

Current conservation status of Germain's langur (*Trachypithecus germaini*) in Vietnam

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Abstract Following the split of the silvered langurs of Indochina into two species based on molecular and phenotypic data, there is a need to reevaluate their distribution and update their conservation status. Here, we report the distribution and assess the population size of Germain's langur (*Trachypithecus germaini*) within its known range across Vietnam. We confirmed this species at six of seven survey sites in different habitats within three provinces in the Mekong Delta Region, including semi-evergreen forest at the Seven Mountains of An Giang Province, mangrove forest in Ngoc Hien and Nam Can Districts and *Melaleuca* forest in U Minh Ha National Park of Ca Mau Province, and limestone forest at Kien Luong Karst Area and semi-evergreen and evergreen forests at Phu Quoc National Park of Kien Giang Province. We found no evidence of this species in Mui Ca Mau National Park, Ca Mau Province where it was previously reported. We conservatively estimate that the total population of Germain's langurs in Vietnam consists of 362–406 individuals, with the largest population found in the Kien Luong Karst Area. Hunting and habitat loss are severely impacting Germain's langur, resulting in the extirpation of the population in Mui Ca Mau National Park and small, isolated populations in the Seven Mountains and Ngoc Hien and Nam Can Districts. However, the ability of this species to inhabit a wide range

of forest types, and its increasing population sizes in Phu Quoc National Park and Kien Luong Karst Area, provide signs of hope that continued conservation actions may help in its long-term survival.

Keywords Colobine · Distribution · Population size · Presence/absence method · Best count

Introduction

Vietnam has the highest number of primate taxa in mainland Southeast Asia with 24 species (Blair et al. 2011). Included are 11 species of colobine monkeys (Cercopithecidae: Colobinae), seven of which belong to *Trachypithecus* making this the most speciose genus in Vietnam (Roos et al. 2014). Despite having a high number of species, most populations of members of this genus likely consist of fewer than 300 individuals, for example the Cat Ba langur (*Trachypithecus poliocephalus*) has a population of about 60 individuals (Leonard, personal communication). The one known exception is the Hatinh langur (*Trachypithecus hatinhensis*), which has an estimated population size of 2,143 (± 467) individuals in Phong Nha-Ke Bang National Park (Haus et al. 2009). However, this estimate was generated based on computer modeling of the observation of 27 groups with a total of 93 individuals (Haus et al. 2009) and there is some uncertainty about the accuracy of this estimate. The primates of Vietnam are threatened by hunting, illegal trading, habitat loss, and forest fragmentation (e.g., Ratajczak 1989; Baird and Ha 1996; Li and Li 1998; Baker 1999; Nadler et al. 2007; Nadler and Brockman 2014), causing a rapid decline in the population sizes of many primate species, including members of *Trachypithecus*. Without robust population

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estimates and distribution information, effective conservation plans for a species cannot be designed.

Current research suggests that the distribution of the two silvered langur species is divided by the Mekong River with Germain's langur, also known as the Indochinese silvered langur (*Trachypithecus germaini*) found to the west and the Annamese langur (*Trachypithecus margarita*) to the east (Nadler et al. 2005; Roos et al. 2007, 2008; Hoang et al. 2012a). In Vietnam, Germain's langur has a small distribution range in the Mekong Delta. This species can be found in at least eight sites in Cambodia (Moody et al. 2011) which is thought to be home to the largest population, while in the Lao People's Democratic Republic (PDR) only one site was confirmed for the species (Timmins et al. 2011). The species has been reported to extend to Kanchanaburi Province in western Thailand up to the Bay of Bengal in Myanmar (Groves 2001; Nabhitabhata and Chan-ard 2005) but details of its distribution and population size are presently unknown.

Since the recent taxonomic split, there has been no systematic survey of the population size and distribution of Germain's langur in Vietnam although estimates for a few populations in Kien Giang Province are available, such as ca. 45 individuals in Phu Quoc National Park (Le and Nguyen 2010) and ca. 200 individuals in Kien Luong Karst Area (Hoang et al. 2012b). There are no recent estimates for populations from other sites in Ca Mau and An Giang Provinces for which there are historical records of their occurrence. Here, we provide the first information on the population size of Germain's langur in Ca Mau and An Giang Provinces and reassess the total population size and distribution of this species in Vietnam.

Methods

We conducted intensive surveys at seven locations in three provinces (Fig. 1), from April 2014 to December 2015. Two surveys were conducted in the Seven Mountains of An Giang Province, including one reconnaissance survey of 4 days in May 2014 and an intensive 10-day survey in November 2015. In Phu Quoc Island, a rapid assessment was carried out for 4 days in June 2014 and an intensive 15-day survey in July 2015. Because the distribution of this species in the Kien Luong Karst Area was relatively well known, only one survey was conducted on this population for 12 days in October 2015. In Ca Mau Province, a 5-day survey was conducted at U Minh Ha National Park in December 2014, and a 16-day survey was conducted at Mui Ca Mau National Park, Tam Giang I Protection Forest, and Ngoc Hien Forest Enterprise in November 2015.

Background information about this species and its distribution was obtained through interviewing local people

during reconnaissance surveys. The presence/absence method (Ross and Reeve 2003) was used to confirm the distribution of the species for most survey sites. In addition, the distance method (Buckland et al. 1992; Thomas et al. 2010) was employed to estimate population sizes in Phu Quoc National Park, Mui Ca Mau National Park, Tam Giang I Protection Forest, Ngoc Hien Forest Enterprise, and U Minh Ha National Park by three survey teams consisting of two to three people each. In Phu Quoc National Park, we conducted surveys on 13 transects totaling 21.4 km. Each transect was walked for 2 consecutive days. In U Minh Ha National Park, we covered four transects of 18.3 km. For the remaining three sites in Ca Mau Province, transects followed canals and boats were used to travel through the forests. The total transect length was 41.8 km, of which 28 km (16 transects) were in Mui Ca Mau National Park, 5.5 km (seven transects) in Tam Giang I Protection Forest, and 8.3 km (seven transects) in Ngoc Hien Forest Enterprise. However, Germain's langurs were only sighted 13 times, of which ten were in Phu Quoc National Park and three in Ngoc Hien Forest Enterprise. Due to this low encounter rate, it was not possible to provide a robust population estimate based on the distance method. Therefore, we used direct count for surveys in these areas. In Kien Luong Karst Area and Seven Mountains, due to the small area of each isolated hill, four observer groups were positioned around the hill to observe the langurs and count the number of individuals seen on 3 consecutive days. Hence, the population size was estimated based on the best count (Ross and Reeve 2003) for each hill.

In addition to the number of individuals observed, we also recorded the age class of each individual in four categories: adult, juvenile, older infant and younger infant. A sub-adult category was not used because the difference between sub-adult and adult is not obvious for this species. An individual was defined as an older infant if that animal was small and has silvered pelage, indicating that it was likely 1–2 years old. An individual was defined as a younger infant if it had a golden-orange pelage, indicating that it was likely less than 1 year old.

Results

In Vietnam, Germain's langur is found only in the three provinces of An Giang, Kien Giang and Ca Mau. There is no information about the occurrence of this species in other provinces located west of the Mekong River in Vietnam. Moreover, local people have not observed or reported sightings of this species in other protected areas which have suitable habitats such as Tram Chim National Park of Dong Thap Province, Lang Sen Nature Reserve in Long An

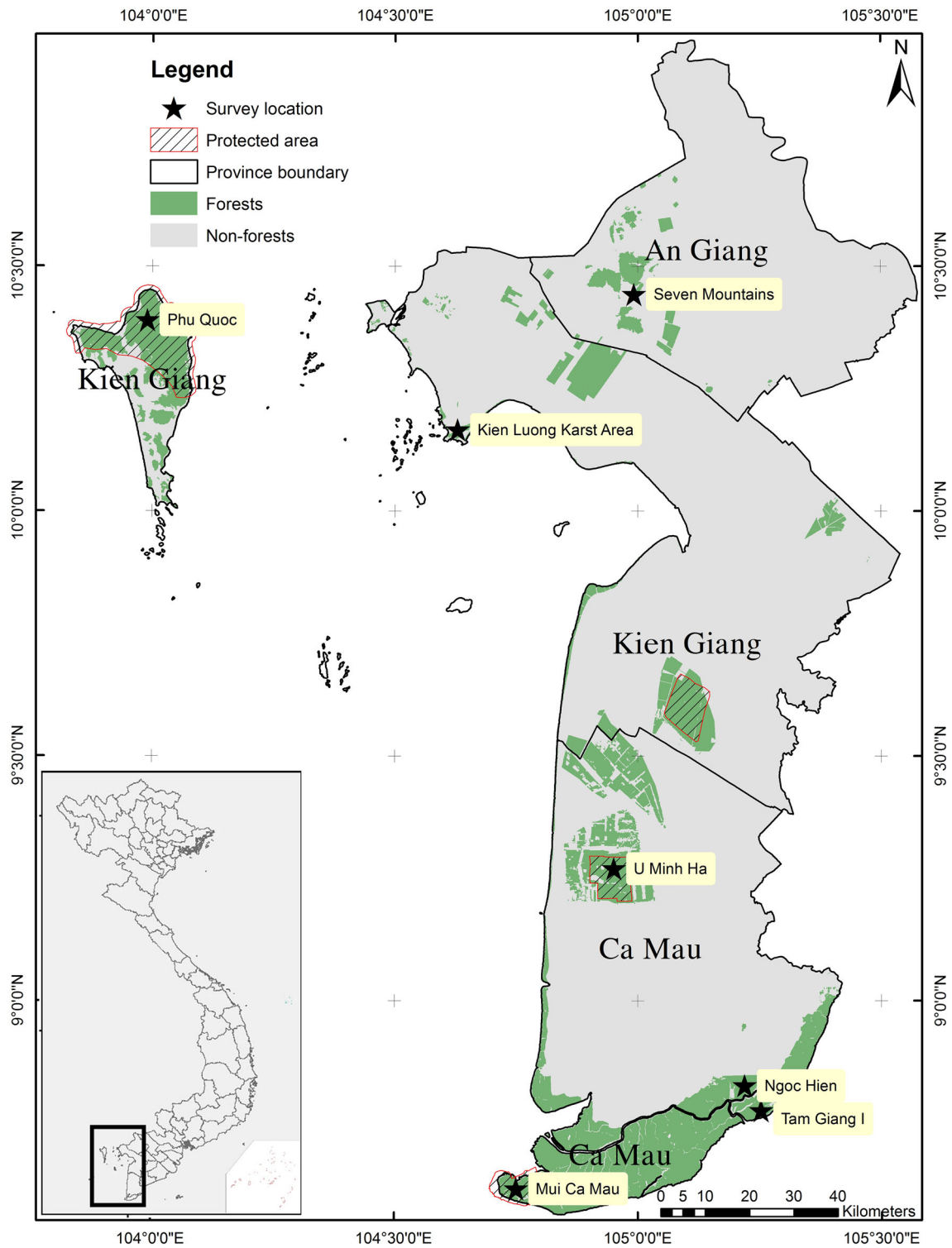


Fig. 1 Forest distribution and survey locations of Germain’s langur (*Trachypithecus germaini*) in the three provinces of Vietnam reviewed in this study

Province, and U Minh Thuong National Park of Kien Giang Province. Based on our research, we estimated that the total population size of this species in Vietnam is between 362 and 406 individuals (Table 1), and the largest

population comprises 286 individuals in Kien Luong Karst Area of Kien Giang Province.

The langur population in Kien Giang Province is divided into a mainland population inhabiting the Kien Luong

Table 1 Estimated population sizes of Germain's langur in Vietnam

Location	Main habitat	Area (ha)	Groups	Individuals		
				Observed	Interviews	Total
Phu Quoc National Park, Kien Giang Province	Semi-evergreen and evergreen forest	31,422	9	54	–	54
Kien Luong Karst, Kien Giang Province	Karst forest	212	13	286	–	286
U Minh Ha National Park, Ca Mau Province	<i>Melaleuca</i> forest	8527	1	3	7	7 ^b
Tam Giang I Protection forest, Ca Mau Province	Mangrove forest	5626	2–3	–	20	20
Ngoc Hien Forest Enterprise, Ca Mau Province	Mangrove forest	23,100	3–6	14	20	34
Seven Mountains, An Giang Province	Semi-evergreen forest	1500 ^a	1	5	–	5
Total				362	47	406

^a Area for Nui To only

^b This number is based solely on the interview data since interviewees were reporting on the same location where the langurs were observed by park staff

Karst Area and an island population living in Phu Quoc National Park of Phu Quoc Island. The Kien Luong Karst Area consists of 21 small karst hills which are isolated from one another by cultivated land and human settlements. Among these karst hills, Germain's langurs are found only on four, with a total of 286 individuals (Table 2), with the largest population on Chua Hang hill. On Phu Quoc Island, the langurs are found primarily in Phu Quoc National Park, located on the north side of the island with 26,986 ha of natural forest (Phu Quoc National Park 2007). Here, we recorded at least 54 individuals from nine groups based on ten sightings. In 2010, it was estimated that there were 31–44 individuals from seven groups in the national park (Le and Nguyen 2010). Demographic data of this population were not collected because it was difficult to observe the langurs in thick forest canopy and they were sensitive to human presence and fled very quickly.

On Nui To Mountain of the Seven Mountains area of An Giang Province, we observed only one group of five individuals consisting of one adult male, two adult females, one juvenile and one unknown. Hoang et al. (2012b) also observed five individuals at this location without noting information on age and sex. This group is likely the same as the one we observed during our survey. However, one female langur skeleton was collected by local people in 2014 which means that at least one individual died between

2012 and 2014, and at least one individual was born into this group.

The occurrence of Germain's langur in Ca Mau Province was confirmed in Mui Ca Mau National Park up until 1997 (Nadler et al. 2003) but there is no evidence for its continued existence based on our current study. The species had been reported in Ngoc Hien District, but it was considered extirpated in this area in recent years (Nadler et al. 2003) until the re-discovery of a group of five individuals at a shrimp farm in Tam Giang III Commune of Ngoc Hien District (Hoang et al. 2012b). The forest areas in Tam Giang III Commune are under the management of Ngoc Hien Forest Enterprise and we found three groups with a total of 14 individuals in two forest sectors of the forest enterprise, one of which was likely the group observed by Hoang et al. (2012b). The local people confirmed the presence of two additional groups of about 20 individuals in another forest sector that is separated from the other sectors by a large canal. Based on this information, we estimated the population of Germain's langur in the Ngoc Hien Forest Enterprise to be between 14 and 34 individuals.

While we did not observe langurs in the mangrove forests near the coast in Tam Giang I Commune (Nam Cam District), interviews with local people suggested that about 20 langurs still occur here. In addition to mangrove forests,

Table 2 Population size and age class of the silvered langur sub-populations in Kien Luong Karst Area

Location	Area (ha)	Population size	Groups	Adult	Juvenile	Older infant (1–2 years old)	Young infant (<1 year old)
Chua Hang	56	131	5	85	37	3	6
Mo So	73	21	2	13	6	0	2
Lo Coc	12	25	1	15	6	4	0
Khoe La	71	109	5	74	25	6	4
Total	212	286	13	187	74	13	12

the *Melaleuca* forest in U Minh Ha National Park is also inhabited by the langurs based on a photograph of an individual feeding on a *Melaleuca* tree taken by a member of the national park staff on 24 December 2014. Some days later, three langurs were seen at approximately the same location and local people confirmed the occurrence of at least seven langurs. Therefore, the total population of Germain's langur in Ca Mau Province is estimated at 17–61 individuals.

Discussion

Currently, we conservatively estimate the total population of Germain's langur in Vietnam to be between 362 and 406 individuals, the largest count of directly observed individuals for any of the seven species of *Trachypithecus* occurring in Vietnam. Delacour's langur (*Trachypithecus delacouri*) and the Cat Ba langur are globally critically endangered (IUCN 2016), endemic to Vietnam, and are the two species for which we had the most robust data on population size. Nadler (2015) provided an estimate of 234–275 individuals for Delacour's langur based on intensive surveys sampling in the known range of this species between 2012 and 2015. The Cat Ba langur has a very small area of distribution being restricted to Cat Ba Island, and the current population is approximately 60 individuals (Leonard, personal communication). A closely related species to Germain's langur, the Annamese langur (*Trachypithecus margarita*), has a larger distribution in Vietnam, but we have population information only for Takou Mountain, where there are about 60 individuals (Hoang et al. 2010). The population sizes and distributions for the remaining species of *Trachypithecus* (*Trachypithecus francoisi* and *Trachypithecus crepusculus*) are poorly known. *Trachypithecus* may be more threatened than any other primate genus in Vietnam, with the exception of *Rhinopithecus* (*Rhinopithecus avunculus*).

As with other primates in Vietnam, Germain's langur is threatened by habitat loss and hunting, but they have not received much conservation attention during the past two decades due to a lack of knowledge on their distribution and debate about the taxonomy of the silvered langur group. Data on the natural forest cover of Vietnam from the Vietnam Administration of Forest showed that the natural forest in the Mekong Delta of Vietnam was reduced by 6534 ha from 2002 to 2013, of which 4671 ha of this forest loss occurred in the three provinces reported on here. Due to the threatened status of Germain's langur in Vietnam, it is important that the remaining natural forests in which it lives be protected. In addition to the threat caused by habitat loss, hunting has also been a major cause of population decline over the past few decades. Hunting of

Germain's langur, or “Ca Khu” in Vietnamese, for food during and after the American War was common up until a gun ban was implemented by the Vietnamese government in 1996 (Government of Vietnam 1996). Unfortunately, in recent years, there were still reports of hunting at Phu Quoc National Park (e.g., of three langurs in 2013) and in Ca Mau Province, highlighting the need for better law enforcement. The effects of human disturbance have also resulted in the extirpation of Germain's langur in Mui Ca Mau National Park and the reduced langur populations in An Giang and Ca Mau Provinces. In Kien Luong Karst Area, there are four langur sub-populations on four karst hills, two of which (Mo So and Khoe La) are under human exploitation for the cement industry. When examined together, the population in the karst area showed high genetic variability, but when considered separately, each of the four sub-populations exhibited low variability, suggesting a lack of recent gene flow between them (Ang 2017). Thus, there is an urgent need to restore habitat and genetic connectivity, such as by creating forest corridors.

Globally, this species ranges across South Myanmar, South Thailand, South Lao PDR, Cambodia and the southern tip of Vietnam (Roos et al. 2014). However, we lack a good understanding of this species' population sizes throughout its range with the exception of the data reported here—an estimate of 362–406 individuals in Vietnam. In Cambodia, Moody et al. (2011) reviewed data for the conservation status of this species but was unable to provide a population estimate. In Lao PDR, Germain's langurs are known to occur only in a small region in the Dong Khathung National Protected Area (Timmins et al. 2011). In Thailand and Myanmar, there is no published information on its population size or distribution. Without a comprehensive survey on the distribution and population size of this species within its entire range, changes in habitat, and an understanding of current threats, it is difficult to assess its conservation status. Therefore, it is important to obtain more information on the population sizes of this species in Cambodia, Lao PDR, Myanmar, and Thailand, and to strengthen the protection of this species in remaining habitats.

While Germain's langur faces continued threats in Vietnam, the current information on its population provides some hope for its conservation. The growth in this species' population size in the Kien Luong Karst Area since 2012 reflects its ability to live in highly disturbed environments. Moreover, the fact that the langurs are also found in mangrove plantations is additional evidence of their adaptive flexibility. Additional research on this species' feeding ecology in mangrove plantations and *Melaleuca* forests is needed to improve our understanding on its behavioral flexibility. If it can be established that Germain's langur can do well in these human-modified

habitats this will provide further hope for its successful conservation since these are common habitats in the western region of the Mekong Delta of Vietnam.

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