Primates
https://doi.org/10.1007/s10329-021-00945-3

ORIGINAL ARTICLE

# Factors influencing establishment success in reintroduced black-faced spider monkeys *Ateles chamek*

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Received: 14 September 2020 / Accepted: 16 August 2021


## Abstract

Establishing reintroduced primates in a suitable predetermined area has proven to be a challenge. Establishment is the first major step that has to be taken in the long process of reintroduction. When this first goal is not achieved, the chances of success decline drastically. Understanding the main determinants of establishment is therefore crucial for reintroduction success. This study examined the influence of three independent factors on the establishment success of reintroduced spider monkeys. We analysed data from the releases of eight groups of black-faced spider monkeys (*Ateles chamek*), which are part of the official reintroduction program of spider monkeys in the South Eastern Peruvian Amazon. Establishment success was measured by the proportion of individuals within groups that were found in the target area 6 months after release. The hours research assistants and volunteers spent with the group within the first 3 months after release—in the context of post-release monitoring—was shown to have a positive effect on the establishment success of the released group in the target area. The presence of an already established group in the area was also found to have a significant positive effect on establishment success. The influence of the days of post-release food provisioning had no effect. Our findings emphasize the importance of long-term monitoring programs to help increase the efficiency of primate reintroductions.

**Keywords** Establishment · Post-release monitoring · Primates · Reintroduction · Release · Spider monkey

## Introduction

Species reintroduction is known to be a very costly, labour-intensive and time-consuming conservation method (Sarrazin and Barbault 1996). Despite these costly investments, a large number of reintroduction programs have had poor outcomes (Konstant and Mittermeier 1982; Griffith et al. 1989; Grey-Ross et al. 2009) and only few turned into conservation success stories (Kierulff et al. 2012). Reintroduction success or failure depends largely on two phases: establishment and persistence. Success will ultimately be determined by the persistence of the population, but to reach this phase a population first has to get established. This establishment should happen in a suitable area that will then function as part of their home range. This is often the most difficult step in the process, as elevated mortality and dispersal are common during the initial stage (Parlato and Armstrong 2013). Dispersal results in a number of problems (Richardson et al. 2015), often including the inability to conduct post-release monitoring. This is an essential, but often forgotten, part of reintroduction that is crucial to understanding the complexities of species reintroduction (IUCN/SSC Re-introduction Specialist Group 2002; Seddon et al. 1999) and improving animal reintroduction success (Park et al. 2021; Steiner-Bernardo et al. 2011).

The black-faced spider monkey, *Ateles chamek*, is considered Endangered on both the IUCN Red List (Alves et al. 2020) and the national Red List of Peru (Cornejo et al. 2018). Reintroduction programs can play an important role in the protection of this species (Kierulff et al. 2012). In southern Peru, the species went locally extinct in the lower Madre de Dios area within the Tambopata region due to increasing anthropogenic activities. The Tambopata National Reserve management plan of 2004–2008 (INRENA 2003) reports the local extinction of the black-faced spider monkey within this particular area and this species' absence in the area was confirmed in a study by Rosin and Swamy

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Published online: 14 September 2021

(2013), but Swamy (personal communication, December 17, 2020) estimates that the species disappeared from the region between 1980 and 1990. The Peruvian government created the Tambopata National Reserve in 2000 as a response to the increasing anthropogenic pressure and accompanying loss of biodiversity in the region. The protection the reserve brought to local fauna and flora, together with the overrepresentation of black-faced spider monkeys in zoos and rescue centres throughout Peru due to confiscations from the illegal pet trade, allowed a context in which reintroduction was a feasible conservation option. More importantly, it has been shown that the absence of large primates, such as black-faced spider monkeys, influence the structure and diversity of the forests in this region over time (Bagchi et al. 2018). The primary objective of this program is therefore the restoration of ecological processes through the reintroduction of a keystone species.

This study analyses the effect of post-release food provisioning, presence of resident conspecifics at the release site and post-release human presence/support within the first 3 months after release on the establishment of reintroduced spider monkeys within the first 6 months after release. The factors that play a role in the establishment of reintroduced primate groups have rarely been investigated. We believe our experience and the results of this study could therefore provide important information for future primate reintroduction efforts.

## Methods

Since 2010, eight different groups of black spider monkeys have been released within the Tambopata National Reserve with mixed results (Table 1). All the released individuals have a history as a pet. They were either confiscated by the government from the illegal pet trade or were voluntarily handed over to the Taricaya Rescue Centre by people who kept them as pets, but were no longer able/willing to take care of them. They went through an extensive rehabilitation process at the Rescue Centre, before being incorporated into the reintroduction program (Bello 2018). During the rehabilitation process, all individuals underwent extensive veterinary controls to exclude the risk of any zoonotic diseases related to human interaction spilling over to other wildlife. Furthermore, behavioural evaluations were conducted to obtain a better understanding of the intragroup dynamics and relationships before release.

Each release took place in the presence of local authorities to ensure proper protocols were followed and coincided with the start of the rainy season, when there is more food available in this type of forest (Medina 2009). Additional food was only supplied during the first few days/weeks after release if the post-release monitoring had shown that the released individuals were struggling to find enough to eat. The aim of this post-release monitoring program was to check the overall well-being of the animals through observations and the collection of behavioural data to evaluate the adaptation process. This allowed us to recapture individuals in case they were unable to adapt to their new surroundings, separated from the group or showed issues related to their health. The intensity of the monitoring program varied between groups, depending on the available funds for that particular year, but ideally aimed to track and monitor the released individuals on a daily basis for the first month after release and at least once a week until the third month. The frequency was further reduced to sporadic monitoring of the group after the third month of release. Telemetry equipment VHF (Telenax™) and radio collars (TXE-311CB) were used to facilitate tracking the groups (Trayford and Farmer 2012) released in 2013, 2014, 2016 and 2017. Due to a lack of funding, we were unable to use these materials for the releases in 2018 and 2019.

The reintroduction zone is located within the historical distribution of the species and consists of seasonally flooded primary subtropical wet forest according to the Holdridge life zones system (Holdridge 1967). It is situated within the Tambopata National Reserve and its buffer zone, within the following coordinates: 12° 32′ 11.882″ S,

**Table 1** Overview of the different variables and success rate per group

| Release | Year | Hours of post-release observations—3 months | Released in an area occupied by resident spider monkeys | Days of food provisioning after the release | Number of individuals released | Success rate |
|---|---|---|---|---|---|---|
| 1 | 2010 | 12 | No | 0 | 4 | 0.00 |
| 2 | 2011 | 216 | No | 0 | 6 | 0.83 |
| 3 | 2013 | 400 | No | 60 | 5 | 0.20 |
| 4 | 2014 | 720 | Yes | 0 | 8 | 0.50 |
| 5 | 2016 | 500 | Yes | 0 | 4 | 0.50 |
| 6 | 2017 | 360 | Yes | 0 | 6 | 0.33 |
| 7 | 2018 | 80 | No | 4 | 6 | 0.17 |
| 8 | 2019 | 360 | yes | 30 | 4 | 0.75 |

69° 00′ 14.227″ W. The different release sites were placed as far away as possible from any human settlement or activity, but within reasonable distance from the rescue centre to maintain the feasibility of the post-release monitoring.

In order to investigate our questions, we ran a generalized linear model (GLM) with a binomial probability distribution and logit link function using the proportion of individuals within the group that remained in the target area 6 months after release as the response variable, and hours of post-release monitoring during the first 3 months, days of post-release food provisioning and presence of resident groups in the release area (present/absent) as predictors.

The intensity of post-release monitoring was measured as the total number of hours field researchers/assistants/volunteers spent with the released group within the first 3 months after release (Table 1). These hours had to be logged by staff and volunteers. Days of food provisioning was measured as the number of days additional food was provided to the group after release (Table 1). The presence of resident groups in the release area was determined by whether the release site fell within the estimated home range of an already established reintroduced group (Table 1). These home ranges or territories of previously released groups were determined by taking the minimum convex polygon around the outer location points with a 30 m buffer around the polygon (Robbins and McNeilage 2003).

## Results

In total, eight groups, involving 32 individuals and 43 releases, have taken place over the years. The number of individuals and releases is not the same due to the fact that issues related to the health of some individuals (broken limbs after falling out of trees) or adaptation problems (individuals that remained on the ground instead of in the trees) led to the recapture of these individuals. They were then released again the following year, with the next group. 41.8% of all releases were successful in their establishment, meaning they remained in the target area for at least 6 months after their release.

The model indicates that the post-release monitoring hours had a significant effect on the proportion of individuals per group establishing themselves successfully within the area 6 months after the release, with this predictor increasing the odds for successful establishment with 1.001. The presence of an already established group at the release site also showed a significant positive effect on establishment success, with this predictor increasing the odds for successful establishment with 1.608. The days of food provisioning were found to have no significant effect on the establishment success (Table 2).

## Discussion

The analyses showed that the intensity of the post-release monitoring has a significant positive effect on the establishment success of reintroduced spider monkeys (Table 2). A possible explanation for this result is the fact that the vast majority of these released spider monkeys were raised as pets in a captive setting, meaning that their strongest social bond growing up was not with another spider monkey, but with a human on whom they depended for food and protection. Even though all these individuals went through a long process of rehabilitation, it is unlikely to transform a pet into a wild animal within a captive setting—in this case a rescue centre. This continued dependence on humans becomes problematic during releases, as this is a very stressful period for the animal (Meyer and Hamel 2014) during which they can no longer rely on humans for their basic needs. Individuals will often disperse within the first days or weeks after release as a stress response to their new environment (Dickens et al. 2010), and they often end up finding their way back to the rescue centre. This is also why, at least in our experience, it is important to have people with the released individuals during these first weeks after release. The monkeys tend to stay around the release site in those first days and weeks as long as there is a human presence at site with them. This is especially true for people the released individuals are familiar with. This seems to give them a bit more confidence during a stressful period where everything is new to them. Each post-release monitoring team therefore consisted of at least one person who was also part of the pre-release rehabilitation process of that specific group.

**Table 2** Generalized linear model predicting the proportion of individuals per group established within the area of release after 6 months

| Predictor | Estimates | Std. error | Wald Chi-square | Sig | Odds ratio (exp estimates) |
|---|---|---|---|---|---|
| Intercept | −0.576 | 0.270 | 4.571 | 0.033 | 0.349 |
| Post-release monitoring after 3 months | 0.001 | 0.001 | 6.843 | 0.009 | 1.001 |
| Post-release days of provisioning | −0.003 | 0.004 | 0.595 | 0.441 | 0.997 |
| Resident groups in release area | 0.475 | 0.230 | 4.252 | 0.039 | 1.608 |

It is also important to note that upon reaching adulthood, females may disperse naturally in search of a new group to ensure genetic diversity within the population (Shimooka et al. 2008). On the other hand, male immigration may also occur under certain demographic circumstances, but is less common, as they generally stay within their natal groups (Aureli et al. 2013). This tendency of a higher probability of female dispersion in comparison to males was not observed in this study, as females were found to be less likely to disperse within the first 6 months after release than males. This could be related to the females displaying a stronger social bond between them than males during pre-release observations, or it may be that natural dispersion events just do not occur during the adaptation process.

The fact that the presence of an already established group gave a significant positive result (Table 2) is more complicated to explain, even though this factor is clearly more important in our model as the odds ratio indicates an effect size stronger than the post-release monitoring. The groups released in 2013 and 2014 seemed to benefit from the presence of an already established group that may facilitate their adaptation process, as regular fusion events were observed with the group released in 2011, especially during feeding and foraging bouts. However, we also witnessed intergroup aggression from the already established group towards newly released individuals in 2016 and 2017, complicating their chances of successful establishment. Intergroup aggression is well-documented in spider monkeys (Aureli et al. 2006) and the observation that some newly released groups were received with a more welcoming attitude than others is probably on one hand related to the group composition, as resident adult males will be more likely to conduct aggressive behaviour towards other released adult males than to females or juveniles (Valero et al. 2006). On the other hand, groups that were in close contact with each other in the rescue centre before release are already more accustomed to one another and appear less likely to conduct aggressive behaviour when they encounter each other after release, as was the case for the groups released in 2011, 2013 and 2014. It is therefore important that post-release monitoring in the future takes place and more data can be obtained to confirm the importance of this variable.

It is important to note that there are many more different variables that may have an influence on an individual successfully establishing itself in a predetermined area (Parlato and Armstrong 2013). For example, Bello et al. (2018) showed in a preliminary study that the conditions under which the release and post-release monitoring are conducted have an influence on the establishment success of these spider monkeys. Nonetheless, there have been releases where the conditions of the release and post-release monitoring were more than adequate, but not successful (as was the case for the release in 2013). This shows that each individual's response to release is different and that factors related to life history are also affecting primates in their establishment (Bello 2018; Cheyne 2009). Furthermore, predation can play a significant role in the successful establishment of a group. For example, both the groups released in 2011 and 2013 suffered losses from predation by harpy eagles *Harpia harpyja*, which are known predators of spider monkeys (Everton 2018). More information on these post-release events is described in Table 3, which was included to provide additional information. Individuals that are mentioned in the table as "disappeared" are individuals of which we were unable to record any observations for over a year and have not been seen again up to this day and could therefore, but not necessarily, be deceased.

Our findings emphasize the importance of the presence of resident conspecifics in the release area for the success of primate reintroductions as well as post-release human presence/support, although this should be viewed within the context of this specific reintroduction program where the released individuals have a history as a pet. We acknowledge the limitations of our study due to the small sample size and therefore underline the importance of a thorough post-release monitoring program. This will provide the scientific community with more data and will aid reintroduction programs in their decision-making process, which in turn will help increase the efficiency of these programs.

**Table 3** Details on the group composition of the released groups and on the events that occurred after release

| Release year | Group composition | Events within the first 6 months after release | Events after the first 6 months of release up until March 2020 |
|---|---|---|---|
| 2010 | 2♂–2♀ | All individuals disappeared | 1♂ was recaptured in 2012 at a touristic site due to incidents with tourists. This site was 12 km from the original release site |
| 2011 | 3♂–3♀ | 1♂ was attacked by a harpy eagle within the first month after release | 1♂ was killed by illegal hunters. He was the father of the first two offspring born in the wild |
| | | | 1♂ is the current alpha male of the stable group and fathered all the remaining offspring in the wild |
| | | | 2♀ are part of the stable group and have each produced three offspring (2013, 2016 and 2019) |
| | | | 1♀ separated and recaptured in 2014, released again with the group of 2014 |
| 2013 | 2♂–3♀ | 1♂ was recaptured after 2 months due to its inability to adapt to its new surrounding (he remained on ground level) | 1♀ separated from the group and was therefore recaptured to be released again with the group of 2014 |
| | | 1♀ was recaptured during the first month due to a fracture in the forearm after a fall from a tree | |
| | | 1♂–1♀ were attacked by a harpy eagle in the third month | |
| 2014 | 1♂–7♀ | 1♂ was recaptured within the first month because he separated from the group | 1♀ was originally released in 2013, but recaptured to be released again in 2014. She has produced two offspring in the wild, of which one died |
| | | 1♀ was released originally in 2011, but recaptured after 2 years, because she became separated from the group and was living solitary. Released again in 2014, but separated from the group once again, 1 week after release | 1♀ died in 2018, because she fell from a tree. She produced one offspring in 2016 |
| | | 1♀ was recaptured within the first month, because she did not adapt well to her new surroundings | 1♀ had one offspring in 2018, but disappeared later that year. Her baby was adopted by another female |
| | | 1♀ disappeared in the third month | 1♀ separated from the group in 2016 |
| 2016 | 4♀ | 1♀ separated from the group in the second month. She was reported to be in an area 5 km from the original release site, but attempts to recapture her failed | 2♀ remained together and adapted well, but were recaptured after 7 months to be released with the next group |
| | | 1♀ was recaptured after a month, because the already stable group showed aggressive behaviour towards her, which interfered with her adaptation process | |
| 2017 | 2♂–4♀ | 1♂ disappeared during the first month, after being attacked by the alpha male of the stable group | 2♀ adapted well to the wild, but are both living solitary |
| | | 1♂ was recaptured with grave injuries, after a fight with the alpha male from the stable group | |
| | | 2♀ that were already recaptured in 2016, were recaptured again to be released with the group of 2018, as they could lead this group due to their experiences from previous releases | |
| 2018 | 2♂–4♀ | 1♂ separated from the group during the first month and was recaptured | 1♂ who was injured and recaptured in 2017 established himself in the area, but is living solitary |
| | | 4♀ were recaptured in the first weeks after release, because they kept finding their way back to the rescue centre in search of humans. They were released again in 2019 | |
| 2019 | 4♀ | 1♀ was recaptured, because she kept returning to the rescue centre | 3♀ adapted well and established themselves in the same area as the stable group |

**Acknowledgements** This study would not have been possible without Taricaya Ecological Reserve for running this reintroduction program and Kawsay Biological Station for the help with the post-release monitoring of these groups. Furthermore, we would like to thank Tambopata National Reserve, Wildlife Department of Madre de Dios and SERFOR for their authorizations.

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