Primate Conservation 2018 (32): 167-174

Resource Assessment and Development Impact on Douc Population at Son Tra Nature Reserve, Vietnam

Lois K. Lippold[1], Vu Ngoc Thanh[1,2] and Tran Dinh Nghia[1,2]

[1]*Douc Langur Foundation, San Diego, CA, USA*
[2]*University of Science, Vietnam National University, Hanoi, Vietnam*

Abstract: Recent intensified development pressure at Son Tra Nature Reserve threatens one of the last places in Vietnam where red-shanked doucs survive in large numbers. Since the war, these doucs have survived development, hunting, capture and loss of feeding areas due to local government decisions. In 2016, Danang People's Committee proposed a plan to construct hotels and villas to house more than 300,000 by 2025. Their construction will destroy more than 70% of the habitat necessary for the survival of this unique douc population. This paper identifies food items and the habitats used by doucs throughout the reserve. Food resource seasonality and the impact of weather are also presented. Maps identify douc feeding areas and the current and potential construction sites. Together they illustrate the consequences for the douc population if this massive development project is allowed to proceed. With the loss of adequate habitat and food resources, red-shanked doucs will follow the rhino and the tiger to extinction in Vietnam.

Key words: Douc diet, Son Tra Nature Reserve, effects of development, extinction

Introduction

The assessment of specific food sources and their locations are important for conservation efforts for all species. It is even more important for a large isolated population such as that of the red-shanked douc langur (*Pygathrix nemaeus*) in Son Tra Nature Reserve, on the Son Tra Peninsula, Vietnam. Red-shanked doucs are colobine monkeys found in Vietnam, Laos, and Cambodia (Lippold 1995; Timmins and Duckworth 1999; Rawson and Roos 2009). They are classified as Endangered in all habitats (IUCN A2cd+3cd+4cd), with severely declining populations in Vietnam (Vu *et al*. 2008). Vietnam's total red-shanked douc population appear to be around 2,000, with the Son Tra population estimated at 700 (Vu and Lippold 2016). High human population pressure (the city of Danang abuts the reserve inland) resulting in habitat fragmentation and loss, hunting, and collection for the illegal animal trade is the major threat to their survival (Lippold and Vu 1998).

The aim of this paper is to identify food sources, their location and use by the douc langurs in Son Tra Nature Reserve (STNR) and predict what may happen to these food sources if the proposed large-scale construction and development is allowed to proceed in the reserve. This information must precede Son Tra land-use planning so that this unique and endangered *Pygathrix nemaeus* population can be protected.

Son Tra Nature Reserve (Fig. 1) was created in 1977 by Decision 41 of the Prime Minister. In 1992, the Ministry of Agriculture and Rural Development upgraded it from a cultural and historical site to a nature reserve because of the presence of endangered doucs. The reserve originally consisted of 4,439 ha, of which 4,190 were forested, but it has since been reduced by more than 2,000 ha by the illegal development of resorts, camps, private farms, and an army base.

Studies since 1971 (Van Peenan 1971; Lippold 1977, 1995, 1998; Pham 1993), firmly established the presence of *Pygathrix nemaeus* on Son Tra. The earliest reports were followed, however, by reports of their extinction (MacKinnon and Mackinnon 1986; Anh 1997) a falsehood that made way for intensified development of the reserve. In December 2006, the Douc Langur Foundation (DLF) was invited to survey Son Tra Nature Reserve in an effort to establish whether the douc was in fact extinct there (Lippold *et al*. 2007, 2008). The survey located at least 171 individuals in 12 groups. At that point the DLF initiated a long-term study of the doucs feeding ecology and behavior and has had a team in the reserve continuously since 2007. Since this initial count,

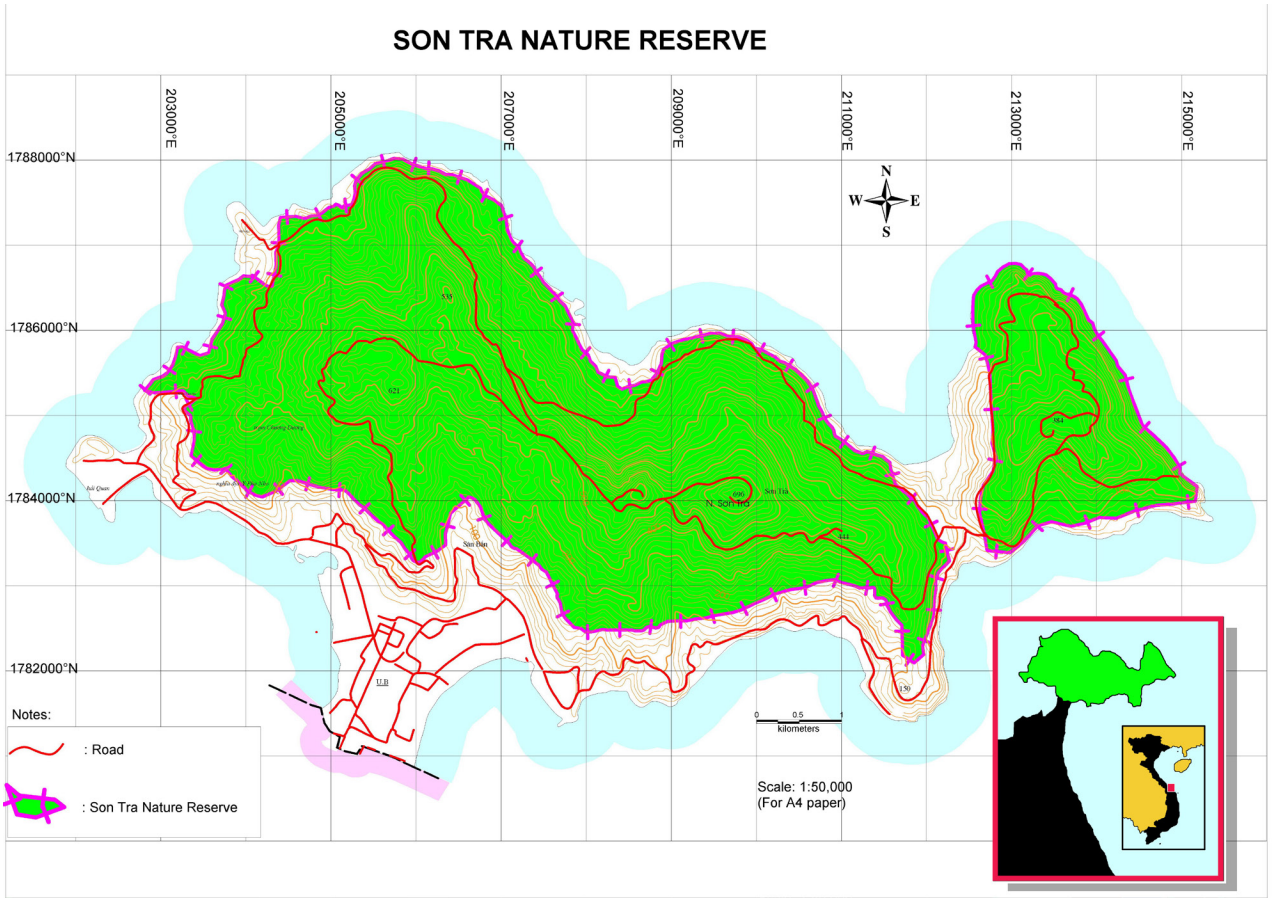

Figure 1. Son Tra location in Vietnam from Birdlife International (2005).

the *Pygathrix nemaeus* population has continued to expand. In our last survey we counted more than 700 individuals (Vu *et al.* 2016).

In late 2016, the Government released plans which called for intensive development of hotels, villas and restaurants in the nature reserve. These plans were proposed even though an existing Vietnamese Environmental law adopted in 2004 (Vietnamese Law of Protection and Development No. 29/2004/QH14) stipulates that no construction is permitted in either a reserve or national park when endangered species are present. This law further specifies that no development, hunting or collecting of any kind be allowed to take place in reserves or national parks.

The Douc Langur Foundation staff has catalogued each douc food item and feeding area at Son Tra Nature Reserve over a ten-year period. These studies clearly demonstrate that illegal construction has already destroyed many douc feeding areas. Further construction will destroy douc food sources and impact the integrity of the entire reserve. If the planned development is allowed to proceed this unique douc population will not have sufficient food sources to survive.

To illustrate the present and future situations, this paper presents two maps: one establishes the douc's most important feeding locations and the second shows where development has already occurred and where it is proposed by 2025. Construction of more than seven roads, the Intercontinental Hotel, Son Tra Resort, many restaurants, and an army base have already destroyed essential douc feeding areas, and further construction will destroy areas of the reserve that the doucs rely on for their survival.

Data collection

We collected data on diet using scan sampling (Altmann 1974) and video recording between September 2007 and March 2018. Our study continues. We started taking scans of all visible individuals every 5 minutes for 30 minutes per follow. Doucs stay in one feeding area for approximately three days and cover and travel about 800−1000 m during the day. We record date, time, individual, GPS location, food species and the part eaten. Because it is difficult to identify the specific part of the plant the doucs are consuming with either a spotting scope or binoculars, we document feeding behavior by video. We use a digital movie camera attached to a spotting scope to record all feeding bouts (Leupold scope SX-1 Ventana 15×45×60 mm). We record all feeding activity so that we can later identify exactly which tree species and plant part are eaten. This technique provides a permanent record of all feeding bouts that we have observed. These records are archived by specific group, location and time of year.

Feeding records include both manipulation and ingestion of food items. Food items were identified by species and by

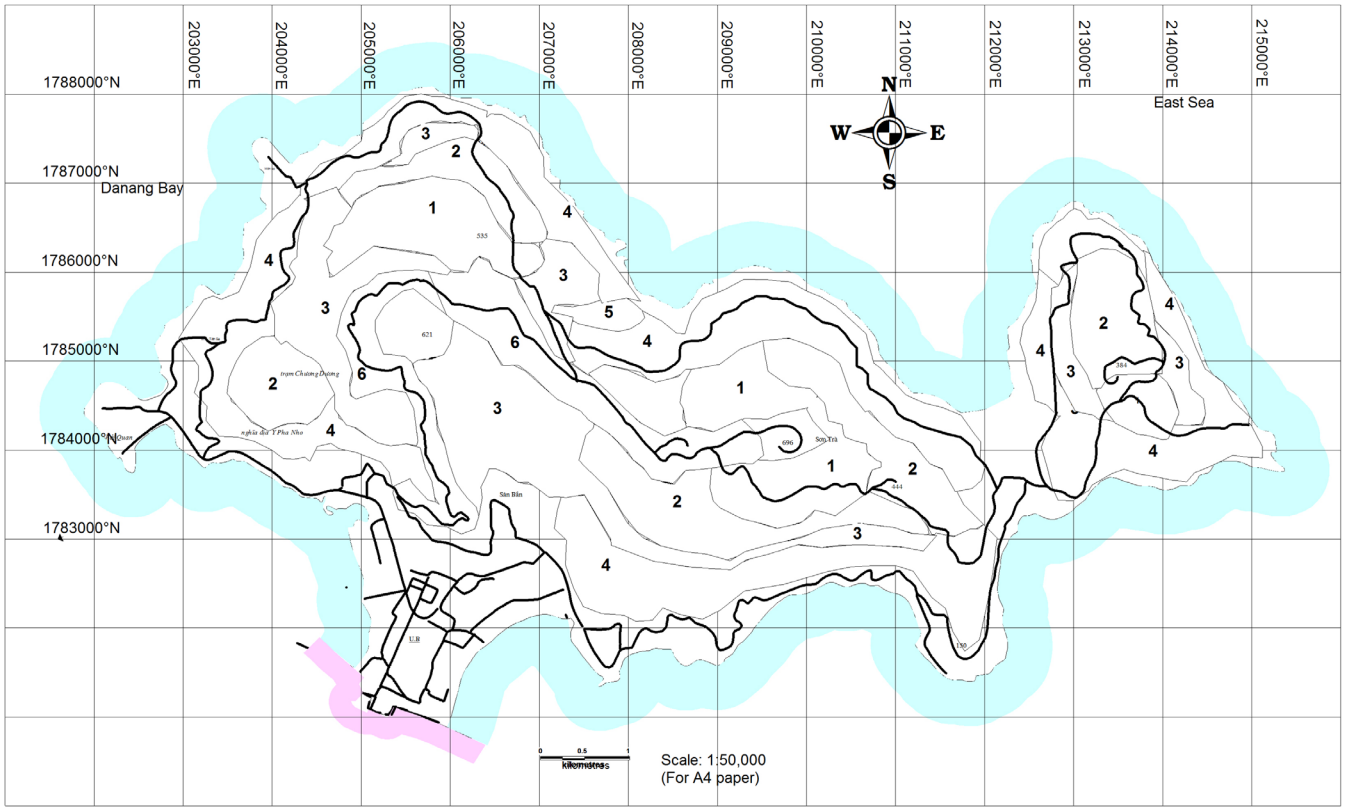

Figure 2. Habitats on Son Tra by number as described in the text.

plant part, and include: young leaves, young leaves including buds and shoots, mature leaves, petioles, fruits (ripe and unripe), mature leaves, seeds, flowers, flower buds, branches and bark.

In addition to scan samples and video analyses, we record all partially consumed and discarded foods on the forest floor with tooth marks or other signs of having been handled by the doucs. We use evidence from such feeding signs as additional evidence to estimate seasonal variance in diet. We also collect botanical specimens of all plants which we observe doucs eating so that these species can be identified by plant taxonomists Dr. Tran Dinh Nghia and Nguyen Anh Duc from the Department of Botany, Faculty of Biology, Vietnam National University, Hanoi, and Dr. Nguyen Tien Hiep from the Institute of Ecology and Biological Research, Center for Rare Plant Protection, Hanoi.

Results

Diversity of food plants used by the Son Tra doucs

A total of 220 food plant species of 90 genera and 46 families have been recorded, accounting for 21.26% of all the species, 23.55% of all the genera, and 35.10% of all the families found in Son Tra Nature Reserve. So far, the annual number of food plant species in the diet accounts for 18% to 21% of the total species of the flora.

The families that are included in their diet are: Leguminosae, Moraceae, Fagaceae, Lauraceae, Euphorbiaceae, Verbenaceae, Myrtaceae, Annonaceae, Guttiferae, Sterculiaceae, Anacardiaceae, Apocynaceae, Araliaceae, Dipterocarpaceae, Flacourtiaceae, Loganiaceae, Menispermaceae, and Vitaceae.

The genera with the highest number of species are: *Ficus* – 10 species, *Litsea* – 5 species, *Syzygium* – 5 species, *Lithocarpus* – 5 species, *Schefflera* – 3 species, *Dalbergia* – 3 species, *Millettia* – 3 species, and *Vitex* – 3 species.

Habitats on Son Tra that provide food for the doucs

On Son Tra, *Pygathrix nemaeus* groups were found feeding on the species in the following habitats (Fig. 2):

Habitat 1. Closed tropical evergreen seasonal forest with a dominance of *Shorea guiso* + *Parashorea stellata* + *Dodonea viscosa* + *Ormosia pinnata* + *Lithocarpus bonneti* + *Syzygium cumini*. This habitat is found on the north slopes of the Son Tra mountain system, covering two stream valleys (Suoi Lon and Suoi Cay Tram) which have water year-round. *Pygathrix nemaeus* food plants in this habitat include large, many-branched trees with strong trunks such as *Shorea guiso* and *Parashorea stellata* that comprise the forest canopy layers. The doucs eat few lianas, but they do consume the young leaves of *Ancistrocladus cochinchinensis* at the level of the forest canopy.

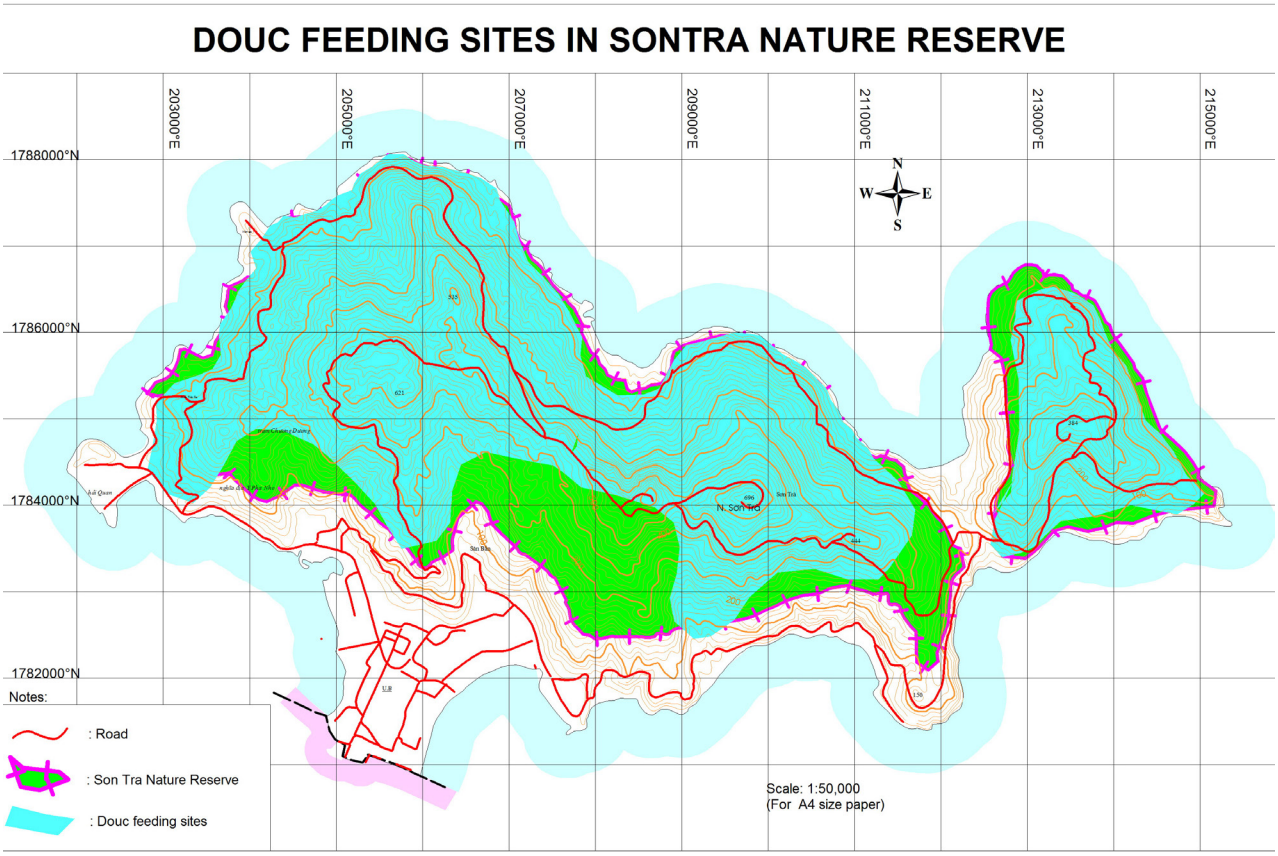

Figure 3. Douc feeding sites in Son Tra Nature Reserve.

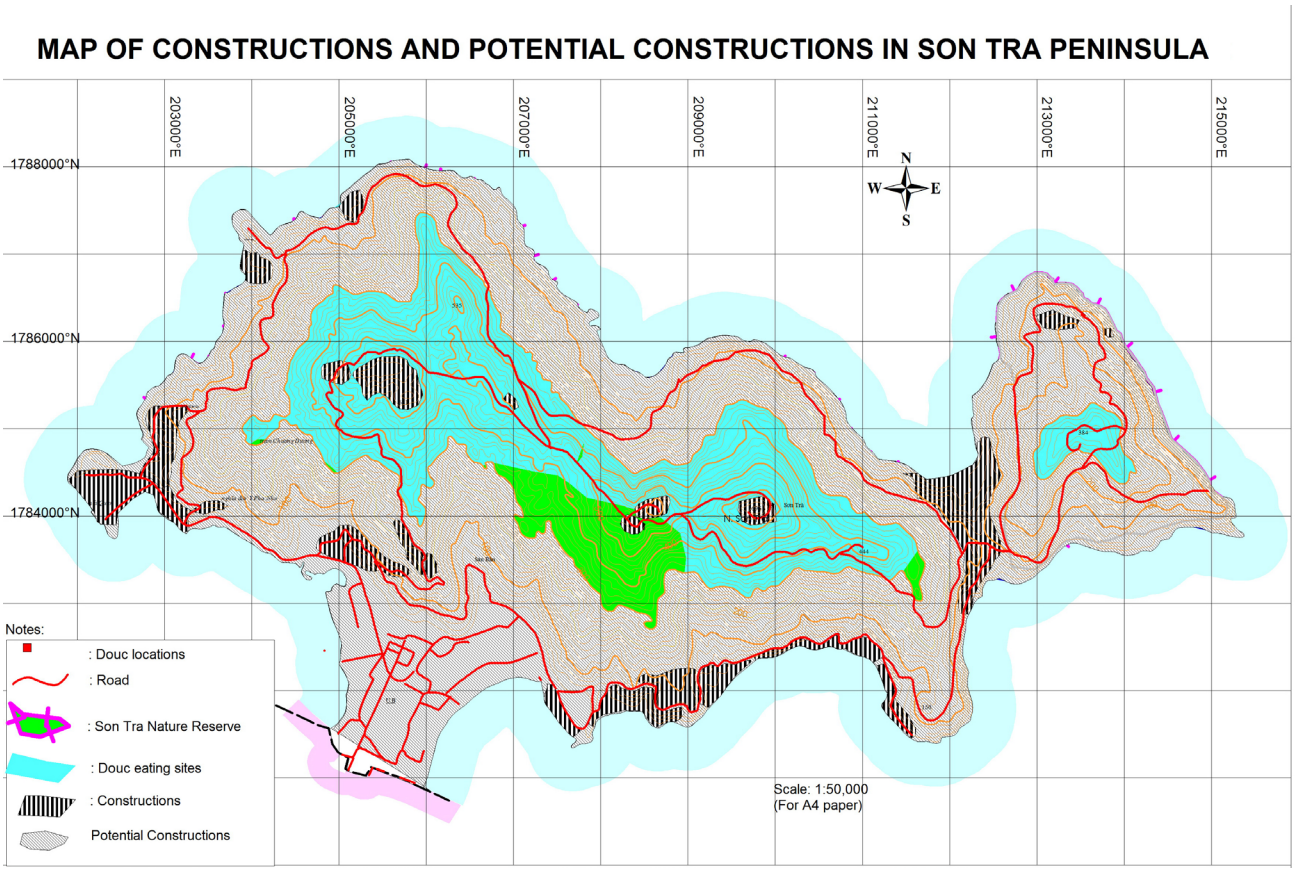

Figure 4. Construction and potential construction proposed by the Danang People's Committee.

Habitat 2. Closed tropical evergreen seasonal forest with a dominance of *Castanopsis ceratacantha* + *Lithocarpus bonnettii* + *Lithocarpus scortechini* + *Cleistocalyx retinervius* + *Syzygium zeylanicum* + *Pometia pinnata*. This forest type occurs at elevations higher than 200 m above sea level on the western slopes of the Son Tra Nature Reserve. Key food trees are *Castanopsis ceratacantha* and *Lithocarpus bonnettii*, which are especially important for *Pygathrix nemaeus* because they supply large amounts of young leaves during January–February.

Habitat 3. Tropical evergreen broadleaf woodland dominated by *Castanopsis ceratacantha* + *Toxicodendron succedanea* + *Gluta vrayii* + *Vitex trifoliate* + *Vitex quinata* + *Mallotus tetracoccus* + *Antidesma bonius* + *Litsea glutinosa*. This habitat is found on slopes just below the mountain ridge line. Food trees are: *Castanopsis ceratacantha* and *Lithocarpus bonnetti.*

Habitat 4. Tropical evergreen broad-leaved woodland that is dominated by *Endospermum chinense* + *Ficus vasculosa* + *Ficus annulata* + *Syzygium zeylanicum* + *Lithocarpus bonnetti* + *Planchonella obovata.* This habitat is found from the shore up to elevations of 200 m above sea level. Food trees include *Endospermum chinense*, *Ficus vasculosa*, *Ficus annulata*, *Ficus microcarpa*, *Ficus racemosa*, and others.

Habitat 5. Tropical evergreen broad-leaved woodland dominated by *Livistona saribus* + *Planchonella obovata* + *Lithocarpus bonnetti* + *Arytera litoralis* + *Vitex trìfolia* + *Zanthoxylum acanthopodium*, and others. This habitat intersects with habitat 4 in the same elevation band below 200 m above sea level. Key food trees are: *Planchonella obovata*, *Lithocarpus bonnetti*, and others.

Habitat 6. Tropical evergreen broad-leaved monsoon shrubland dominated by *Rhodomyrtus tomentosa* + *Melastoma septanervia* + *Memecylon ligustrinum* + *Planchonella obovata* + *Rubus cochinchinensis* + *Rubus rosaefolius* + *Acacia pruinescens* + *Eupatorium odoratum* + *Helicteres angustifolia* + *Tarietia cochinchinensis* + *Ilex wallichii*. This habitat is located along mountain ridge lines. Food trees are few and scattered, mainly *Planchonella obovata*, *Illex wallichi*, *Heritiera cochinchinensis*, and others.

Habitats 1 and 2 in the closed evergreen forest have only about 37% of the total number of plant food species. In comparison, more than 63% of *Pygathrix nemaeus* feeding trees are distributed largely in open forest, scrubland, and along roadsides in habitats 4, 5 and 6. These habitats, therefore, have the highest numbers of food plant species.

Annual seasonality and abundance of douc food sources in Son Tra Nature Reserve

Food sources of *Pygathrix nemaeus*, such as buds, young leaves, mature leaves, and petioles are seasonal and therefore influenced by the annual cycle of weather and climate conditions of Son Tra Nature Reserve. Of the 220 food plant species recorded, only six lose their leaves for a short time before new leaves appear. For the majority of the remaining species, there is regular growth of new leaves on old branches along with a mass of new leaves on new branches. This forms a new-leaf season which occurs between two and three times per year. This phenomenon results in a complicated picture of the forest. At the same time, it provides the doucs with plentiful and highly nutritious food during most of the year.

This phenomenon happens due to specific weather conditions on the Son Tra Peninsula where spring falls in the dry season (February to April according to the bioclimatic pattern) and water volume evaporation is higher than rainfall (Field notes). This weather pattern produces early spring budding in a few species such as *Lithocarpus* sp. and *Syzygium* sp. Budding is delayed in several other species throughout the dry period (February to April). At the end of May and through June, rains occur restoring the natural water balance. This allows several species to continue their budding. Budding is again delayed by hot westerly winds and hot-dry weather from June to August when evaporation volume is nearly double rainfall. At the beginning of the rainy season in September, another new-leaf season occurs, and this is the last new-leaf season of the year. Most rain in Son Tra occurs from September through December.

In some habitats, especially in the *Shorea* forest area (Habitat 1), food shortage occurs during the late winter to early spring when hot weather and storms occur. At that time, the doucs move to secondary forest in Habitats 3−5 in the northern sections of Son Tra Reserve where there are abundant food sources all year (Field notes).

Impact of extreme weather on douc food in Son Tra Nature Reserve

Strong winds occur frequently on Son Tra. In fact, Son Tra acts as a storm barrier for nearby Da Nang. These wind events create a great danger for the douc food supply. They result in the sudden and considerable loss of leaf volume from their food plants. This loss of leaves produces a food shortage for the doucs during these periods.

In the closed evergreen forest, large trees (including the doucs food plant species) have many big branches which receive the entire force of strong winds. Most leaves are shaken off in these events. Because they are perennial plants, new leaf growth is slow, producing a food shortage for doucs from these trees (Field notes).

Light-tolerant trees in secondary, open forest have more rapid growth of leaves and buds. This shortens the period of food shortage for doucs. Scrub plants and lianas of secondary forests are light-tolerant and fast-growing species. They have small, thin tops and branches which can bend along the wind direction to minimize the effect of wind, consequently, their leaves are generally not lost in strong winds. As a result, the habitats having many light-tolerant, lianas and scrub plant species (such as habitats 3, 4, 5, and 6) have a high diversity of food sources and higher food security for doucs due to their resistance to strong storm winds and their rapid leaf growth (Field notes). During this study, just after a storm stopped (storms in September 2009 and in October 2013), doucs were found highly concentrated in habitats 3, 4, and 5 at elevations below 200 m to sea level in the northern section of Son Tra (Field notes).

Of all of the habitats on Son Tra, those at elevations below 200 m in the northern section of the reserve (habitats 4 and 5) are the most important to the doucs because they provide diverse and secure food sources and protection during storms (Field notes). These habitats must, therefore, be strictly protected, and active conservation of these habitats must be a priority in any further development of Son Tra Nature Reserve.

Douc feeding requirements and construction maps

The food requirements of the doucs of Son Tra Nature Reserve are now well known (Pham 1993; Lippold 2010, 2016; Ulibarri 2014). Extensive studies of the douc diet have established the food items, their location and seasonality. Our research has demonstrated that the douc population relies on the forests of Son Tra Nature Reserve for food throughout year.

Past construction has completely destroyed some habitats, as shown in Figure 3. White areas show the impact of intense construction: the Intercontinental Resort, Son Tra Resort and many restaurants and other businesses. The intensity of development has already resulted in the movement of douc groups toward the northern part of the peninsula. In spite of this continued development, douc populations have grown as a direct result of intensified protection. At this time (2018) our observations reveal that the douc population is becoming concentrated in the north-western part of the reserve.

Figure 3 illustrates the Douc Feeding Sites in Son Tra Nature Reserve that we have documented since 2007. All areas where douc feeding has been documented are shaded in blue. Habitats where they feed extend from sea level to the mountain tops in all areas. White areas on the map are those without forest or doucs. Green shading is where human habitation and recent construction has resulted in movement of the doucs out of the area.

Illegal construction sites in Figure 4 are shown as hachured areas. These were all built after the Environmental Law of 2004 was written. Examples of these are the Intercontinental Hotel, Son Tra Resort, and numerous restaurants. At each site, areas of forest were destroyed entirely. The most recent two construction projects, started in 2016, were halted for the time being by actions of the Prime Minister and international pressure.

Discussion

Son Tra Peninsula includes rich and diverse food resources in habitats which cover all natural forest and scrubland. At the moment, without further construction, these resources provide a secure food supply for this population of endangered red-shanked doucs. In order to conserve them, the future development of the Son Tra Nature Reserve must include complete protection of the food resources they use. The most important criteria necessary for their survival have been identified. A Douc Conservation Area must include all habitats that have been identified as necessary for their survival, including all feeding and habitation areas where the doucs are found.

In this paper, we recommend that all habitats 1−6 should be protected for conservation of doucs. Habitats 3, 4, and 5 at elevation below 200 m are all secondary forest, which contain over 67% of the food items they use during the year. These secondary forests also provide protection (security) during the annual cycle when weather and climate heavily impact habitats 1 and 2. We estimate that doucs use habitats 3, 4, and 5 for more than 70% of the year. They are found in habitats 1 and 2 no more than 30% of the year. It is imperative, therefore, that no more construction or clearing ever occur in habitats below 200 m.

New, illegal construction sites appeared in the reserve in early 2016. At each site, areas of forest were entirely destroyed. The last two construction projects were halted by international pressure and the demands of the Prime Minister, but in late 2016 the Danang People's Committee proposed a massive development plan (Fig. 4; in tan) to construct hotels and villas to house more than 300,000 inside the reserve by 2025. This construction, as proposed, will destroy approximately 70% of the douc feeding areas, and leave only the upper habitats 1 and 2 which the doucs use for less than 30% of the year.

Construction has already deprived the doucs of many feeding sites. Recent disruptions by continued illegal construction have resulted in douc groups moving to the northern areas of the reserve. Areas proposed for intensive development and construction are located from the beach to above the 200 m areas in habitats 3, 4, 5, and 6. We found these habitats to be those most used by the doucs throughout the year because they provide constant, rich food resources as well as protection and security. These are the habitats where douc groups go during intense storms and where they hide during danger. Destroying these habitats will deprive the doucs of both food and protection.

Preservation of this unique and endangered douc langur population hangs in the balance. The future of almost 50% of the entire *Pygathrix nemaeus* population in Vietnam rests

upon the Prime Minister's decision to stop further construction and development on Son Tra. If the proposed development and hotel construction takes place it will destroy the remaining habitats evidently vital for their survival there.

The Prime Minister is the governmental officer responsible for the decision on further development. He stopped the last illegal construction in 2016. He further stated that he would decide by June 2017 upon further proposed development. By September 2018 no decision had been made upon further construction. Since January 2017, there has been a petition and letter campaign to stop further construction involving many international conservation organizations such as International Union for Conservation of Nature (IUCN), International Primate Protection League (IPPL), and the Douc Langur Foundation (DLF) besides such as Pan Nature, Green Viet and Education for Nature (ENV). Tens of thousands of signatures and letters have been directed to the Prime Minister. Still no decision has been announced.

The facts still remain that unless the Prime Minister acts to permanently halt any further construction and he instead allows this massive development to proceed it will result in the extinction of this critically endangered primate, following the fate of the rhino and the tiger in Vietnam.

Summary

Governmental development plans released recently call for intensive development and construction of hotels, villas and restaurant within Son Tra Nature Reserve. Douc Langur Foundation staff have catalogued each douc food item and feeding area over an 11-year period and our studies demonstrated that construction has already destroyed many of the doucs feeding areas. New construction will not only destroy douc food sources but also impact the integrity of the entire reserve. If the planned development is allowed to proceed this unique douc population will not have sufficient food resources to survive.

This paper presents two maps. The first establishes the douc's most important feeding areas in the reserve. The second shows where development has already occurred and where it is proposed to occur by 2025. The location of the proposed development and construction areas show clearly the widespread loss of the essential feeding areas for this population of red-shanked doucs, and consequently the wherewithal for their continued presence in the reserve's diminishing forests.

Acknowledgments

The authors would like to thank the Forest Protection Departments of Da Nang and Son Tra, Douc Langur Foundation, International Primate Protection League, United States Fish and Wildlife Service, Hanoi University of Science, and San Diego Zoo Global, for their support. The authors thank Anthony Rylands and Russell A. Mittermeier for encouragement and support. The authors would also like to thank three reviewers, whose comments greatly improved this paper.

Literature Cited

Altmann, J. 1974. Observational study of behaviour: sampling methods. *Behaviour* 49: 227−267.

Anh, D. T. 1997. Studies on Fauna, Flora and Impact Factors in Son Tra Nature Reserve with Recommendations of Rational Conservation Solutions. Final Report, Da Nang University, Da Nang, Vietnam.

Bennett, E. L. and A. G. Davies 1994. The ecology of Asian colobines. In: *Colobine Monkeys Their Ecology, Behaviour and Evolution*, A. G. Davies and J. F. Oates (eds.), pp.129−171. Cambridge University Press, Cambridge, UK.

Lippold, L. K. 1977. The douc langur: a time for conservation. In: *Primate Conservation*, H. S. H. Prince Rainer and G. H. Bourne (eds.), pp.513−538. Academic Press, New York.

Lippold, L. K. 1998. Natural history of douc langurs. In: *The Natural History of the Doucs and Snub-nosed Monkeys*, N. G. Jablonski (ed.), pp.191−206. World Scientific Publishing, Singapore.

Lippold, L. K. and N. T. Vu. 1998. Primate conservation in Vietnam. In: *The Natural History of the Doucs and Snub-nosed Monkeys*, N. G. Jablonski (ed.), pp. 293−300. World Scientific Publishing, Singapore.

Lippold, L. K. and N. T. Vu. 2008. The time is now: survival of the douc langurs of Son Tra, Vietnam. *Primate Conserv.* (23): 1−5.

Lippold, L. K. and N. T. Vu. 2016. Douc feeding ecology at Sontra Nature Reserve, Vietnam: basic necessities and seasonal choices. Presentation at the Joint Meeting of the XXVI International Primatological Society and the American Society of Primatologists, 21−27 August 2016, Chicago, Il, USA.

Lippold, L. K., N. T. Vu, T. D. Nghia, N. X. Thuan, L. T. Hoang and N. D. Huynh. 2010. Feeding ecology of the red-shanked douc langur (*Pygathrix nemaeus*) at Son Tra Nature Reserve, Vietnam. Presentation at XXIII Congress of International Primatological Society, 10−17 September 2010, Kyoto, Japan.

MacKinnon, J. and K. MacKinnon. 1986. *Review of the Protected Area System in the Indo-Malayan Realm*. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

Pham Nhat. 1993. The distribution and status of douc langur (*Pygathrix nemaeus*) in Vietnam. *Asian Primates* 3(12): 2−3.

Pham Nhat. 1994. Preliminary results on the diet of the red-shanked douc langur (*Pygathrix nemaeus*). *Asian Primates* 4(1): 9−11.

Rawson, B. and C. Roos. 2008. A new primate species record for Cambodia: *Pygathrix nemaeus. Cambodian J. Nat. Hist.* 1(1): 7−11.

Timmins, R. and J. Duckworth. 1999. Status and conservation of douc langurs (*Pygathrix nemaeus*) in Laos. *Int. J. Primatol*. 20: 469−489.

Ulibarri, L. R. 2014. The Socioecology of Red-shanked Doucs (*Pygathrix nemaeus*) in Son Tra Nature Reserve. PhD thesis, University of Colorado, Boulder.

Van Peenan, P. F. D., R. H. Light and J. F. Duncan. 1971. Observations on mammals of Mt. Sontra, south Vietnam. *Mammalia* 35: 126−143.

Vu, N. T., L. Lippold, R. J. Timmins and N. Manh Ha. 2008. *Pygathrix nemaeus*. IUCN Red List of Threatened Species. Version 2018. Website: <www.iucnredlist.org/>. Downloaded 6 September 2018.

Vu, N. T., L. K. Lippold, T. H. Le, X. T. Nguyen and N. D. Huynh. 2016. Red-shanked douc langur in Son Tra Nature Reserve, Vietnam: status, monitoring and conservation. Presentation at the Joint Meeting of the XXVI International Primatological Society and the American Society of Primatologists, 21−27 August 2016, Chicago, Il, USA.

Authors' addresses:
Lois K. Lippold, Douc Langur Foundation, PO Box 23912, San Diego, CA 92193, USA, **Vu Ngoc Thanh** and **Tran Dinh Nghia**, Douc Langur Foundation, PO Box 23912, San Diego, CA 92193, USA, and University of Science, Vietnam National University, Hanoi, Vietnam. Vu Ngoc Thanh: e-mail: <thanhdouc@gmail.com>. *Corresponding author*: Lois K. Lippold: e-mail: <foundation@douclangur.org>.

Submitted for publication: 13 August 2018
Revised: 15 September 2018