Vietnamese Journal of Primatology (2017) vol.2(5), 37-49

The ranging patterns of reintroduced pygmy slow lorises (*Nycticebus pygmaeus*) in Cuc Phuong National Park, Vietnam

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Key words: Home ranges, nocturnal primate, translocation, Southeast Asia, Lorisidae

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Summary

The pygmy slow loris (*Nycticebus pygmaeus*) is threatened by hunting and deforestation throughout its range countries. To restock wild populations several organizations use reintroduction as a conservation strategy. In the pygmy slow loris and other *Nycticebus* species reintroductions have yielded low survival rates, leading many to question the welfare of released individuals and the conservation value of reintroduction. In response to these concerns, researchers have begun to investigate critically various aspects of slow loris reintroduction. Here we evaluated the ranging patterns of six released pygmy slow lorises in the former botanical garden of Cuc Phuong National Park, Vietnam. Following ten months of staggered releases and nightly observations, we recorded the nightly movement of three male and three female adult pygmy slow lorises. The mean home range size in males was 81±105 ha (Minimum Convex Polygon); 25±31 ha (Kernel Contouring) and in females 0±2 ha (Minimum Convex Polygon); 9±5 ha (Kernel Contouring). Observed home range sizes in males were larger than those reported for wild and reintroduced pygmy slow lorises. Individuals dispersed out of the release site (N=1), lost their collar or signal (N=2), or were found dead (N=2). A number of factors including territoriality, natal habitat preference induction, and stress play a role in the observed results. Future reintroductions should select a release site with more space than seen in wild home ranges, as released individuals maintain larger home ranges while in a novel environment, as well as consider how individual experiences can have a lasting effect on fitness.

Mô hình di chuyển của loài Culi nhỏ (*Nycticebus pygmaeus*) được di dời đến Vườn Quốc gia Cúc Phương, Việt Nam

Tóm tắt

Loài Culi nhỏ bị đe dọa bởi nạn săn bắn và phá rừng tại tất cả những nước mà loài có sự phân bố. Nhằm tăng số cá thể trong quần thể, một vài tổ chức bảo tồn đã chọn giải pháp di dời các cá thể bị đe dọa và tái hòa nhập chúng như là một chiến lược bảo tồn. Đối với loài Culi nhỏ và những loài khác thuộc giống Nycticebus giải pháp này thường có tỷ lệ sống sót thấp. Do đó, nhiều câu hỏi về sự an toàn của các cá thể được di dời và giá trị bảo tồn của giải pháp này đã được đặt ra. Để tìm câu trả lời, nhóm nghiên cứu đã tiến hành điều tra những yếu tố quan trọng trong di dời loài Culi lớn. Trong nghiên cứu này, chúng tôi đánh giá mô hình di chuyển của 6 cá thể loài Culi nhỏ được di dời vào vườn thực vật cũ của Vườn quốc gia Cúc Phương, Việt Nam.

Chúng tôi đã theo dõi số cá thể nghiên cứu trong đêm và ghi chép sự di chuyển của 3 cá thể đực và 3 cá thể cái trưởng thành, loài Culi nhỏ. Kết quả cho thấy, vùng sống trung bình của các cá thể đực là 81± 105 ha (MCP); 25±31 ha (KC) và 10±2 ha (MCP); 9±5 ha (KC) đối với các cá thể cái. So sánh kết quả về vùng sống trung bình ở nhóm đối tượng nghiên cứu cho thấy vùng sống trong nghiên cứu này cao hơn trong tự nhiên ở cùng loài và cao hơn vùng sống của loài Culi lớn được di dời. Số cá thể di chuyển ra khỏi khu vực nghiên cứu là 1 cá thể (N=1), mất vòng đeo cổ là 2 cá thể (N=2) và chết là 2 cá thể (N=2). Một số yếu tố ảnh hưởng được xem xét là tập tính bảo vệ vùng sống, sự thay đổi môi trường sống ưu thích, và stress. Chúng tôi đề xuất cho những lần di dời sau nên tìm những vị trí có không gian rộng hơn, bởi vì những cá thể được di dời cần vùng sống rộng hơn. Đồng thời cần xem xét kinh nghiệm của từng cá thể trong việc thích nghi với môi trường mới.

Introduction

The pygmy slow loris (*Nycticebus pygmaeus*) (hereafter the pygmy loris) is one of 21 primate species in Vietnam listed as 'Critically Endangered', 'Endangered', 'Vulnerable', or 'Near Threatened' (Roos et al., 2013), largely due to hunting for the pet trade, use in traditional medicine and deforestation (Fooden, 1996; Ratajszczak, 1998; Groves, 2007; Nadler & Brockman, 2014; Nekaris & Starr, 2015). The pygmy loris, like other *Nycticebus* species, is characterised by an unusually long life history relative to body size, slow climbing locomotion, exudativourous diet, nocturnality, and use of torpor (Duckworth, 1994; Nekaris & Bearder, 2011; Rasmussen & Izard, 1988; Ruf et al., 2015; Streicher, 2009). Following years of popularity as a 'social media star' linked with unsustainable wildlife trade, the pygmy loris was up-listed on the International Union for Conservation of Nature (IUCN) Red List from 'Vulnerable' to 'Endangered' in 2016 (pers. comm. Nekaris). As a result of the above-mentioned characteristics and their poor affinity for captivity, the continuous hunting pressure placed on this species is particularly destructive.

Translocation, defined by the IUCN as "the deliberate and mediated movement of wild individuals from one part of their range to another" (IUCN, 2013), is an important conservation tool used to combat high numbers of declining animal populations. Translocation is the overarching term used to define any form of population restoration – reinforcement or reintroduction - and conservation introduction. Despite its frequent use and purported importance to conservation, historically reintroductions have a low success rate (Griffith et al., 1989); the causes of these failures are poorly understood due to the difficulty of post-release monitoring (Fisher & Lindenmayer, 2000) and reluctance to publish negative outcomes. Furthermore, difficulties arise with the way we define success; is it the creation of a self-sustaining population or a pre-determined period of survival immediately following the release? The success or failure of reintroduction is dependent upon short- and long-term processes, including the immediate reaction of releasees to the novel area and the social dynamics of creating a new functional population (Armstrong et al., 1999). Intensive post-release monitoring allows us to determine whether a population that disappears following release has succumbed to stochastic demographic processes, increased post-release mortality, or post-release dispersal (Armstrong et al., 1999). Data on these various components of post-release are important, as they allow the identification of the mechanisms responsible for success or failure of translocation efforts (Griffith et al., 1989; Armstrong et al., 1999).

Only a handful of organisations use systematic slow loris reintroduction and post-release monitoring as a practical, yet expensive strategy to aid in replenishing wild populations, with an attempt at adherence to IUCN Reintroduction Specialist group policies. Throughout their range translocations of *Nycticebus* spp. occur that violate IUCN recommendations to the extent of introducing species outside of their endemic range. This practice may be due to government agencies requiring animals be returned to the wild immediately (Streicher, 2004), but it is also largely due to misconceptions regarding beneficial actions for individual welfare and conservation. Concerns regarding the welfare of translocated individuals have also risen with the increase in unsuccessful and unmonitored releases (Moore et al., 2014). To avoid arbitrary primate releases, it has become increasingly important for organizations to develop a conservation strategy that includes well-planned and well-monitored reintroductions to document and share their work, whether successful or unsuccessful (Kumar et al., 2015). Nekaris & Starr (2015) noted that the limited success of slow loris translocations was associated with scarce knowledge on social, behavioural, and ecological factors, including the variability across species, within this genus.

In Vietnam pygmy loris reintroductions have been systematically carried out with published results by two rescue centres, the Endangered Primate Rescue Center (EPRC) in Cuc Phuong National Park, about 130 km south of Hanoi, and the Endangered Asian Species Trust (EAST) in the Cat Tien National Park about 150 km north of Ho Chi Minh City. The EPRC was the first to report their reintroduction and post-release monitoring of pygmy lorises in 2000 releasing nine individuals into the Cuc Phuong

National Park (Streicher & Nadler, 2003; Streicher, 2004). Streicher & Nadler (2003) observed a high intake of insects and exudates in the released individuals and their sensitivity to cooler temperatures, noting hypothermia as a possible cause of death. EAST has reported on more than 20 released pygmy lorises since 2009 (Kenyon et al., 2014). Kenyon et al. (2014) noted that reintroduced pygmy lorises had a mean home range size of 20 ha, required at least two days in an *in-situ* release cage, and the ideal release season was between June and November (wet season). Following a wild study on this species in Cambodia, Starr (2011) noted that knowledge of the spacing and mating systems of the pygmy loris may lead to the development of useful *in-situ* and *ex-situ* conservation strategies, aiding in estimating population size and the carrying capacity of wild populations. She reported a mean home range size of 22 ha in males and 12 ha in females (Starr 2011).

Home range formation and ranging patterns are essential aspects of long-term survival in all animal species (Schick et al., 2008). Ecological, behavioural, and social factors are known to influence ranging patterns in primate species; researchers have even associated the size and formation of home ranges with stress, specifically in reintroduced individuals (Nekaris, 2011). When trying to establish or re-establish a population, dispersal from a release area is a concern, since this will decrease the number of possible founders and will expose individuals to unknown factors outside of the release site (Allen et al., 1993; Clarke & Schedvin, 1997). Natal habitat preference induction (NHPI) can cause post-release dispersal as some animals show a preference for areas that resemble their natal range (Davis & Stamp, 2004). During the establishment phase of translocations the mortality rates can be higher than seen in a normal population, due to stress and the inexperience of released individuals (Tweed et al., 2003).

In this paper we focus on the ranging patterns of six translocated pygmy lorises at Cuc Phuong National Park. Our aim is to examine their home range formation and to discuss possible contributing factors to the fitness and potential survival of the individual pygmy lorises.

Methods

Reintroduction

All pygmy lorises included in this reintroduction were residents at the EPRC having been confiscated in Vietnam. Once deemed appropriate for release, staggered pair releases took place between October 2014 and June 2015. Prior to release each pygmy loris spent two-three days in a medium sized in-situ pre-release cage (Fig. 1). Releases occurred between 6pm to 8pm, and released individuals were observed using a red-filter head torch (Clulite®).

Fig.1. The temporary release cage at the reintroduction site.

Release Site

The release site was the Cuc Phuong National Park Botanical Garden, the same site used in the EPRC's first release in 2004. Relying on informal accounts, no pygmy loris population has been seen since this initial release, but no formal population survey was conducted prior to the releases in this study. Strictly based on the same criteria used in 2004, which is the sighting of a wild pygmy loris in 1999, the site was deemed a suitable release site in this study (Streicher & Nadler, 2003). During retrospective surveys there was no presence of predators and the fence surrounding the 120 ha area provided added security from hunters. Characterised by tall continuous tree coverage, a dense variety of vegetation, and large limestone hills covered in sparse primary forest. As the area was a former plantation, many trees have remained in planted rows but much of the area has become overgrown, further contributing to the vines and branches that increased connectivity.

Radio-tracking

Each released pygmy loris was fitted with a collar (4 g Holohil® transmitters model PD-2C) prior to being placed in the pre-release cage at the release site (Fig. 2). This allowed us to track them on foot from the date of release until the lifespan of the collar elapsed, the collar fell off or trackers were unable to locate dispersing animals (Fig. 3). Staff members from the EPRC were trained in radio-tracking methods using an antenna and a handheld radio receiver (IcomInc® receiver model ICOM IC-R10) and each animal was located and observed each night between the hours of 6pm and 3am. When possible, prior to each night shift, sleeping sites were located, this aided in forming trails and locating individuals at night (Streicher & Nadler, 2003). Due to the dense vegetation in which pygmy lorises regularly slept, triangulation was used to pinpoint the location of an individual when it was not possible to make a reliable visual confirmation. GPS points were recorded on both a Garmin 64S and Garmin eTrex 10, by the observer (Fig. 4).

Fig.2. Pygmy loris fitted with a 4g radio collar (Holohil® transmitters model PD-2C). Photo Tilo Nadler.

Fig.3. Released pygmy loris with radio collar. Photo Tilo Nadler.

Fig.4. Daily night tracking to download the coordinates of the released lorises. Photo Tilo Nadler.

Home range calculation

Kenward (2001) defines home range as the area traversed during normal activity. Based on the techniques employed to analyse location data, the size and shape of a home range can appear differently (Lawson & Rogers, 1997). Minimum convex polygons (MCP) are commonly used and are easy to calculate. Kernel contouring (KC) uses more complex calculations to estimate the density of a distribution at any point (Seaman et al., 1998). Here we used both MCP and KC to analyse the GPS data in Ranges $8_{v2.16}$. (Anatrack LDT). We defined the home range as 95% of the area covered by the individual and the core area as 50% of the area covered (Pope et al., 2004; Sharpe & Goldingay, 2007). To calculate these areas, we analyzed the collected GPS points using a convex polygon with the selected cores of 95% and 50% and a focal site peel. Additionally, we analyzed data points using Kernel Contour with selected cores of 95% and 50%, a fixed kernel type, location density contours, and a smoothing multiplier of 1. We analyzed range overlap including areas within 95% and 50% of individual home ranges. To measure area development we performed an incremental area analysis with the same procedure used to calculate the home range sizes in both Minimum Convex Polygons and Kernel Contours in Ranges $8_{v2.16}$. (Kenward et al., 2008).

Statistical analyses

We used SPSS version 23 to calculate descriptive statistics, excluding outliers we calculated mean home range sizes and standard deviations, we also calculated median, which included all individuals. Home range sizes between males and females were compared using the non-parametric Mann-Whitney U test, with an alpha-value of 0.05 signifying significance.

Results

Home range size

The average home range size for males was 81±105 ha (MCP); 25±31 ha (KC), while the average size for females was 10±2 ha (MCP); 9±5 ha (KC). The median home range size for males was 156 ha (MCP); 47 ha (KC) and 9 ha (MCP); 2 ha (KC) for females. Though males maintained a larger home range compared to females there was no statistically significant difference. Table 1 details the individual home range areas, including the number of fixes. It is important to note that some lorises were observed for a longer period of time, which is evident in the number of fixes collected for each pygmy loris.

Table 1. Observed home range sizes of six pygmy lorises, presented in hectares (ha) for 50% and 95% of the home range calculated in Ranges $8_{v2.16}$ via Convex Polygons and Kernel Contouring. ± SD is provided where the mean home range size is presented between males and females.

ID	# of fixes	MCP 50% (ha)	MCP 95% (ha)	Kernel Contour 50% (ha)	Kernel Contour 95% (ha)
F_1	20	4.87	8.48	4.66	11.98
F_2	85	7.61	11.58	4.63	12.14
F_3	125	8.84	9.26	.58	2.49
Mean		**7.10±2.03**	**9.77±1.61**	**3.29±2.34**	**8.87±5.52**
Median		**7.61**	**9.26**	**4.63**	**11.98**
M_1	495	137.35	156.12	16.37	47.39
M_2*	65	601.72	669.65	48.51	196.71
M_3	145	.76	6.84	.54	3.21
Mean		**69.05±96.58**	**105.55±105.55**	**8.45±11.19**	**25.3±31.23**
Median		**137.35**	**156.12**	**16.37**	**47.39**

* Denotes excluded outlier

Overlap

All pygmy lorises overlapped within 95% of their home range (Fig. 5), at 50% of the home range, the core; there was less overlap (Fig. 6). Due to the staggered release and the variable number of days observed temporal overlap varies. M1 was present during the entire observation period and overlapped with all subsequent pygmy lorises. F3 and M3 overlap for one month in January 2015, while F1 and M2 overlapped in May and June 2015.

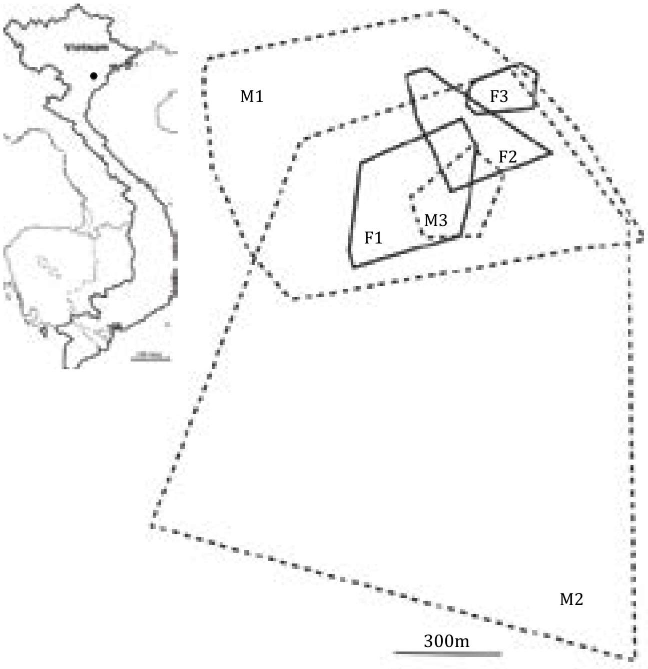


Fig.5. All pygmy lorises overlapped within 95% of their home range (Minimum Conex Polygons; males: dotted line, females: solid line). The study site is indicated by a black dot on the map of Vietnam.

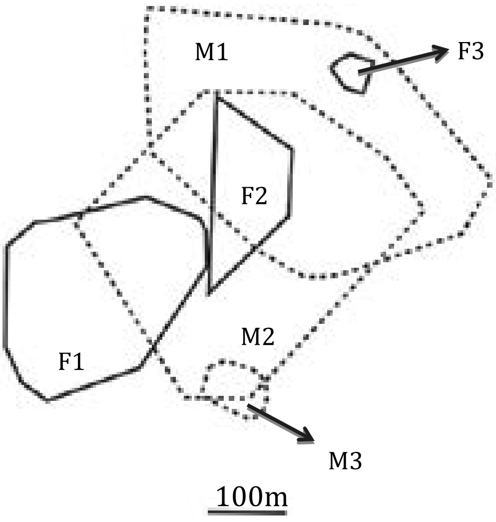
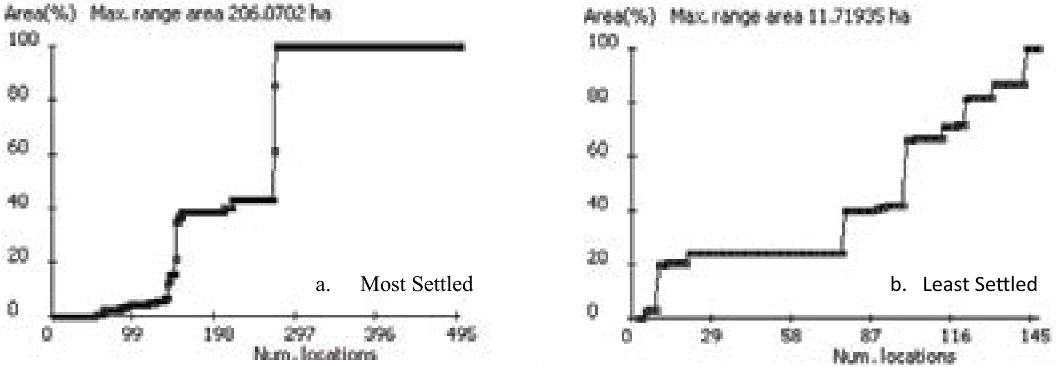


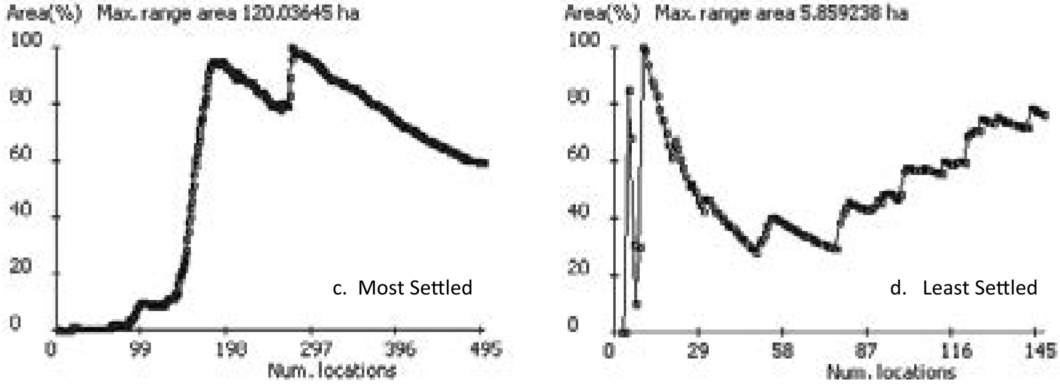
Fig.6. At 50% of the home range, the core; there was less overlap. (Minimum Conex Polygons; males:dotted line, females: solid line).

Incremental Area Development

The number of fixes it took before reaching a more stable home range was variable and some individuals never reached a consistent home range size during the study period. M1 was the only individual who displayed a graph where he plateaued at ~ 280 fixes (Fig. 7a). M3 continuously increased his area, never remaining consistent (Fig. 7b). The incremental areas differed between the method of analysis with MCP displaying more settlement and KC displaying a much less settled home range (Fig. 7c and 7d).



MCP



KC

Fig.7. Incremental area for M1 and M3, showing how individual settlement varies. The top two graphs were created using convex polygons and the bottom two were created using kernel contour. Max range area represents 100% of the home range.

Post-release Status

Of the six released pygmy lorises reported in this study, we only know that M1 settled into the release site. We suspect that F3 remained in the area as well, following occasional sightings of a habituated female with similar pelage throughout the observation period. Two pygmy lorises (F2 and M3) died of unknown causes, but there was no evidence of wounds indicating an attack. We lost F1's signal very early into the study period and she was never seen again. Following dispersal out of the release site we lost M2's signal, and we were unable to relocate him again.

Discussion

Homerange size and formation

Home range sizes in the reintroduced males were larger than those reported in wild pygmy lorises in Cambodia (Starr, 2011) and the translocated pygmy lorises in Dao Tien National Park (Kenyon et al., 2014). In this study individuals were lost due to long-range dispersal and detached collars. Of the published slow loris translocations, individuals traveling long distances and disappearing soon after release is a common problem (Streicher & Nadler, 2003; Streicher, 2004; Keyon et al., 2014). The incremental area development of these six released pygmy lorises provides a unique view on their ability to acclimate to a new area.

Measuring the development of pygmy loris home range can act as a proxy for adaptability in primates (Ossi & Kamilar, 2006), as it represents behavioural flexibility, showing how quickly an individual is able to settle into a new environment (Wright et al., 2010). In a study of wild and reintroduced Javan slow lorises (*Nycticebus javanicus*) in Indonesia, wild slow lorises displayed an incremental area development graph where 100% of their home range was identified in fewer fixes compared to the reintroduced slow lorises. Once they were observed in 100% of their home range the graphs plateaued showing that they were settled in the observed area, while the translocated Javan slow lorises continued to expand their area, which never stabilized (Nekaris & Rodes, 2013). In other translocated animals, unusually large or small home ranges, and previously unobserved ranging patterns are commonly reported, but many of these individuals normalize their behaviour in a matter of weeks or months (Molyneux et al., 2011; White et al., 2006; Tweed et al., 2003). The current observation period for this study included ten months, and a similar level of normalization was not observed, suggesting that these pygmy lorises were not as behaviourally flexible as the individuals or species in the above studies.

In regards to home range fidelity, Starr (2011) observed a saturation point after a range of 100 to 300 fixes between wild males and females. Here the first released male (M1) was the only pygmy loris that reached a point comparable to a saturation point seen in settled wild animals. To uncover the maximum area covered by M1 required 297 fixes. Other individuals' areas continued to grow suggesting instability in their home range formation. M2 maintained a small part of his ultimate area, but at the 40th fix, he moved to a completely new area, significantly widening his calculated home range.

Based on previous field reports of home range size, it was believed that the national park's former botanical garden (120 ha) would be large enough to support multiple pygmy lorises. The variation present not only between wild and translocated pygmy loris home ranges, but also between two translocated populations seems to be based on an unidentified factor, leading us to conclude that practitioners should overestimate the space needed for translocated pygmy lorises to establish a stable home range. During their release and in response to this novel environment, pygmy lorises will traverse large areas as they 'survey' the release site and hopefully settle into an ideal location within it. Kelt et al. (2014) observed larger home ranges in the reintroduced riparian brush rabbit (*Sylvilagus bachmani riparius*) compared to wild individuals, but hesitated to offer an explanation other than the effects of the varying topography. This may explain the differences seen between home range sizes reported at EAST and those observed at the EPRC.

Males tended to move outside of our discernible radio signal range, except for M1 who we were able to observe for the longest period of time. This individual was not only released first, but was released nearly two months before another male was reintroduced into an adjacent area. M2 and M3 spent the initial part of their post-release overlapping with M1, but eventually travelled far outside of his established territory. Partitioning territories is typical in wild slow and pygmy lorises as they are highly territorial (Fischer et al., 2003), but in this instance M1 maintained an unusually large home range of 156 ha (MCP)/47 ha (KC), accounting for all or half of the release site. The subsequent dispersal by M2 and M3 was no surprise, but the sheer size of M1's home range was surprising and caused M2 and M3 to move large distances to leave this claimed area. The home range reported for M2 is better described as a dispersal range, as he occupied very little of the area included in his calculated home range.

In contrast to the released males, the released females did not to our knowledge disperse out of the release site, and maintained smaller home ranges compared to those of the males. Reduced observation periods in females were largely due to lost and faulty collars; this also hindered our evaluation of their home range size. We did however continue to see these individuals within the release site throughout the observation period and on occasion we saw F2 and F3 interact with M1.

The overlap seen in the male and female home ranges further supports the proposed promiscuous mating system in pygmy lorises (Starr, 2011), which is contrary to the mating system seen in other *Nycticebus* species (Nekaris, 2014). Wiens & Zitzmann (2003) observed spatial groupings in greater slow loris (*N. coucang*) representative of a monogamous mating system and across slow loris species this is the accepted mating system. Female lorises are known to display aggression and territoriality, as they only share their wild territory with their offspring and one-three males (Nekaris et al., 2013). On the other end of the spectrum female tolerance has also been observed in captive Bengal slow loris (*N. bengalansis*) housed together in groups of three to four adults, their offspring and one male (Poindexter & Nekaris, 2014). Here we saw evidence of both the territorial and the tolerant female pygmy loris as they overlapped with each other in areas included in their 95% home range, but no overlap was observed in areas included in their 50% core area.

Stress

An animal's survival in a new environment depends on the individual's ability to: secure resources, orientate themselves, decide how to respond to environmental stimuli and maintain the location of conspecifics and predators (Teixeira et al., 2007). Mendl (1999) found that stress might influence animal survival by disrupting processes involved in decision-making. Hormones, such as epinephrine and vasopressin are released during stressful events, and can affect memory storage (Gold & van Buskirk, 1978). In a chronically stressed animal, the short-term behavioural changes needed to alleviate acute stressors no longer aid survival, but become harmful to the animal, leading to pathological conditions (McEwen, 1998). Transfer of an animal from a known area to a novel environment stimulates both the glucocorticoid response, which is associated with learning and memory, and the fight-or-flight response (Roozendaal et al., 1997; Hennessy et al., 1995). Stress can contribute to reintroduction failure by increasing the animal's vulnerability to the effects of chronic stress (Dicken et al., 2010). The direct cause for failure is likely external factors, but vulnerability to these external factors is worsened by chronic stress among the reintroduced individual.

Though we are unable to identify the exact cause of death in the deceased pygmy lorises in this study, there was no evidence of an attack from either a conspecific or a predator, leaving us to suspect that the cause was starvation, an illness, or poor acclimation to the environment. Starvation is often cited as a cause of mortality during the establishment phase of reintroductions (Islam et al., 2008; Rosatte et al., 2002; Work et al., 1999). The hypothalamic–pituitary–adrenal (HPA) axis plays a very important role in the regulation of food intake and metabolism (Dallman et al., 1993). A dysfunctional HPA axis, caused by chronic stress, will lead to both decreased feeding (Herzog et al., 2009) and increased energy requirements (García-Díaz et al., 2007) putting animals into a negative energy balance. Regardless of the suitability of the release site, this negative relationship will put the stressed reintroduced individual in a vulnerable position and much more susceptible to starvation, or other external factors. Additionally the pygmy lorises in this study travelled great distances throughout the observation period, causing them to exert extra energy.

Natal habitat preference induction (NHPI)

The post release dispersal seen in these pygmy lorises may be the result of NHPI. Even in cases where there is no question about the suitability of the release site, NHPI can lead released individuals to leave the release site seeking familiar environmental cues. Marbry & Stamps (2008) showed that brush mice (*Peromyscus boylii*) will settle in a habitat type similar to their natal habitat more than expected by chance. Hanghland & Larsen (2004) reported similar behaviour in red squirrels (*Tamiasciurus hudsonicus*) where given the choice between logged or intact conifers forest individuals selected the option that reflected their natal habitat. One major component of NHPI is associative learning; this speaks to the complex cognitive processes present in these species. Further study of the pygmy and slow loris cognitive capacity may shed light on the extent to which NHPI influences *Nycticebus* translocation successes. Unlike wild studies looking at NHPI the pygmy lorises in this study did not have the option to decide between habitat types. Our limited knowledge of their individual origin, especially their natal habitat type, limited the opportunity to include their characteristics as a criterion for release site selection.

Conclusion

Territoriality, chronic stress and the negative effects that stress can have on physiological process, as well as, NHPI are all possible explanations for the unusual ranging patterns and deaths seen in this reintroduction study. Following further examination and consideration, we conclude that the Cuc Phuong National Parks former botanical garden is no longer suitable for future pygmy loris releases. It is increasingly apparent that this area is not large enough to support multiple reintroduced male pygmy lorises. Having seen the post-release dispersal in the 2014-2015 release and the lack of a viable re-established population after the 2004 release, it is clear that some needed resources in this area are missing, or that the reintroduced individuals were not prepared to handle the added stressors associated with reintroductions. Beyond the former botanical gardens, Cuc Phuong National Park may have a flourishing population of pygmy lorises. Following population, predator, and forest structure surveys; it is possible to find a more suitable release site for future reintroductions. Though it was not particularly successful in this study, evident in the successes seen in Cat Tien National Park, reintroductions should still be considered a valuable conservation strategy for the pygmy loris. Learning from both successful and unsuccessful reintroduction programs is vital to improving practices for individual release candidates and for the species as a whole.

Acknowledgments

This work was completed in conjunction with the Endangered Primate Rescue Center (EPRC) in Cuc Phuong National Park, Vietnam. We would like to thank the Director of Cuc Phuong National Park, Truong Quang Bich and the Vice Director, Do Van Lap. Additionally, we want to thank all of the animal caregivers at the EPRC, who supported this study's tracking and observation efforts. A special thanks to Tilo Nadler and Sonya Prosser, who provided needed resources and support throughout the data collection, analysis, and the writing of this article.

The reintroduction of lorises into Cuc Phuong National Park was generously supported by an anonymous donor. For the comprehensive studies on lorises we thank the Margot Marsh Biodiversity Foundation, People's Trust for Endangered Species, the Little Fireface Project, the Mohamed bin Zayed Species Conservation Fund, the Primate Society of Great Britain, the European Human Behaviour and Evolution Association.

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