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# Factors influencing the release success of captive Blue-headed Parrots (*Pionus mentruus)* in Pastaza, Ecuador

Presented to :

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## Summary

Although many organizations attempt to rescue and rehabilitate animals involved in wildlife trafficking in order to return them to the wild, there are few published accounts of the methods employed and the level of success obtained through these “homemade” procedures. Here I report one of the first attempts to reintroduce a group of Blue-headed Parrots (*Pionus mentruus*) into the wild. I used a soft release approach with a system of feeders around the release cage and monitored the dependence on feeders of 15 parrots released in January 2017 at Merazonia Wildlife Rescue and Rehabilitation Centre (MWRRC), Pastaza, Ecuador. The birds gradually stopped using the feeders, but most individuals could still be found around the center 425 days post-release. The release was considered successful if birds were alive at the end of the monitoring period (April 2017) and were completely independent (no contact with humans and no use of the feeder). Twelve parrots reached independence by 77 days after release. The remaining three individuals were alive, but still used the feeders at the end of the monitoring period. Unfortunately, 15 birds were not enough to detect a statistically significant link between release success and their individual history (time since arrival at MWRRC, physical condition upon arrival, and paired or not). Success was observed even among birds that had severe injury upon arrival at the center, that spent more than 2,650 days in captivity, or that were unmated. In February 2018, two of the three parrots that still used the feeders at the center joined the rest of the group that could still be seen within a radius of 500 m from the center. In March 2018, the last parrot still used the platform. One year after their release, a minimum of two released individuals have been observed constructing nests, which is good as many authors consider a release to be successful only when individuals have a chance to reproduce. Although it is difficult to compare the efficiency of the release procedure for *Pionus* parrots used in this study, it remains promising and provides a benchmark to which other release protocols can be compared.

## Introduction

All around the world, many species are facing problems linked to ever-growing human populations and their activities. Global populations of vertebrates have declined by 58 percent between 1970 and 2012 (WWF, 2016). Moreover, climate change is expected to increase the extinction probability of many species (Araújo and Rahbek, 2006). In addition to this global threat, habitat loss and fragmentation, as well as habitat degradation through alteration and pollution related to anthropogenic activities, are among the most important causes of biodiversity loss (Betts *et al.,* 2017). Another significant cause of biodiversity loss, yet less often mentioned, is poaching in its various forms. Indeed, wildlife crime is one of the biggest illegal businesses in the world. Wildlife crime is defined as the taking, trade, exploitation, or possession of the world's wild flora and fauna in contravention of national and international laws (Pires and Moreto., 2011). It is difficult to evaluate monetary importance of this industry, but the experts of TRAFFIC (2017), the Wildlife Trade Monitoring Network, estimate it at hundreds of millions of dollars per year.

Wildlife crime has a major impact on endangered species, causes the introduction of invasive species, and can negatively affect local economies if biodiversity resources are not well managed. CITES monitors the international trade of species of conservation concern. From 2005 to 2009, CITES recorded, among others, an annual trade average of 317,000 live birds, 2 million live reptiles, 2.5 million crocodile skins, 1.5 million lizard skins, 2.1 million snake skins, 73 tonnes of caviar, 1.1 million coral pieces, and nearly 20,000 hunting trophies. If live animals are not rescued before the sale, they generally end up as exotic pets and can be sent as far as foreign continents (Merazonia, 2017).

When live animals are confiscated, authorities face three choices: return them to nature, keep them in captivity, or euthanize them (IUCN, 2000). The decision is linked with different ethical or health-based choices. To be selected for release, the animals must meet specific criteria. For instance, individuals need to be able to move adequately, recognize their kin, their natural food, as well as different sources of danger (e.g., wild predators and humans), and be in good body condition (Blair, 2001). Although releasing the confiscated animals into the wild is often considered the best option by refuges and governmental entities, this option is not always successful and may even cause harm to local populations of the same species (Efe *et al.,* 2006; IUCN, 2000).

Reintroduction projects of all species must always include very strict health screening and disease detection measures. When possible, the released animal should not leave its country of origin. For instance, individuals maintained in captivity may be exposed to multiple diseases or parasites that may be exotic to their habitat (Woodford, 2000). Moreover, sub-species and genetically different local populations can become mixed during trafficking (Magroski *et al.,* 2017). To maintain the genetic integrity of wild populations, it is thus important to verify the origin of each animal before releasing them. Yet, the authorities that confiscate the animals are not always able to distinguish the origin of the animals. The fact that such information is often hard to obtain and that release centers generally do not have the financial resources, knowledge or technology to obtain this information is problematic.

A release is generally considered successful when individuals can survive and produce viable offspring in the wild (Garson *et al.,* 1992; Lockwood *et al.,* 2005; Parish and Sotherton, 2007). Accordingly, most studies evaluating the level of success of a release attempt to follow the animals over a long time period and evaluate their survival and reproduction rates (Guy *et al.,* 2015; Kingsley *et al.,* 2012; Zhang *et al.,* 2016). However, obtaining detailed information on individuals after their reintroduction is a major challenge because it requires long-term monitoring and often the ability to track individuals over large spatial scales. This is particularly evident in cases where reproduction is only possible several years after reintroduction and will thus depend on the success of the release, the age of the individual, and the timing of the reproductive season. Such limitations are unfortunately current in studies assessing release success (e.g., Garson *et al.,* 1992: Lockwood *et al.,* 2005: Parish and Sotherton, 2007).

There are some very good examples of successful releases and reintroductions. For example, trophic cascade research in Yellowstone National Park was conducted during the first 15 years after a wolf (*Canis lupus*) reintroduction by translocating wild individuals. The population released in 1996 is still viable since its reintroduction. The results indicate substantial initial effects on both plants and animals (Ripple and Beschta, 2012). Another successful reintroduction can be found in the Lower Silesia Forest in Poland, where the capercaillies (*Tetrao urogallus*) is now back in its natural habitat and reproducing at healthy levels (Merta *et al.,* 2016). In this case, it is a group of juvenile captive-bred birds that were released and now exhibit the same behavior as wild birds.

The traffic of live animals is a huge problem for many countries, including Ecuador. In this country, the species most subjected to illegal trade are birds. For example, among the 634 vertebrates that were confiscated by the Ministry of the Environment in 2013, 161 were birds, and 71% of these were parrots (Ministerio del ambiente Ecuador, 2014). According to Blanco *et al.* (2007), some parrot species play an important role in the dispersal of the seeds of many fruit trees and often have a system of parrot-plant mutualisms. These species of parrots are also often the victims of illegal trade, which puts high pressure on their population and brings higher risks of decline (Tella *et al.,* 2014). The release of trafficked parrots can however mitigate these problems. However, confiscated live birds pose a big challenge for wildlife rescue centers as these birds often arrive in poor health (Kuhnen, 2012). Moreover, healthy individuals cannot be released upon confiscation as poachers often cut their primary flight feathers or capture them in the nest before they learn to fly (TRAFFIC, 2017).

The release of parrots is rarely attempted because they are especially difficult to rehabilitate. Consequently, in most cases, wildlife refuges offer them the most natural captive environment possible. Difficulties stem from two key aspects of the parrots' biology: the importance of learned behaviour and their social ecology with respect to foraging and predation avoidance. Indeed, learned behaviours, such as recognizing food and dangers, depend not only on parental care, but also on social learning from flock members which can also play a significant role in their education. Young captive birds that are released may thus experience difficulties in finding food or recognizing predators in the wild and thereby starve or fall prey to predators more easily (Juniper and Parr, 1998). Snyder *et al.* (1987) suggests that it is important to release parrots in flocks because it increases their ability to detect predators and enables the sharing of predation risk among individuals. Although wild parrots eat and fly together in flocks, most studies on this group indicate that the fundamental, permanent social unit is the pair (Snyder *et al.,* 1987; Bradbury, 2003). Some projects have failed in the past, because this important information was not considered (Snyder *et al.,* 1994; Seddon *et al.,* 2007; Wilson *et al.,* 1994).

If possible, a soft release is recommended as the conservative and precautionary method of choice for avian reintroductions (Wanless *et al.,* 2002). A soft release means that the bird is freed in the wild but still has access to an artificial food source and an open cage that can be used as shelter. This choice allows for a better follow-up of the released individuals and improves release success (Wanless *et al.,* 2002; Earnhardt *et al.,* 2014; Mitchell, 2011). This has also been observed for parrots according to the meta-analysis of White *et al.* (2012). This study synthesizes the results of 47 releases and reintroduction of parrots that were reported in 9 different countries in the last 25 years. A release was considered successful when half of the birds were still alive after one year and an episode of reproduction was reported. More than half (55%) of the 47 projects reported a success. The quality of the release environment, a pre-release wild food training and a post-release provisioning of food are the factors affecting the degree of success of a release (White *et al.,* 2012).

The parrots of the *Pionus* genus comprise an important part of the wildlife traffic in Ecuador. *Pionus mentruus* are the second most trafficked birds in the country (Ministerio del ambiente Ecuador, 2014). Yet, there are very few, if any, published studies that report, compare or assess the efficiency of release and reintroduction protocols for this genus. This is of great concern since most of the release attempts of *Pionus* that were conducted in Ecuador failed and were not reported (Merazonia, 2017). Moreover, none of the 47 release projects included in White's *et al.* (2012) meta-analysis involved the reintroduction of a large group of social parrots. In order to fill this knowledge gap, I report here the results of new release protocol applied to a group of 15 Blue-headed Parrots (*Pionus menstruus)* that were released in 2017 at the Merazonia Wildlife Rescue and Rehabilitation Centre (MWRRC), Pastaza, Ecuador. A soft release was used with a system of feeders around the release cage. To improve survival and the likelihood that parrots remain in the area, pairs within the group were separated. Half of the separated pair members remained temporarily in a closed cage in the hope that the released individuals would explore Merazonia, while staying close to the cage. The remaining captive individuals were then released two days after the first ones. Before the release, birds were trained to recognize their natural food and associate a whistle blow with feeding time.

This release plan was a collaborative effort between Merazonia, the Ecuadorian Ministry of the Environment, and the Schubot Exotic Bird Health Center at Texas AetM. Blue-headed parrots are among the most trafficked birds in the Americas and the need for a viable rehabilitation and release model is critical as they can live between 30 and 40 years (Hilty and Brown, 2001). This species can be found in Central America and in Venezuela, Colombia, Ecuador, Peru, Bolivia, and Brazil (Hilty and Brown, 2001). In Ecuador, they were given a Vulnerable status (Ministerio del Ambiente, 2014). In 2013, 18 Blue-headed parrots were confiscated by the Ministry of the environment (Ministerio del ambiente Ecuador, 2014). The knowledge gained from this release along with subsequent monitoring of the birds will be of great value to the scientific community as there is currently limited accessible scientific data about the Blue-headed parrot

More specifically, this research measures the progressive independence of released Blue-headed parrot individuals from feeders using the daily number of observations of parrots made within 50 m of the cage. It also quantifies the influence of the number of years since a bird's arrival at the center, its physical condition upon arrival (wing feathers cut, eye problems), and its pairing status on its release success. I expected that parrots that spent less time in captivity, that exhibited fewer health problems upon arrival, and that were mated would reach independence more quickly.

## Methodology

### Study species

Blue-headed parrots are about 28 cm long and weigh around 250 grams. They live mainly in tropical forest, semi-open country and along rivers below 1,100 m of altitude, though they can sometimes be found at altitudes > 1500 m (Juniper *et al.,* 1998). They are highly social and form small groups that roost together (Juniper *et al.,* 1998). Most species of *Pionus* do not appear to have a hierarchy of dominance. They use a system of ''scouts'' to find the best area for the group and sentinels that use tall trees to scan for predators while the others eat (Shade, 2004). If food is abundant, they can be found in very large groups. These parrots tolerate proximity with humans and can live in a disturbed habitat. They can damage fields of rice, corn and banana. They mainly eat fruits, seeds and buds (Juniper *et al.,* 1998). They can often be found in cliffs of clay where they find vital minerals. It is impossible to differentiate the male and the female without a genetic test (Southeast Texas Avian Rescue, 2004). They nest in tree cavities and form pairs for life. The breeding season usually begins sometime in May. They tend to have an average of 3 to 4 eggs, which are incubated for close to a month (26 days). They fledge around 70 days and are typically independent by 3 months of age (Juniper *et al.,* 1998).

**Study area**

The study took place at the Merazonia Wildlife Rescue and Rehabilitation Centre (MWRRC), which is located on 101 hectares of Amazonian cloud rainforest at 1300 m of altitude, near Mera, Pastaza, Ecuador, South America (Merazonia, 2017). The weather is stable all year long and the differences between the seasons are not notable. The site is heterogeneous and is composed of 60% secondary forest and 40% primary forest (Merazonia, 2017). Only one road bordered by a few plantations of sugar cane, corn, and palm leads to the MWRRC, which is 7 km from the nearest village, Mera. The main predators of birds within the area include birds of prey, snakes and monkeys (Juniper *et al*, 1998). Other rescued animals in cages from MWRRC can be found around the release site such as parrots, monkeys, pumas, and kinkajous. They can be a cause of stress or danger.

**Origin of confiscated parrots**

The Blue-headed parrots found at the MWRRC all have different captivity histories. Among the 27 individuals found at the center in 2017, 15 were ready to be released (Table 1). Birds that could not be released had health problems, could not fly or were still in quarantine. Of the 15 released, 10 arrived at the center in 2009, 2 in 2010, 1 in 2011, and 2 in 2014. Nine were transferred together in 2009 from another center, two were confiscated at the police control in Mera, Pastaza, Ecuador, three were brought in by the Ministry of the Environment of Ecuador, and one was found in a street by citizens of Mera. Nine of them were not able to fly when they arrived because their primary flight feathers were cut (PETA, 2016). All birds were in quarantine for a minimum of 60 days before being integrated with the other blue-headed parrots. All the birds were treated with Promectine (Imovec 1%) p.o 0,2 mg/kg (Zygosis, 2017) and Panacur (11mg fendendazol) p.o 25 mg/kg (MSD Salud Animal, 2017). Both products act against parasites. They were also treated with Doxycycline (100 mg/kg) every 5 days on 9 occasions to avoid the risk of psittacosis caused by *Chlamydia psittaci* (Dokter, 2017). This disease can cause infections analogous to a flu illness and even lead to fatal interstitial pneumonia. The effects vary strongly among individuals and can cause problems for birds released in the wild (Kalmar *et al*, 2015).

**Table 1:** Different characteristics of each bird release in Merazonia Wildlife Rescue and Rehabilitation Centre (MWRRC), Pastaza, Ecuador in January 2017. A minor problem was considered when birds had lost feathers, or weight. A major problem was considered when they were unable to fly or had eye problems. The time in cage represents the number of days before the release since their arrival at the MWRRC. Success was considered if the birds were alive at the end of the monitoring period (April 2017) and were completely independent of humans (no contact with humans and no use of the feeder).

| **Bird ID** | **Problem at arrival** | | **Time in cage (day)** | **In pair with ID** | **Release group** | **Success** |
|---|---|---|---|---|---|---|
| | **Minor** | **Major** | | | | |
| **4158** | Yes | No | 2650 | 4647 | A | Yes |
| **3850** | Yes | Yes | 2650 | 4159 | B | Yes |
| **4160** | No | Yes | 2650 | 3577 | B | Yes |
| **4159** | No | No | 2650 | 3850 | A | Yes |
| **4157** | No | No | 2650 | Alone | A | Yes |
| **3847** | No | No | 2650 | 4648 | B | No |
| **4151** | Yes | Yes | 2650 | Alone | A | Yes |
| **3846** | No | No | 2650 | 4650 | B | No |
| **3577** | No | Yes | 2650 | 4160 | A | Yes |
| **4650** | No | Yes | 2612 | 3846 | A | No |
| **4649** | Yes | Yes | 2508 | Alone | B | Yes |
| **4648** | No | Yes | 2312 | 3847 | A | Yes |
| **4647** | No | Yes | 2087 | 4158 | B | Yes |
| **4154** | No | Yes | 961 | Alone | A | Yes |
| **3879** | No | Yes | 620 | Alone | B | Yes |

**Pre-release procedure**

**Table 2:** Schedule of the release of 15 Blue-headed parrots (*Pionus menstruus*) in Merazonia, Pastaza, Ecuador between June 2016 and April 2017.

| **Pre-release** | | | **Release** | | **Post-release** |
|---|---|---|---|---|---|
| June 1th, 2016 to January 19th, 2017 | January 20th, 2017 | January 24th, 2017 | January 26th, 2017 | January 28th, 2017 | January 26th, 2017 to April 15th, 2017 |
| Training of birds | Radio-transmitters fitted to 2 birds | Separation of the 8 mated birds | Release group A (4 mated birds + 4 unmated birds) | Release group B (rest of mated birds and unmated birds) | Monitoring of the released birds |

All birds were in the same enclosure (Figure 1) in a semi-open area. From June 1th, 2016 to January 19th, 2017, eight months before the release (Table 2), a whistle was blown before and during feeding to train the birds to associate the whistle with food (Brightsmith *et al*, 2005). Each day, parrots received wild berries with their normal diet to initiate recognition of their natural food. Two months before the release, three feeders were installed outside the enclosure. The first was 2.5 m high and located 2 m in front of the enclosure (Feeder 1); the second was 3.5 m tall and located at 2 m behind the cage (Feeder 2); and the third at 4.5 m high with a pulley system, situated 23 m in the valley between the river and the enclosure (Feeder 3) (Figure 1). The two feeders near the cage were connected to this one by a perch to facilitate access during the first days of the release. Feeders 1 and 2 required the use of a ladder to enable cleaning and food provisioning and feeder 3 was built with a pulley system in an open area.

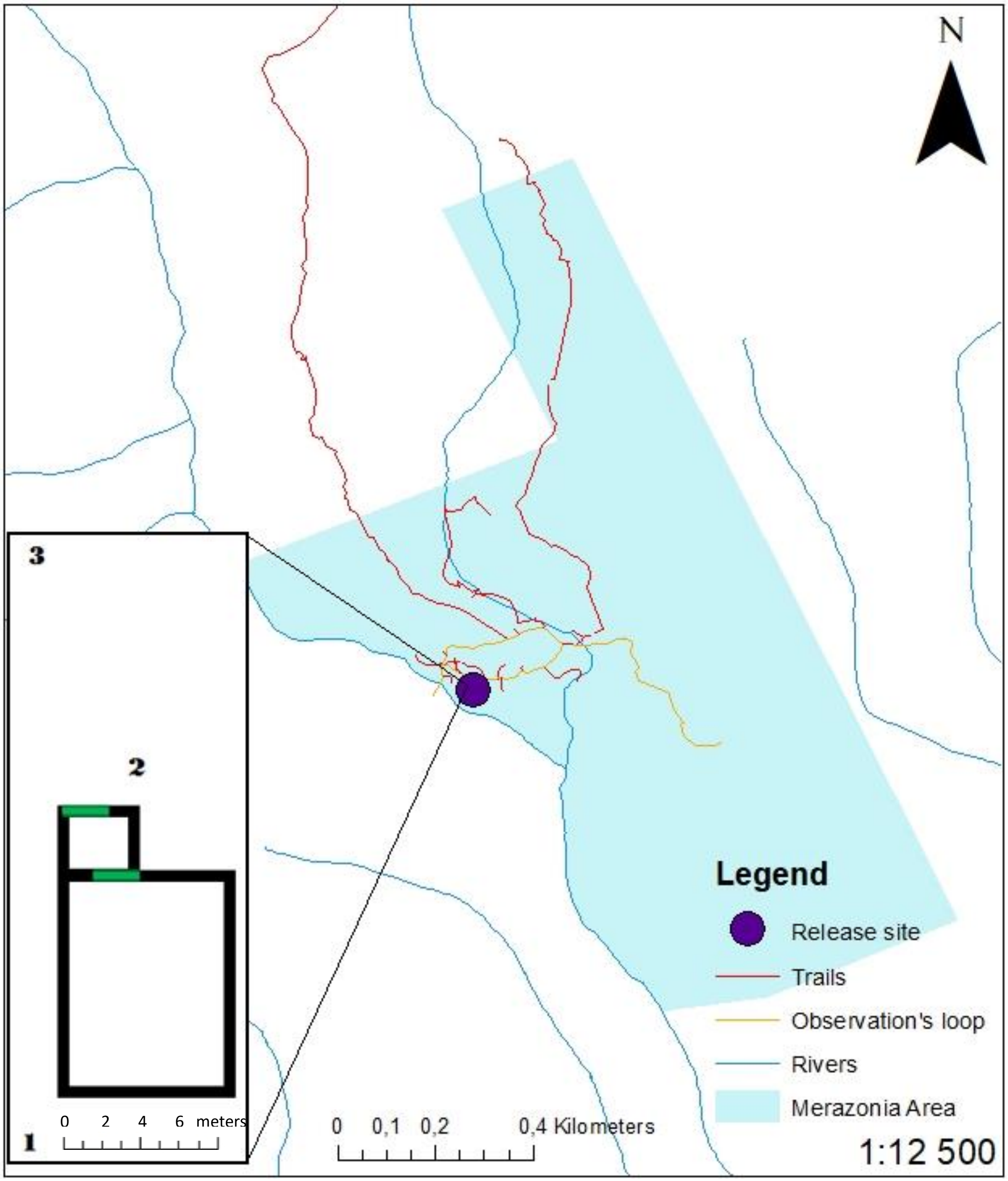


**Figure 1:** Map of the Blue-headed parrot release site in Merazonia Wildlife Rescue and Rehabilitation Centre, Pastaza, Ecuador, and plan of the release cage and feeders (#1-3; see text for details). Green lines represent doors. The orange lines represent the loop done on each day of observation.

Between January 12th, 2017 and January 19th, 2017, one week of observation was undertaken to identify mated birds. Parrots were considered in pairs when they ate together, and cleaned, protected, and followed each other in the enclosure (Snyder *et al.,* 1987). Parrots could be identified individually as all birds were injected with an intramuscular passive integrated transponder (PIT-tag) in the pectoral muscle (model TIS-8010 from Datamars) in 2014.

Two birds had a radio-transmitter on their tail (model PIP3 of the Company Biotrack with a Battery Ag392 of the Type tail mount with a weight of 2.5 grams (1% of the body weight)) installed on January 20th, 2017 on two individuals of different pairs. A telemetry system from the company Telonics was used to follow them (Part number: TR-4K 148/152 MHz, serial number: 692695).

Two days before the release on January 24th, 2017, the group was separated into two sub-groups (A and B). Each paired bird was separated to encourage group A to stay close to the enclosure once released. Knowing that the fundamental, permanent social unit is the pair (Snyder *et al.,* 1987; Bradbury, 2003), the team hoped that they would explore Merazonia and return to their captive partners. A total of 4 bonded pairs were found. In so doing, it was possible to test if group A recognized the refuge as a good habitat and influenced the decision of the group B to stay. Group A had 8 members and group B had 7. The parrots not in pairs were divided equally. The groups were separated by a transparent plastic sheet within the enclosure that allowed group A to maintain visual and auditory contact with group B. Two days after the release of group A, group B was released.

Several conditions were established before officially releasing group B two days after group A:

1. If group A should stay close to the enclosure, eating from the feeding stations, the release of group B will proceed after two to three days.
2. If group A should suffer immediate and substantial loss of life, the release of group B will be reassessed.
3. If group A should fly away from the enclosure and are unable to be located, the release of group B will be reassessed.
4. If group A should stay inside the enclosure for an extended period after the doors have been opened, the release of group B will be postponed.

5. If any member of group A stays inside of the enclosure for an extended period once the rest of group A has departed, it will be added to group B.

**Release procedure**

On January 26th, 2017, the day of the release of group A, the three feeding stations were filled before opening the enclosure. At 10h00, the cage was opened for the first group so that parrots could leave and return to the enclosure at their leisure. Each behaviour (exit the cage, enter the cage, eat, fly, interact with other individuals, interact with humans) was monitored by focal sampling while the birds exited the cage. At 12h00, each platform was checked to see if enough food remained. If not, the feeding station was re-filled. If birds had not left, or returned to the enclosure by sundown, the door was closed for the night and reopened the next morning. This continued until no bird entered the cage for a period of more than one week. After that, the cage was officially closed and locked. Finally, two days after the release of group A (January 28th, 2017), and all conditions having been met, group B was released.

**Post-release monitoring**

The birds were fed at 6h30. An observer positioned in an observation tower between 6h30 and 10h00 monitored the behavior of the birds around and in the enclosure (exit the cage, enter the cage, eat, fly, interact with other individuals, interact with humans (physical contact, try to get attention) and also the presence and behavior of other wild animals (exit the cage, enter the cage, eat at the feeder, walk or fly near the cage, interact with the Blue-headed parrot, interact with humans). From 11h30 to 13h30 and 15h00 to 17h00, the observer walked one loop from the enclosure towards the jungle and back around looking visually and via telemetry for individuals and documenting their location and activity. Then, the observer walked along the river and along the road if time allowed or if he heard birds. Individuals without radio-transmitters were found by visual contact and by their calls. If the identification of different individuals was not clear, the observation was not counted. At 11h30, the feeding stations were checked to see if enough food remained. Between 18h00 and 18h30, the feeding stations were cleaned and a last observation around the enclosure was conducted.

For each observation, the time and weather were noted. The weather was classified into 5 categories: sunny, cloudy, light rain, medium rain and heavy rain. The total number of different birds seen during the day was also noted in order to have an idea of how many birds stayed around the area. This number is deliberately conservative in order to be sure not to exaggerate the number of birds seen in one day. Alternatively, the observer needed to be sure that he saw different birds by seeing them at the same time or based on feather patterns. The location of the sightings was taken with a GPS (Garmin 2000 Legend Extrex).

The monitoring respected the following schedule: every day in the first two weeks that all the birds were released, every two days of the third and fourth weeks, every three days of the fifth week and every seven days until April 15$^{th}$, 2017. For those days without an official follow-up, all observations were noted, but the count was not official.

**Statistical analyses**

The association between the number of observations of parrot behaviors within 50 m of feeders and the time elapsed since the release of group B was measured using a Spearman's rank correlation coefficient. An observation of parrot behavior represented the behavior of the birds around and in the enclosure (exit the cage, enter the cage, eat, fly, interact with other individuals or interact with humans). The same method was used to quantify the correlation between the distance of observations of parrot behaviors with respect to the enclosure and the time elapsed since the release of group B.

A release was considered successful if a bird was alive at the end of the monitoring period as well as completely independent of humans (no contact with humans and no use of the feeder). We assessed the influence of explanatory variables on release success using a logistic regression. Explanatory variables were considered one at a time and included the number of years since the bird's arrival at the center, its physical condition upon arrival (wing feathers cut, eye problems), and its pairing status (mated or not).

The significance level was set at 0.05. A total of 31 full days of behavioral observation of the birds and 600 observations of parrot behavior were considered in the analyses. All analyses were conducted within R environment (R Development Core Team, 2016).

## Results

Twelve (80%) of the 15 blue headed parrots reached independence 77 days after release. The remaining three individuals were alive, but still used the feeders. One year after their release, a minimum of 2 individuals have been observed constructing nests. In February 2018, two of the three parrots that remained partly dependent upon feeders joined the rest of the group. On March 2018, only one parrot continued to use the feeders and the release group could still be seen within a radius of 500 meters from the enclosure.

The number of observations of parrot behavior within 50 m of the enclosure showed a significant exponential decrease in time ($r_s$ = -0.863; $p < 0.001$; Figure 2). After 19 days of freedom, food was placed on feeders at 7h30 instead of 6h30 because parrots did not come earlier to eat. Feeder #3 was closed after 33 days. Only 4 observations of birds using feeder #3 were reported and the last one was 16 days before the closure. After 54 days, feeder #2 was also closed since no bird had used it in 20 days. Parrots did not use the different feeders equally as 68.5% of observations were made on feeder #1, 26.3% on feeder #2 and 5.2% on feeder #3.

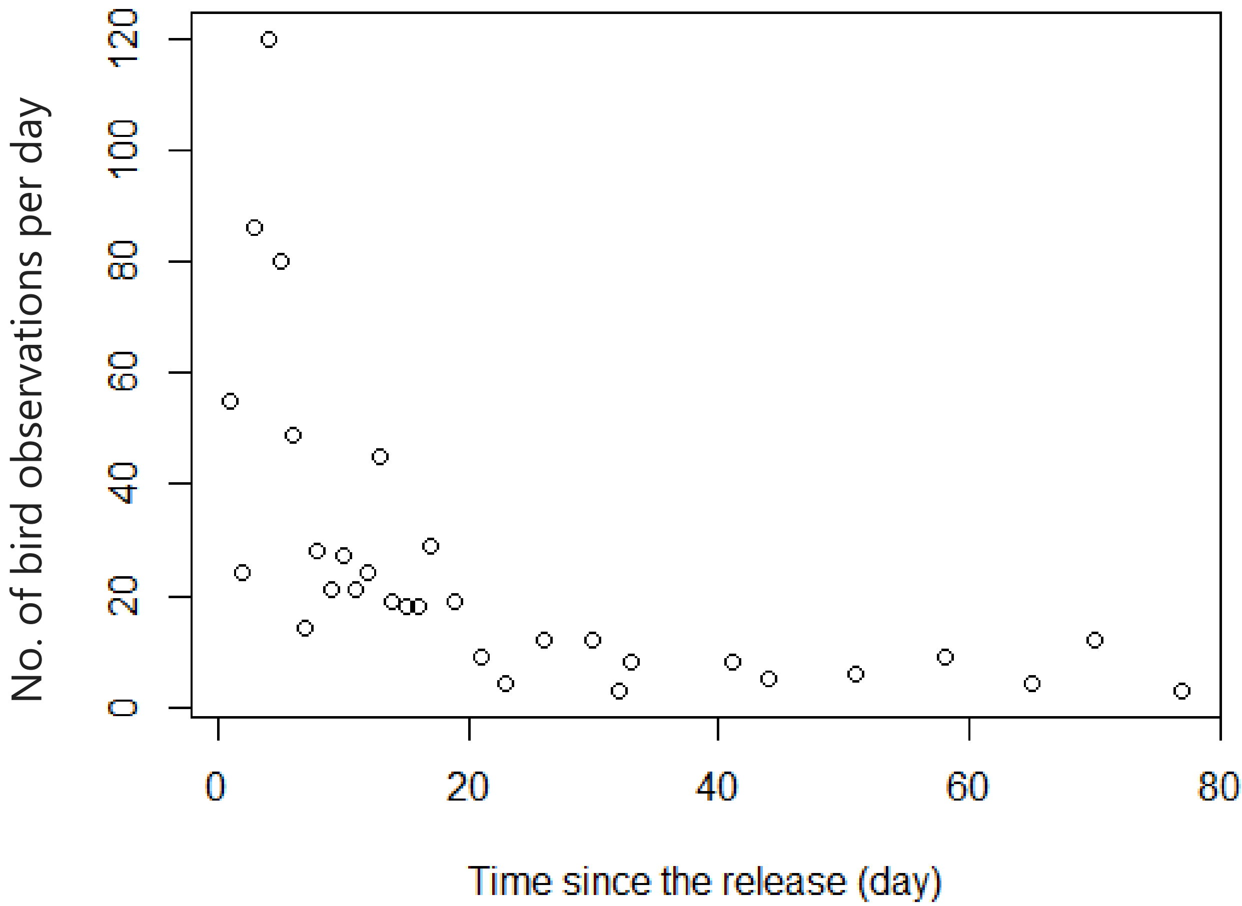


**Figure 2:** The number of observations of parrot behavior per day around a radius of 50 m from the release cage each day of complete follow up (January 26th to April 5th 2017) in Merazonia Wildlife Rescue and Rehabilitation Centre (MWRRC) in Pastaza, Ecuador.

The distance where the birds were found increased with time ($r_s$ = 0.408, $p$ < 0.001; Figure 3 and 4). Although parrots were found farther from the enclosure, they were also more difficult to detect when they were further than 100 m from the enclosure. On 7th March (41 days after the release), a group of 10 wild blue-headed parrots was seen 75 m from the main cage at 8h30 (Yellow circle on Figure 4). On 23th March (57 days after the release), a group of at least 10 blue-headed parrots was found in the jungle at a distance of more than 500 m from the main cage (Green circle on Figure 4). It was not possible to determine if the observed parrots were wild or released ones. On 12th April (77 days after the release), a group of more than 15 blue-headed parrots that seemed in good health was found at the same location, which was dominated by palm tree and without any human installation (Green circle on Figure 4).

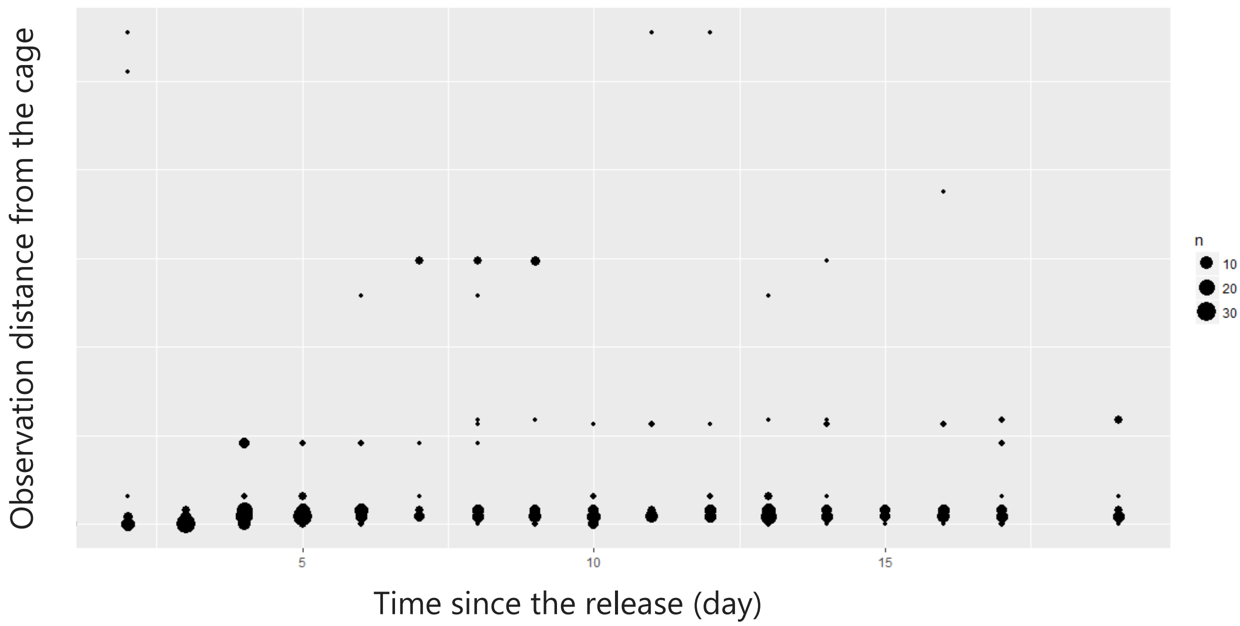


**Figure 3:** Distance of each observation of parrot behavior from the release cage the first 20 days after the release in Merazonia Wildlife Rescue and Rehabilitation Centre (MWRRC) in Pastaza, Ecuador. Every size of point represents the number of points which overlap.

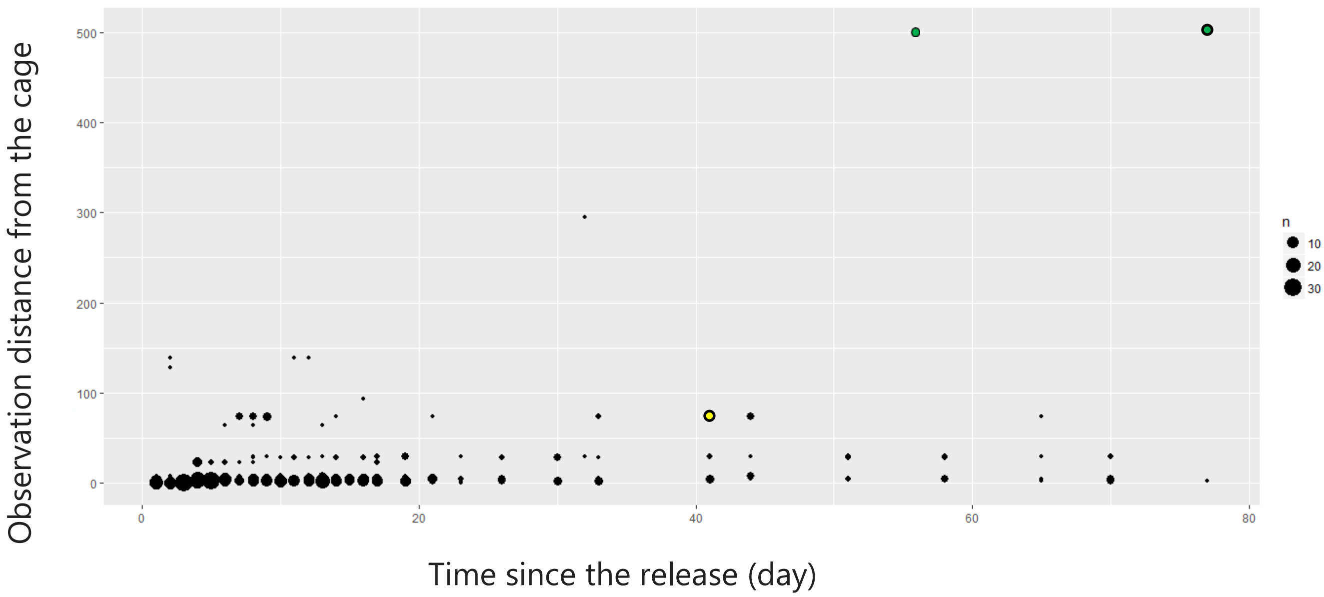


**Figure 4:** Distance of each observation of parrot behavior from the release cage each day of complete follow-up (January 26th to April 5th, 2017) in Merazonia Wildlife Rescue and Rehabilitation Centre (MWRRC) in Pastaza, Ecuador. The yellow circle represents a group of only wild Blue-headed parrots seen near the release enclosure. The green circle represents observation of a part of the release group mixed with wild Blue-headed parrots. Every size of point represents the number of points which overlap.

None of the explanatory variables (i.e., number of years at the center, physical condition upon arrival, and pairing status) influenced release success when considered in a logistic model. The variable that showed the smallest p-value (0.199) was the physical health when the birds arrived at the center. The result of that non-significative observation would indicate that birds with major problems upon their arrival had a greater chance of success than others.

## Discussion

Here we describe one of the first attempts to reintroduce a group of 15 Blue-headed parrots into the wild and monitor their survival after a soft-release program. The progressive diminution of birds around the enclosure (Figure 2) showed that the utilisation of a soft release was useful because they were seen in other parts of the MWRRC. The birds gradually stopped using the feeders probably because they explored a bit more each day and found the resources that they needed in the wild (Figure 3). This result also supports the use of a soft release. It shows that the use of platforms with food is not a factor that creates dependence for the parrots. White *et al.* (2012) showed that the parrots of different release projects had a greater chance of success when food was provided for more than a year. The fact that two birds that were not considered a success joined the others after 400 days shows the importance of keeping the platform open for more than a year.

The preparation before the release to ensure that all the parrots were able to fly and recognize wild food may be a reason for their progressive independence (Reading *et al.,* 2013). Different studies explain that the enrichment before the release was one of the factors that most affected the level of success (Kleiman *et al.,* 2000; Miller *et al.,* 1998).

The observations far from the cage were rare (Figure 4) probably since birds were difficult to detect outside the main paths of the MWRRC. The open space near the release cage as well as the platform facilitated the detection of individuals. The use of telemetry did not improve our detectability of released birds. The first transmitter was lost on the first day. The second bird was only detected when near the cage or in an open area. Merazonia is surrounded by mountains and dense jungle. We think that this dense jungle and mountainous terrain contributed to signal loss and inhibits the use of this type of radio transmitter. White *et al.* (2012) said that this was the main problem in all 47 release projects of his meta-analysis. A better tracking device needs to be used.

No statistically significant link between the success and the individual history was found. The results showed, without a significant p-value, that the individual with major problems had a greater chance of success than the others. This result was curious; it can probably be explained by the fact that the parrots had spent enough time at the centre prior to release to nullify this variable. The meta-analyse of White *et al.,* (2012) explains that even after a major problem, if the birds are in good health at the release date, it should not have an impact on the success. The group's size can also provide some explanation. The degrees of freedom were too small to see the real impact of each variable. It is interesting to note that all types of the parrots were able to achieve success, including those with severe injury, birds that spent more than 2,650 days in a cage and birds that were not paired. These results would indicate that successful release is possible for all parrots regardless of initial status and that the protocol needs to be tested on other groups to bear out this finding.

For the last bird not deemed a success, the team at the center decided that it could still be released in Merazonia, even if it didn't mix with the rest of the group. Its life is not in danger if it remains in the protected area of Merazonia. The center will continue to put food on the feeder until it stops using it.

For a better follow-up, each parrot needs to have clear identification that facilitates its recognition.  The use of feather patterns was good at short distances with binoculars but was not an option when the birds were further than 15 m away. The use of dyes or colored leg bands could mitigate this limitation. According to the Canadian Wildlife Service (2018), dyes used to mark birds is an easy but temporary method. Dyes are rapidly lost through weathering or molt and are rarely obvious for more than a few months. Colored leg bands for small birds come in a variety of colors that give unique combinations because of their placement on the bird and are more durable (Canadian Wildlife Service, 2018).

Wild Saddle-back tamarins (*Saguinus fuscicollis*) were a problem because they scared the birds on the feeders when they arrived and stole the food. The biggest disadvantage was to lose count of the birds around the feeder. It was observed that the tamarins did not have interest for some kinds of food. A regime without food that interests tamarins can be sought and used to reduce their impact on the study. The study of Peres (1993) shows that tamarins eat mainly ripe fruits, insects, and nectar. More nuts, seeds and green vegetables can be given to the blue-headed parrots according to the Southeast Texas Avian Rescue (2011).

The type of feeding platform used during the release needs to be improved. The birds were afraid of the ladder necessary to clean and put food on the platform. A model with a pulley like the one used at feeder #3 will be recommended for all the platforms. It will then be possible to work with the platform without disturbing the birds that come to it. The use of perches around feeders #1 and 2 appear to work well since the number of observations around these is 94.0%. Feeder #1 was the most popular with 68.5% observations of birds on a feeder. This one was in a semi-open area with a connection to the cage far from the door and near to the path where humans circulate. A feeder close to natural shelters such as shrubs is likely ideal to give a place to rest and provide concealment if a predator flies near (Cornell Lab, 2009).

In conclusion, the goals of the study were partially reached. The successful release of 14 out of 15 parrots can be considered a success for the first year, but the follow-up was not as complete as we hoped because of the ineffectiveness (few observations) made with the radio transmitters and the difficulties in differentiating the birds at a far distance. It will be necessary to change the type of tracking devices used and find a better way to recognize individuals. However, it was possible to observe that the release group mixed with a wild one, and even after one year of freedom the parrots remained in Merazonia and are now complete independent. Longer monitoring will be necessary to see if the released blue-headed parrots are able to reproduce and have a viable offspring. Since January 2018, some members of the group have started to build nests. As many studies propose (Garson *et al.,* 1992: Lockwood *et al.,* 2005: Parish and Sotherton, 2007), a successful release is seen when released individuals are able to reproduce.

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