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Reintroduction of the Golden Conure (*Guaruba guarouba*) in Northern Brazil: Establishing a Population in a Protected Area

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Abstract: Brazil has the highest number of parrots in the world and the greatest number of threatened species. The Golden Conure is endemic to the Brazilian Amazon forest and it is currently considered as threatened by extinction, although it is fairly common in captivity. Here we report the first reintroduction of this species. The birds were released in an urban park in Belem, capital of Para State, where the species was extinct more than a century ago. Birds were trained to recognize and consume local food and to avoid predators. After the soft-release, with food supplementation and using nest boxes, we recorded breeding activity in the wild. The main challenges before the release were the territorial disputes within the aviary and the predation by boa snakes. During the post-release monitoring the difficulties were the fast dispersion of some individuals and the dangers posed by anthropic elements such as power lines that caused some fatalities. Released birds were very successful at finding and consuming native foods, evading predators, and one pair reproduced successfully. Monitoring continues and further releases are programmed to establish an ecologically viable population.

Keywords: reintroduction; soft-release; acclimatization; monitoring; Amazon; dispersion

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1. Introduction

Parrots are among the most endangered birds in the world, having over 29% of their 402 extant species at risk of extinction [1]. This vulnerability is mostly due to their charismatic nature that leads to a high demand in the illegal pet trade, which, consequently, reduces wild populations. In turn, this situation attracts many conservation actions on their behalf [2,3].

The reintroduction of captive-bred wildlife is an important conservation tool, being increasingly used to compensate human impacts on populations and ecosystems [4,5]. In extreme cases, it has already been used to recover species that were on the brink of extinction such as *Petroica traversi* and is currently the only option to return extinct in the wild species such as *Pauxi mitu* and *Cyanopsitta spixii* [6–9].

Brazil is known for having both the greatest richness of parrot species and the largest number of endangered birds in the world [10,11]. However, reintroduction programs are still rare in the country, while indiscriminate release actions, carried out without technical rigor and monitoring are common [12]. This seems to be a rule in most of South America [13], but there are successful examples with parrots that highlight the potential for their reintroduction [14,15].

The Golden Conure (*Guaruba guarouba*) is an endemic species of the Brazilian Amazon forest. Given their exuberant appearance, these conures have suffered a dramatic

population decline due to the illegal pet trade, which in addition to severe habitat loss, has led them to be vulnerable to extinction [16,17]. Although it is estimated that their wild population is small, with less than 10,000 remaining individuals, Golden Conures are prolific and quite common in captivity [17].

Considering the Amazon's progressive habitat destruction, and how the occurrence area of this species has drastically shrunk over the years, the long-term survival of this species in the wild is seriously jeopardized, and actions for its conservation are urgent [17–20].

In such an unfavorable scenario, the reintroduction of captive-bred Golden Conures may be a viable way to restore the species to key areas, reduce the risk of extinction and raise awareness of their importance as a conservation symbol to the local population. However, there are no records of previous attempts to reintroduce this species. Additionally, they remain poorly studied, with many aspects of their behavior and natural history not yet clarified [16,21].

Lymington Foundation, a Brazilian non-profitable organization located in Juquitiba, São Paulo state, Brazil, has successfully bred this species over the last 20 years, and in 2017, teamed up with IDEFLOR-Bio, from Belém, Pará state, Brazil, to start the first attempt to reintroduce the Golden Conure in the wild. Here we report the preliminary results of this collaboration.

2. Study Area and Methods

Identify and remove the causes or the main threats that lead the targeted taxa to be extinct in a given area are of paramount importance for a successful reintroduction [22]. Hence, we chose a recently created protected area in Belem, capital of the state of Para, where the last credible sighting of the Golden Conure dates from over 150 years ago [23].

The Utinga State Park, located in Belém, Pará state, has 1393 km^2 mostly represented by lowland rainforest, connected to the continuous forested area to the east, the Guamá River to the south, and the city by the west and north (Figure 1a) [24]. The area is constantly under surveillance by both private security and the public environmental police, so the main causes for the Golden Conures' extirpation, which were habitat loss and capture, are controlled in this area [24].

(**a**) (**b**)

Figure 1. (**a**) The Utinga State Park (dark green), located inside the environmental protected area (light green). (**b**) The acclimatization aviary is composed of two modules connected.

We built the acclimatization aviaries in the intended release site at the center of the park. They consisted of a maintenance module of 6 m × 2 m × 2 m, connected to a larger one with 5 m × 5 m × 5 m. Two nest boxes were available in the maintenance module for the birds to spend the night, the second module had a tree inside, and both with enough space for flight (Figure 1b). We chose a previously opened site with sparse secondary vegetation, known to be preferred by the species for roosting and nesting [18]. The site was rich with *Byrsonima* sp. Trees, an important resource in the post-fledgling period [17] and

provided good visualization during the monitoring. The adjacent patches were composed by primary forest fragment and a lake, providing various environmental options.

Individuals selected for the reintroduction were bred at Lymington Foundation, where the installations are surrounded by Atlantic Forest, with visual and acoustic exposure to local wildlife. We selected birds both hand-raised and raised by their parents. The group was composed of birds genetically diverse and kept at Lymington Foundation in aviaries similar to the one built in the reintroduction area. Individuals had numbered metallic bands to allow for identification up close. Males and females had their bands placed on the right or the left leg respectively, for quick identification. Identification of individuals outside of close range relied on physical traits such as plumage patterns, eye coloration, and beak marks.

After performing the standard health evaluations (including PCR exams for circovirus, bornavirus, and herpesvirus, among other important diseases), and the results being negative in all cases, two groups of birds were sent to the release site. Both groups were composed of mostly young individuals of two to three years old, in equal proportion of males and females. The first group was sent to Belem in August 2017, consisting of 14 birds, and the second group of 10 individuals was sent in May 2018.

The birds were moved to the aviary, where they stayed for five months for adaptation to the local conditions. The diet was gradually adapted to native fruits until a total replacement was achieved. Native food was served attached to the branches of the respective plants and placed on hard-to-reach spots, so the birds would have to practice the recognition and foraging techniques. Predator recognition training was performed using live boa snakes placed in the proximity of the enclosure. Birds of prey were naturally present in the area and could occasionally be seen diving for lizards on the ground and at the top of the aviary. During these occasions we evaluated the behavioral response of the Golden Conures by scanning their reactions after the predators were sighted and approached the enclosure. The group was considered apt when all individuals reacted together, demonstrating alertness and emitting alarm vocalizations when potential predators approached. We made daily ad libitum observations to record social interactions in search of aggressive behaviors and couple formation, in order to identify which individuals were more inclined to fights and/or reproduction.

To provide experience to gain and increase site fidelity before the group release, we selected three males that showed the strongest attachment to females for prereleases. These males were released individually and on different days in the morning (Figure 2a), allowing them to explore the surroundings during the day, but still being aware of the group vocalizations in the aviary. Before the afternoon, they were attracted back to the aviary by food offering (Figure 2b).

(**a**) (**b**)

Figure 2. (**a**) A single male being prereleased separately from the group. (**b**) The single male returning to the aviary at the end of the day.

For the reintroduction, we used the soft release method, which consists of opening the windows of the aviary and allowing them to decide when to leave and to return if they desire [25]. Supplementary food was offered daily on the top of the aviary and in two suspended feeders, distributed around the release site. In an additional effort to promote site fidelity, we installed nest boxes on the top of the enclosure, using the same model that the birds were already familiar with. A total of 20 individuals were released.

3. Results and Discussion

Golden Conure is a social species, usually living in groups varying from 3 to 30 birds [17,26]. However, in the acclimatization aviary we recorded territorial fights, with two females being killed by a very aggressive female. This bird was separated from the main group, returning a few days before the release. The fact that females were involved in aggressions, and not males, contradicts anecdotical reports from breeders, which indicated that males were the most aggressive sex.

During the prerelease we considered a group of 10 individuals as the optimal size for release. The aggression events recorded in the first group but not in the second, suggest that the birds should be released before the breeding season. The breeding season of the Golden Conure starts in October, lasting to March, and the casualties recorded were related with a female defending a nest site. It is relevant to report that the second group showed no negative interactions when we avoided the breeding season and, after release, no territorial disputes in the wild were recorded.

We recorded a random dispersion of the conures after the release, with a few birds staying near the enclosure. In the first group, 72% of the Conures dispersed in one week, while in the second event, 50%. The birds that showed site fidelity spent most of the time over the enclosure, but without re-entering, as reported by other psittacine releases [27,28]. From these dispersed groups, three birds were located 10 km away from the releasing area. On multiple occasions, other sightings of flying birds were reported in different sites in urban areas of Belem. Although we cannot confirm if those were the same three individuals or the others from the group, we had evidence of a quite long-distance dispersion for some individuals. The second group showed a stronger site fidelity over 12 months after release, but afterward they moved to the border between the protected area with the city, 4 km away from the release site, leaving it vacant (Figure 3).

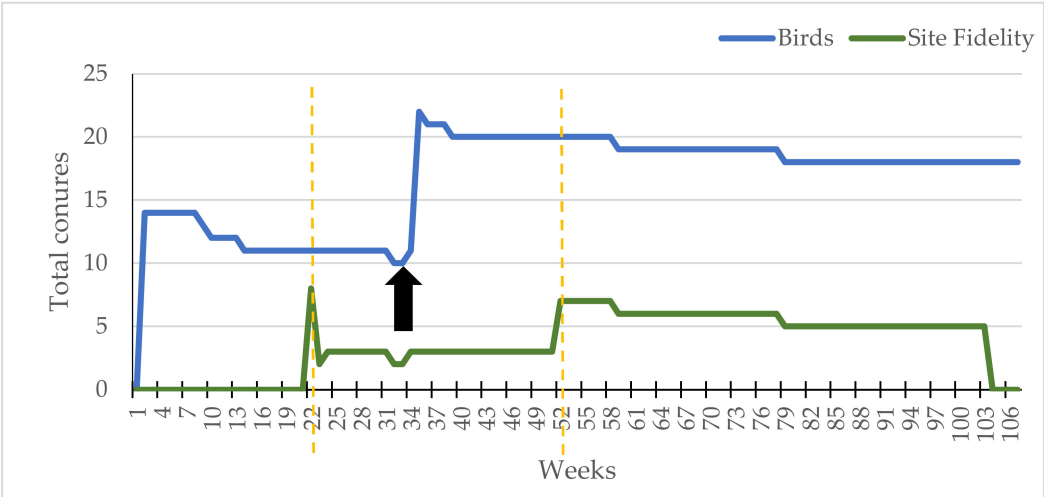

Figure 3. Number of golden conures potentially alive over time (blue) and those that remained near the release site (green); every reduction in the blue line represents a recorded death. The space between the blue and green lines represents the individuals with uncertain fate during a given time. Dashed orange lines mark the first and second release, the arrow points to the first breeding in the wild, in which one individual is added to the total population.

The dispersion of the Golden Conures after release can be associated with fluctuations of food availability in the area, which included fragmented landscapes and pristine forests. Since the supplementary food was constant throughout the monitoring, we believe there may be other causes for the higher dispersion and nomadism. Groups of other psittacines, mostly *Amazona amazonica*, were often seen flying from northeast to southwest during mornings and the way back in the afternoons. Even though we did not see any interaction with the conures, they may have influenced these movements, since the five conures were found in the northeast of the release site, in the same path that these parrots use daily. It is also possible that they were attracted to the numerous plantations of *Euterpe oleracea*, that are concentrated in the area where the dispersed birds moved to, since this is a favorite food item with a nutritious pulp. The uncertainty of the fate of some individuals that dispersed was the main problem to attest the level of success of this reintroduction. Dispersal and difficulty of monitoring has already been reported in the reintroduction of the Thick-billed Parrot, when it deeply affected the survival rates [29]. The recent release of the Orange-bellied Parrot (*Neophema chrysogaster*) in Tasmania also showed an elevated dispersion, with 38–46% of birds flying over the monitoring range, despite the training to instill site fidelity [30]. These cases suggest that elevated dispersal is still one of the main challenges for monitoring in psittacine reintroductions. Even so, this trait can be positive for a population, given the possibility of finding more suitable habitats and being able to expand their range.

We recorded a successful reproductive event only one month after the first release (Figure 4) by the same aggressive female that caused two deaths during prerelease. We did not register any behavior of nest helpers as we expected from previous reports [18,26]. Despite the first breeding attempt being successful, the two following attempts failed, even with the female incubating to the eggs apparently in the same way. It was not possible to evaluate if either the eggs were unfertilized or if they suffered any mechanical damage, but the latter might be the most probable cause, since individuals from the second group were sharing the nest box at night, and broken eggs were later found.

Figure 4. Released Golden Conure parents positioned in the extremities guiding the wild-born young at the center.

Reintroductions often present pronounced mortality in the first month of release, and predation is often considered the main factor leading to loss of individuals [3]. In our study, after the release, one individual was predated but the main threat was electrocution in powerlines, which caused two deaths. Predation by boa snakes, *Boa constrictor*, was

a major problem in the prerelease. Despite the conures showed an aversive response to predator exposure and being alert near their presence, three individuals were preyed upon inside their nest boxes during the night, two before the release. We addressed this problem by moving the nest boxes to trees that had no contact with the rest of the canopy and protecting their base with metallic belts, avoiding snake access. Other reintroductions also reported psittacines preyed mostly inside their nests [25,28], therefore the selection of sites for the installation of artificial nests must be carefully evaluated to avoid predation.

In previous studies with psittacines, the absence of antipredator training led to high losses to raptors, especially with hand-reared birds [29,31]. In our case, the golden conures were alert in the presence of bigger birds of prey like *Heterospizias meridionalis*, evading their attacks on multiple occasions. *Milvago chimachima* a smaller falcon that does not pose a risk to them was abundant in the area, and in that case, the conures did not show any concern and even shared perches occasionally. By the end of the monitoring, no losses to avian predators were recorded.

Toucans are known to be nest predators of conures [26], and many individuals or groups of *Pteroglossus aracari* and *Ramphastos vitellinus* were often seen around the release site. However, no interaction between them was recorded during the breeding period or in the rest of the monitoring. Two individuals of black tamarins, *Saguinus niger,* tried to access the nest box once but were rapidly fended off by the breeding couple. Given the conures´ positive reactions to conspicuous predators after going through exposure in captivity and given that captive parrots tend to lose antipredator behavior without exposure [32], we reinforce the importance of these conditions during the prerelease period.

As for post-release feeding, we did not register any individual suffering from starvation during monitoring. On multiple occasions, individuals dispersed for weeks or months and were found later without apparent signs of food deprivation, meaning they were able to forage and survive without supplementary food. Thus, we attest to the success of the food recognition training and recommend it before any release. The supplementation of food was important in the maintenance of site fidelity for the individuals that did not disperse far, given they were routinely present in the site at the exact time of the food exchange. This importance has also been attested in the reintroduction of *Ara macao* [15]. Similarly, reintroduced Conures switched supplementary feeding for natural foraging gradually over time, despite the offer remaining constant.

4. Concluding Remarks

Even while this reintroduction is still in its first steps, important milestones of success were already achieved such as an early reproduction in the wild, conures developing natural foraging skills, and avoiding avian predators. However, we still lack accurate data on post-release dispersal that is vital to understand how this species will move and occupy the region. We aim to address this matter with the use of telemetry, since these questions rely on it. We also seek to standardize the methods to better record feeding habits and group interactions. With the learning acquired in this stage, we are confident that future releases will be more successful, and, in the future, an ecologically viable population of Golden Conures will settle in this protected area.

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