by observing birds feeding, especially on the native fruits. All released parrots were considered fit for release.

After the acclimatization period (10 months), the parrots were released by the soft release technique, which allows animals to leave and return their acclimatization aviary, as desired, once the upper windows of the enclosure were opened (Mitchell et al. 2011). Supplementary food was provided in five artificial feeders distributed 0 to 50 m away from the aviaries during the entire monitoring period and seven artificial nests were distributed in the release site.

Monitoring and data collection

The monitoring was performed by a team of five people who were trained to identify and observe the behavior of the released parrots (six parrots to observe per person). These campaigns began just after opening of the aviaries and were performed for 13 months, totaling 26 campaigns. The first one lasted ten days and the others lasted four days each. The intervals between the three first campaigns were of five days and to the others were fifteen days.

The radio-collared parrots were tracked using a portable VHF signal receiver (model: RX-TLNX of Telenax® company), a manual three-element Yagi directional antenna, a compass (Nautika® Tour 30170) and a GPS (Garmin® Etrex Legend), using the triangulation method (Piovezan & Andriolo 2004). The other parrots were tracked with the support of binoculars (Bushnell H^2O 10 × 42 m) and a camera (Canon 60D with 70–300 mm lens) and they were identified by the artificial markings and the natural markings on their faces. Each researcher had an identification card for each released parrot, with a photograph of their foreheads and all individuals' information.

From the third campaign, data on the behavior of each released parrot found were collected. It was noted if the parrot was alone or in a flock and the dispersal zone where it was found: 0–50m from the release point = yard (Y); 51–100 m = nearby (N); 101–500 m surroundings (S); greater than 500 m = distant (D). Data collection occurred in three different periods: in the two hours after sunrise (5:00–7:00 AM), in the two subsequent hours (7:00–9:00 AM), and in the two hours before the sunset (4:00–6:00 PM). Each bird found had their behavior recorded for 25 minutes in each period, using the focal sampling with instantaneous recording of behavior every minute (Altmann 1974, Martin & Bateson 2007). For example, if an individual was found during the campaign in the three periods, it would have 75 minutes of his behavior recorded. An ethogram for *A. aestiva* (Table 1) was prepared before the release based on Andrade & Azevedo (2011) and in 80 hours of preliminary behavioral observations of captive parrots using the *ad libitum* method (Altmann 1974). We evaluated if natural behaviors, such as social, reproductive and feeding behaviors, especially directed to wild parrots and wild food increased over time, and if captive

Table 1. Ethogram for Blue-fronted Amazons based on Andrade & Azevedo (2011) and on 80 hours of preliminary behavioral observations of captive parrots using the *ad libitum* method (Altmann 1974). Capt. — behaviors most prone to be exhibited in captivity), wild — behaviors most prone to be exhibited in the wild.

Behavior	Type	Description
Active	Capt/Wild	Behaviors: pecking (leg rings, feeders, perches, branches, wires), defecating, alert (neck stretched and eyes wide open, focusing on something).
Inactive	Capt/Wild	Parrot is inactive or sleeping.
Cleaning	Capt/Wild	Behaviors: preening, beak cleaning (parrot rubs its beak on a perch/wire to remove food wastes) or water or dust bath.
Moving	Capt/Wild	Behaviors: walking and climbing the wire/tree.
Flying	Capt/Wild	Parrot is flying.
Natural vocalization	Wild	Parrot emits natural vocalizations, similar to those of the wild parrots.
Human vocalizations	Capt	Parrots emit human vocalizations, like whistles, words, phrases, songs, animals' imitations (barks, mews, etc.).
Captivity vocalization	Capt	Parrots emits grunt, loud vocalizations, different from natural and human vocalizations.
Feeding in nature	Wild	Parrot eats fruits collected from trees.
Feeding in feeders	Capt	Parrot eats fruits from the artificial feeders.
Foraging	Wild	Parrot search for food in the area.
Interaction with parrots from the same group	Capt	Parrot positively interacts with other parrot of the same group (released parrots).
	Capt	Parrot negatively interacts with other parrot of the same group (released parrots).
Interaction with wild parrots	Wild	Parrot positively interacts with wild parrots.
	Wild	Parrot negatively interacts with wild parrots.
Interaction with humans	Capt	Parrot positively interacts with humans (parrot approaches humans, allows humans to touch its body, climbs to the humans' shoulders).
	Capt	Parrot negatively interacts with humans (parrot do not allows humans to approach or to touch its body, tries to beak the humans, and shivers its feathers).
Abnormal behaviors	Capt	Abnormal behaviors: swinging upside down, rotating head, making repetitive movements, and pacing.
Avoiding predators	Wild	Parrot flies away from potential predators or lower his head in the presence of a predator.
Reproduction behaviors	Wild	Behaviors: nest building, nest defense (when a parrot lowers his head and raises its tail to another individual), courtship, and mating.
Parental care	Wild	Behaviors: nesting, interaction with nestlings, feeding nestling and cleaning nestling.
Other behaviors	Capt/Wild	Behaviors not previously described.

behaviors, such as the imitation of the human voice diminished over time. These were the key behaviors in the evaluation of parrots' adaptation to the wild.

The use of the artificial feeders was evaluated by counting the number of parrot visits during the first six months of monitoring. The evaluation was performed twice a day (morning — 7:00 AM and afternoon — 3:00 PM) for one hour in each period, during the four days of the monitoring campaign. Food was always offered before the beginning of the observation sessions of feeder use, both in the morning and in the afternoon. When there was no monitoring campaign, the food was offered only once a day, in the morning (6:45 AM).

Data analysis

For the analysis, a parrot that disappeared was not considered a dead parrot. Parrots were considered dead if the carcasses were found or if evidence of predation were found (feathers, parts of the body, etc.). For the missing parrots, we carried out analysis of their behavior until the last campaign before disappearing and inferences were made about their survival or not.

A generalized least square (GLS) regression was used for parametric data analysis: to evaluate if the number of behaviors expressed and the number of parrots using the feeders changed over time (Donner 1984). Spearman correlation was used for non-parametric data analysis: 1) to evaluate if the number of interactions with humans was related to the time each parrot spent feeding at the feeders; 2) if the expression of captive-related behaviors, such as human vocalization mimicry, captivity vocalization, feeding at feeders, interactions with humans, inactive, and abnormal behaviors, and if the expression of natural behaviors, such as feeding in nature, interacting with wild parrots, foraging and flying changed over time; 3) if the behavior "interacting with parrots of the same group" (other released parrots) changed over time. For this latter analysis, 14 parrots that had their behavior recorded for a longer period (eighth months) were selected. Differences in the use of each dispersion zone were evaluated using the Kruskall-Wallis test, with the Mann-Whitney's test as a *post-hoc* test. The evaluation of the frequency of use of these areas over time was also evaluated using a simple linear regression. All analyses were run using Statistica and Mystat and with a significant level of 95% (α = 0.05) (Zar 1999).

RESULTS

Soft release

The release of the Blue-fronted Amazons took place on June 6, 2013. The first individual left the aviary 1 hour and 20 min after opening of the windows. Many individuals left the enclosure walking on the mesh until the roof and then flew to a nearby tree. Others came to the windows and returned to the enclosure. At the end of the day, six parrots (20%) had left the acclimatization aviaries and explored the surroundings. After ten days, only two parrots had not left the aviaries, but many individuals returned to the aviaries to spend the night inside. Most parrots showed good flight condition, starting with short flights, but soon flew for longer distances, however, all parrots showed difficulty in landing.

Three months after the release, three parrots still spent most of their time inside the aviaries. The team decided to close the windows of the aviaries in this campaign, so these parrots were forced to live outside. Even after the closure, at least seven parrots remained on the top of the enclosure or in trees close to them, always using the aviary's roof at night.

Survival

Three released parrots (10%) were confirmed to have died (Table 2). The first one, a male was depredated 75 days after release, apparently when defending its nest, since its feathers and the radio collar were found near the nest entrance. The second one, a male, was found dead four months after release, probably due to starvation. The third individual, a female, disappeared nine months after release, and only its leg ring was found (a fortuitous encounter near the release aviaries). Five individuals (16%) disappeared soon after release and no behavioral recordings or data about their destinations were available. Ten parrots (32%) showed behaviors that suggested adaptation to the wild, such as feeding primarily on wild foods, avoiding humans, exploring natural nests, dispersing from the release site, and interacting with wild flocks. Of these, only four individuals were monitored until the last monitoring campaign. The other 42% (13 individuals) expressed behaviors more appropriate to the life in captivity, preferring to consume food from the feeders, interacting with humans more than wild parrots, remaining closer to the release aviary and sometimes walking on the ground near the aviary. Of these, seven individuals were monitored until the last monitoring campaign. Three females were captured and spontaneously returned to the translocation project by members of the local community. According to the residents who captured the parrots, they seemed to be hungry and

Table 2. Results of the survival of Blue-fronted Amazons released in an area of *Cerrado* of Minas Gerais, Brazil, after 13 months of monitoring. In total 31 parrots were released into the wild.

Situation	Number of released parrots	Proportion (%)
Confirmed survival	11	35.48
Presented natural behaviors after release	4	12.90
Presented behaviors associated with captivity	7	22.58
Considered missing	17	54.84
Presented natural behaviors after release	6	19.35
Presented behaviors associated with captivity	6	19.35
No data	5	16.12
Confirmed dead by predation	2	6.45
Confirmed dead (not adapting to the wild)	1	3.23

approached them, facilitating the capture. We believe that seven other released parrots have been captured by locals and not returned to the project, because they were tamed and stayed closer to the release point.

Behavior

The number of behaviors typical of wild parrots increased significantly over time (GLS regression: $R^2= 0.773$ $F_{1,48} = 68.314$, $p < 0.0001$) after the parrots' release (Fig. 1).

The expression of four behaviors decreased over time: captivity vocalization ($r = -0.13$, $p < 0.05$), inactive ($r = -0.19$, $p < 0.005$), foraging ($r = -0.17$, $p < 0.05$), and negative interaction with parrots from the same group ($r = -0.14$, $p < 0.03$). The first two behaviors were related to the life in captivity and the two formers were related to the adaptation to the wild.

Some of the other behaviors showed a slight decrease over time (human vocalization, feeding at feeders, positive interaction with humans, positive interaction with parrots from the same group, abnormal behaviors, active and moving) or a slight increase over time (feeding in nature, positive interaction with wild parrots, flying and cleaning), but no statistical changes occurred ($p > 0.05$). The remaining behaviors were not sufficiently expressed to be analyzed.

The dispersion zones most frequented by the parrots were: yard (34.5%), nearby (13.4%), distant (4.8%), and surroundings (1%), and the use of each dispersion zone differed statistically ($H = 43.49$, $p < 0.0001$, df = 3, N = 111; post-hoc tests: yard vs. nearby: $U = 219$, $p < 0.008$; yard vs. surroundings: $U = 40.5$, $p < 0.0001$; yard vs. distant: $U = 101$, $p < 0.0001$; nearby vs. surroundings: $U = 195$, $p < 0.005$; nearby vs. distant: $U = 274.5$, $p < 0.05$; surroundings vs distant: $U = 280.5$, $p < 0.05$) (Fig. 2).

The frequency of use of each zone by the monitored parrots did not change over time (yard: $R^2 = 0.027$, $F_{1,24} = 0.61$, $p = 0.44$; nearby: $R^2 = 0.021$, $F_{1,24} = 0.48$, $p = 0.49$; distant: $R^2= 0.038$, $F_{1,24} = 0.86$, $p = 0.36$). The zone "surroundings" was not sufficiently used to be analyzed. Overall, no data were available for 39% of the parrots, since these birds were not located during the monitoring.

Supplementary food

The number of released parrots using the artificial feeders decreased over time (linear regression: $R^2 = 0.73$; $F_{1,10} = 21.26$; $p = 0.002$, Fig. 3). There was no relationship between the use of the artificial feeders and the number of interactions with humans ($r = -0.17$, $p = 0.37$).

Pair bonding and breeding behavior

Four same-sex pairs (29%; one pair of males; one trio of males; and two pairs of females); and four different-sex pairs (26%) were observed. The other birds formed flocks with native parrots (16%) or remained alone (26%).

One pair (male-female) that formed before the release was seen copulating in the first month after the release and in the third month the pair was seen exploring cracks on the cliffs presented in the area, places normally used by this species to build nests (Sick 2001). In the fourth month, the male was seen flying away with a mixed group of up to five individuals of both released and wild

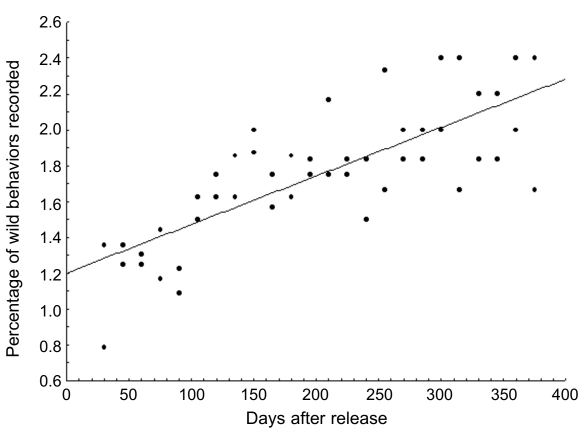

Fig. 1. Number of behaviors normally expressed by wild individuals recorded for the Blue-fronted Amazons over time after release to the wild.

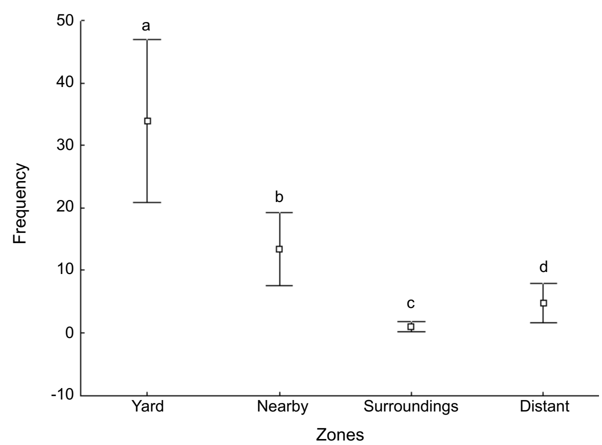

Fig. 2. The frequency of use of the dispersion zones by monitored Blue-fronted Amazons. Dispersal zone measured from the release point: Yard = 0–50 m; Nearby = 51–100 m; Surroundings = 101–500 m; Distant = greater than 500 m. Different superscript letters represent statistical differences between the areas.

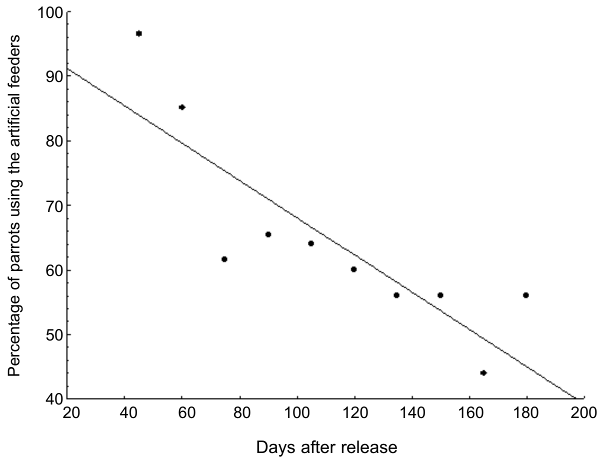

Fig. 3. The use of the supplementary food by the Blue-fronted Amazons over 200 days after release.

parrots, and no observations for this male were made since. After this, the female paired with a wild male, reproduced and was seen feeding a juvenile parrot in February 2016.

Another pair was also formed in the aviary during the acclimatization period. One month after release, the female laid three eggs on an artificial nest, but only one chick hatched. Parental care was provided only by the female, because the male was predated days before the chick hatched. The nestling died 15 days after birth and the cause of death was not determined. After this, the female paired with another female and remained together until the last monitoring campaign.

All same-sex pairs were observed paired during the entire period of the study, except for the male trio. The monitoring team was forced to separate the same-sex trio of males after they began attacking people in the release site; two of the males were captured by the monitoring team and re-released into another farm near the original release point. This pair remained together during the entire monitoring period and the other male, which was not captured, begin to interact with a wild individual.

Monitoring

From the 31 released parrots, seven individuals were monitored during the entire period of the study (13 months), eight were lost (three confirmed dead and five disappeared), and 23 individuals were monitored during the first months after release and then disappeared. From the parrots with VHF radio collars, three were monitored until the last day of the study, one died three months after release, and two individuals disappeared, one in the fourth and one in the sixth month after release. The parrot lost after six months, during two of the six months, was not found by the monitoring team because they could not reach its VHF signal.

DISCUSSION

Soft release, food supplementation and dispersion

The soft release process applied in the present study was considered fundamental for the initial adaptation of the Blue-fronted Amazons to their new habitat, as well as in several other wild animal translocation studies (Teixeira et al. 2007, Mitchell et al. 2011). Even after their release, the acclimatization aviaries were used many times, especially to roost and feed. This result was also observed in other parrot and macaw releases (Seixas & Mourão 2000, Brightsmith et al. 2005, Oliveira et al. 2014).

When kept in CETAS, parrots were unable to fly due to the small size of the aviaries. The large acclimatization aviaries, with spaced perches and without perches accessing the feeders, improved the physical condition and flight abilities of the parrots. However, a difficulty of parrots in landing was observed; in the wild tree branches are flexible, usually swinging due to the wind in a way parrots find difficult to perch. This was also observed in the reintroduction of the Yellow-shouldered Amazon *Amazona barbadensis* in Venezuela (Sanz & Grajal 1998). This problem can be minimized by using non-fixed perches, with varying diameters, inside the acclimatization aviaries, but this technique has not been tested.

Supplementary food provided additional energetic resources for the parrots in the early months after the release, when the birds were most vulnerable to hunger due to the unfamiliarity with the new area and the location of wild food resources. Some researchers believe that supplementary food should be maintained even when there is no more need for nutritional support (Brightsmith et al. 2005). It was observed that some birds became accustomed to the food offered in the artificial feeders, staying close to the supplementary food sites (100m of distance) even months after their release. An interesting observation was that two males that often fed in the artificial feeders, when removed to a new area without artificial feeders by the monitoring team, began to explore the environment, dispersing for longer distances to find food resources and were seen interacting with wild parrots. For this reason, this study corroborates the findings of Snyder et al. (2000), that supplementary food should be gradually reduced as the animals become familiar with the area and discover its resources. There was a significant decrease in the use of artificial feeders by the released parrots three months after release, thus, this time should be an adequate period of time to offer supplementary food. After that, supplementary food should be gradually reduced. However, it is worth noting that the number of parrots confirmed alive or observed decreased over time, and that wild food may have varied throughout the year and this may have changed parrots' reliance on artificial feeders. Therefore, this result should be considered with caution. Furthermore, the monitoring of wild food availability could help in selecting the periods of the year when artificial feeders should be used (especially during the periods of wild food scarcity).

The dispersal zones „yard" and „nearby" were the most frequented by monitored parrots, which means that these parrots spent most of their time at a distance of only 100 meters from the release point. This can be beneficial in the establishment phase when they are adapting to wildlife and have the support provided by the release team. However, for the long-term viability of the translocated population, it is necessary that the individuals explore other areas to find food, nest and interact with wild conspecifics, due to limited resources in a small area (Le Gouar et al. 2012). This fact was not observed in this study for the parrots that were being monitored, as the frequency of use of the areas did not change over time. The other dispersal zones ("surroundings" and "distant") were used only in 6% of the time by the monitored parrots, almost only by birds that interacted with wild parrots. Although "yard" and "nearby" zones were the easiest to observe the parrots, the majority of released birds were recorded using these areas; the five missing individuals, who probably dispersed far away, would not induce much error in this analysis. The willingness to disperse could be related to the life history of each individual, as suggested by Snyder et al. (1994) for the Thick-billed Parrots *Rhynchopsitta pachyrhyncha* released in the USA.

Individuals that dispersed far away from the release area will not contribute demographically to the translocated population and the consequences of dispersing towards urban areas or to areas without the necessary resources to survive could be negative (Tweed et al. 2003, Le Gouar et al. 2012). Collazo et al. (2003), suggested, however, that a greater dispersion of the released parrots would indicate a better physical condition, with more developed flight muscles (an indicator of the efficiency of the pre-release flight training), and the dispersion should be understood as a positive result of the release. Overall data about the use of dispersal zones were not collected for 39% of the parrots, since these birds were not found during the monitoring campaigns. Disappearances could be due to death, re-capture by humans or dispersion, which suggests that the frequency of individuals using distant areas may be higher. It is important to distinguish dispersal from mortality and understanding the factors influencing dispersal is crucial in managing the trade-off between site fidelity and adaptive dispersal (Tweed et al. 2003, Le Gouar et al. 2012). To solve this problem, an effort to use GPS radio-collars should be done in future releases. Comments on the usefulness of VHF radio-collars in the present study are given below.

Skills needed to survive and maladaptive behaviors

Many of the released parrots disappeared along the study or expressed captive-related behaviors. Three parrots were recaptured by local community and were spontaneously returned to the project, but probably seven other released parrots were captured by locals and not returned to the project, since they were tamed and stayed near the release point. Captive-related behaviors should be avoided by training the parrots to behave appropriately: aversive training against human contacts and the use of environmental enrichment to reduce abnormal behaviors are possible measures to increase the expression of normal behaviors (Griffin et al. 2000, Reading et al. 2013).

More than 30% of the released parrots expressed behaviors that suggested adaptation to the wild, also dispersing from the release site, and integrating with wild flocks. We suggest the release of captive-raised parrots in areas with natural populations, because wild parrots can act as teachers to the captive birds, helping in the development of their survival skills (Seixas & Mourão 2000, Oehler et al. 2001, Brightsmith et al. 2005). In the first eight months after release of the Yellow-shouldered Amazon parrots in Venezuela, some parrots were still approaching humans, but over time, they began to maintain a safe distance from humans due to their pairing with wild parrots (Sanz & Grajal 1998). In the present study, parrots continued to approach humans for at least two months when they started to interact with wild parrots, but only after six months of release, were parrots integrated in wild flocks.

Released individuals require a wide range of behavioral skills and cognitive abilities to survive (Reading et al. 2013). The tendency to decrease all captive-related behaviors and increase almost all wildlife-related behaviors suggests that released parrots were developing these skills and cognitive abilities to survive over time. Furthermore, the increase in the number of displayed behaviors, especially those associated with natural behaviors (interaction with wild parrots, reproductive behaviors, natural vocalizations, etc.) and the decrease of inactivity demonstrated that the released parrots were responding in a proper manner to natural stimuli. The increase in the exhibition of behaviors associated to the life in the wild and associating with flocks of wild individuals was also assumed to be important cues for Carnaby's Cockatoos *Zanda latirostris* rehabilitation and readaptation to the wild after being released in Australia (Groom et al. 2018).

The significant reduction of the behavior "captivity vocalization" and the reduction tendency of "human vocalization mimicry" is of utmost importance because it should decrease the chances of the released Blue-fronted Amazon parrots being recaptured by humans. Many species of parrots are vocally flexible in adulthood and this flexibility may, therefore, allow parrots to meet the communicative needs of their frequently-changing social network (Scarl 2009). The use of natural parrot vocalization playbacks prior to release may help in the reduction of unwanted vocalizations, but this needs to be tested.

Breeding and social integration

Reproduction is one of the success indicators of reintroduction/translocation programs and is a fundamental survival parameter for any animal population (Wright et al. 2001, White Jr. et al. 2012). However, parrots tend to reproduce more if the release habitat is suitable (White Jr. et al. 2012). The four different-sex paired parrots expressed reproductive behaviors, and two pairs reproduced. The first chick was born just three months after the release. In a study concerning the reproductive biology of *A. aestiva* in nature, Seixas & Mourão (2002) recorded a complete brood loss in 46% of the monitored nests (28% of the losses occurred in the incubation phase and 18% in the hatchling phase). Thus, the low success in the reproduction of this species may be normal, and efforts to increase the rate of success should be conducted for the reintroduced/translocated birds. The distribution of artificial nests through the release area could be a useful measure. It has been successfully used in an effort to mitigate the paucity of suitable nest sites for the critically endangered Puerto Rican Parrots *Amazona vittata*, (White et al. 2005) and for the Red-spectacled Amazons *Amazona pretrei* (Kilpp et al. 2014). In the present study, artificial nests were constantly explored and a pair who reproduced used one. The other reproduction event observed took place two years after the release, and it occurred between one translocated female and one wild male. The chick survived and fledged. These reproduction events showed that even captive-raised parrots can reproduce upon release, contributing to the increase of individuals in nature and for the maintenance of self-sustaining population.

For the increase in translocation success, it is important to maintain the social relationships established between the individuals of the flock (Snyder et al. 2000). The released Blue-fronted Amazons maintained a social structure similar to that observed in wild groups, forming pairs or small groups, including mixed groups with wild parrots. This result is contrary to what was found for the same species in a release program in Pantanal (Brazil) by Seixas & Mourão (2000), where it was found that the released parrots formed just one group. Parrots released in Pantanal were kept together in small boxes for four weeks, and hierarchy in caged parrots is formed in four-five weeks (Matos et al. 2017). Those parrots were released soon after they formed their hierarchy, and maybe this was responsible for the flock cohesion even 13 months after release. However, this needs to be investigated in future studies.

Agonistic and affiliative relations have the function to maintain the group cohesion and the group hierarchy (Matos et al. 2017). There was a decrease in the negative interactions between the released parrots as the hierarchy between individuals was settled after release. Moreover, there was a tendency to decrease interactions with humans and increase interactions with wild parrots. This means that released parrots were showing less inappropriate social behavior over time and improving appropriate social behaviors. To decrease the interactions with humans after release, the animals can be trained before release (Griffin et al. 2000) focusing mainly on the disassociation of humans and positive stimuli, such as food. This could minimize human contact after release, making the animals less vulnerable to capture and death. We suggest the offering of food at irregular times and with no parrots present in the area, in this way parrots will not associate food with humans.

Monitoring techniques

Monitoring the animals after release is essential to determine the program's success, but it is expensive and needs to be done for long periods to know if the released population has established or not in the area (Batson et al. 2015). The number of six parrots per observer during four day campaigns was considered a maximum and sometimes too many when the animals were dispersed away from the release area. Perhaps, one observer for every four parrots and the campaigns of eight days would be better.

The acquisition of radio collars (VHF or GPS) is expensive for conservation programs that release larger numbers of animals. In this project, due to signal interference, VHF collars were not ideal to locate the dispersed parrots. Many individuals slept or bred the in rock walls present in the area, and the signals emitted by the VHF collars suffered significant interference in these areas, making it difficult to identify the origin of the signals. The monitoring team could not find an individual with collar during four consecutive campaigns (two months), then found again, which emphasizes the idea that a missing individual may not be dead. Nevertheless, it was easy to identify a parrot wearing a collar at great distances or even during flight. Since parrots that used collars were not rejected by the other parrots, it is suggested that all individuals should be marked with "false collars", devices similar in shape and size to the real signal transmitters but with no electronics within, to facilitate locating parrots and recording behaviors during monitoring campaigns.

CONCLUSION

Captive-raised parrots are commonly seen as the worst candidates for release back to the wild because they lose the ability to recognize predators, to find food in the wild and to socialize with conspecifics after life in captivity (Snyder et al. 1996). Our study indicates that confiscated ex-pet Blue-fronted Amazon parrots can be good candidates for translocation, but a training program should be applied to them prior to their release to diminish undesirable behaviors and decrease the chance of parrots approaching and being re-captured by humans. For better results, individuals' histories (origin, time in captivity, type of human-parrot relationship, etc.) should be investigated to better understand their effects on release results. Finally, this study can improve the management techniques of rehabilitation centers and assist wildlife managers to take better decisions about the destiny of Blue-fronted Amazons received by these Institutions.

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STRESZCZENIE

[Przeżywalność oraz zmiany w zachowaniu po wypuszczeniu na wolność wychowanych w niewoli papug — amazonek niebieskoczelnych]
Translokacja jest jedną z technik stosowanych w ochronie zagrożonych gatunków, ponieważ umożliwia wymianę osobników pomiędzy dzikimi populacjami lub dzikie populacje wzmacnia osobnikami pochodzącymi z hodowli. Wypuszczanie zwierząt rozmnażanych w niewoli jest czasami jedyną opcją ratunku dla populacji, której liczebność spada w szybkim tempie. Powszechnie uważa się, że papugi pochodzące z niewoli niezbyt nadają się do wypuszczania na wolność, ponieważ w hodowli tracą zdolność do rozpoznawania drapieżników, znajdowania naturalnego pożywienia oraz wchodzenia w interakcje socjalne z osobnikami żyjącymi na wolności. Amazonka niebieskoczelna jest jednym z najpopularniejszych gatunków papug trzymanych w niewoli. Jednocześnie w Brazylii bardzo często osobniki tego gatunku trafiają do różnego rodzaju azylów dla ptaków — są to zarówno osobniki wymagające leczenia, jak i np. odebrane kłusownikom, czy przynoszone przez mieszkańców. W latach 2008–2010 do takich azylów trafiło 3395 osobników tego gatunku. Jako, że warunki przebywania ptaków w takich miejscach nie są idealne i odbiegają od naturalnych, ważne jest określenie, jak ptaki takie radziłyby sobie po wypuszczeniu na wolność. Gatunek ten jest dość pospolity, jednakże wnioski wypływające z takiej translokacji mogłyby być zastosowane przy wypuszczaniu i reintrodukcji gatunków papug bardziej zagrożonych wyginięciem.

Trzydzieści jeden papug, które żyły od co najmniej trzech lat w niewoli w jednym z ośrodków dla ptaków było wpierw przyzwyczajanych do środowiska naturalnego, a następnie wypuszczonych w terenie porośniętym roślinnością podobną do sawanny w południowo-wschodniej Brazylii. Ptaki te w początkowym okresie mogły wracać do wolier, w których były aklimatyzowane; wykładany był także pokarm, z którego ptaki mogły korzystać. Po wypuszczeniu los ptaków był monitorowany przez trzynaście kolejnych miesięcy, określano częstość korzystania z pokarmu pochodzenia antropogenicznego, oraz opisywano zachowanie ptaków, porównując je z tym obserwowanym w okresie aklimatyzacji, gdy ptaki przebywały w wolierach. Dla celów opisu zachowań stworzono etogram kategoryzujący poszczególne zachowania jako te związane z życiem w niewoli lub na wolności (Tab. 1).

Trzy uwolnione papugi (10%) zostały uznane za martwe, a pięć (16%) znikło wkrótce po wypuszczeniu. Dziesięć papug (32%) wykazywało zachowania, które wskazują na adaptację do środowiska naturalnego, zaś behawior 13 osobników (42%) był bardziej związany z życiem w niewoli (Tab. 2).

Jednym z problemów ptaków na wolności były trudności z lądowaniem. Spośród wypuszczonych ptaków w czasie prowadzenia badań do rozrodu przystąpiły trzy: para utworzona przez osobniki z niewoli oraz jedna samica, która związała się z dzikim samcem. U obserwowanych papug wraz z upływem czasu po wypuszczeniu stwierdzono tendencję do zmniejszania się wszystkich zachowań związanych z życiem w niewoli oraz wzrostu zachowań podobnych do dzikich ptaków (Fig. 1). Wypuszczone ptaki obserwowane były jednak najczęściej w okolicy wolier, z których pochodziły (Fig. 2). Korzystanie z pokarmu dostarczanego przez ludzi zmniejszało się z czasem, jaki upłynął od wypuszczenia (Fig. 3).

Uzyskane wyniki wskazują, że skonfiskowane papugi pochodzące z niewoli można z powodzeniem wprowadzać do środowiska naturalnego. Przed ich wypuszczeniem należy jednak wdrożyć odpowiedni program szkolenia, aby zmniejszyć zarówno niepożądane zachowania ptaków, jak i szansę na ich ponowne schwytanie przez ludzi. Ponadto wykorzystanie niezagrożonych gatunków w programach ochronnych może być przydatne do stworzenia odpowiednich protokołów dla programów ochrony rzadkich i zagrożonych gatunków.