

Short Communication

A rapid assessment of flying fox (*Pteropus* spp.) colonies in Cambodia

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Flying foxes (Chiroptera: Pteropodidae: *Pteropus*) are among the few wide-ranging frugivores still found in many parts of Southeast Asia and play important seed-dispersion and pollination roles in their ecosystems (Cox *et al.*, 1991; Fujita & Tuttle, 1991; Struebig *et al.*, 2007). Three flying fox species were depicted for Cambodia in the range maps of Francis (2008): large flying fox *Pteropus vampyrus*, Lyle's flying fox *P. lylei* and island flying fox *P. hypomelanous*. These species are currently considered to be globally Near-threatened, Vulnerable and Least Concern by the IUCN (Bates *et al.*, 2008; Bumrungsri *et al.*, 2008; Francis *et al.*, 2008) respectively, and as nationally common (*P. vampyrus* and *P. lylei*) or nationally rare (*P. hypomelanous*) in Cambodian legislation (MAFF, 2007). All three species are included in Appendix II of CITES, but almost nothing is known about their conservation status in Cambodia. Although likely present, the occurrence of *P. vampyrus* remains unconfirmed, having yet to be validated by the unequivocal documentation of a live animal or museum specimen to our knowledge. As colony surveys are central to determining conservation priorities for flying foxes (Mickleburgh *et al.*, 1992), we provide here the findings of a rapid assessment of pteropodid colonies in Cambodia.

Using an unpublished list of roost sites provided by the Wildlife Conservation Society, supplemented by additional sites reported by local field workers, we conducted field surveys between June 2013 and February 2014 to assess all of the known or suspected *Pteropus* colonies in Cambodia. At every site, the location and basic setting of the roost environment was recorded and standardized estimates of roost populations made using direct census methods, and, where possible, nightly dispersal counts (Kunz *et al.*, 1996). Efforts were also made to identify the species present at each site, but because these necessarily relied upon impressions of relative size (Francis, 2008) using binoculars, species identifications were uncertain and so no attempts were made to estimate total population sizes for each species. As *P. hypomelanous* primarily occurs in coastal areas and on marine islands, however (Francis, 2008), we assumed that the species present at all inland sites surveyed were *P. lylei* and/or *P. vampyrus* (Fig. 1).

Direct censuses were undertaken by visually counting the bats during the day at each site with the aid of 8 × 42 binoculars and manual hand-counters, whereas nightly dispersal counts began at dusk when the bats emerged to forage until all had left the roost site (typically from 1830 h to 1910 h). The latter was

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Fig. 1 Flying foxes on Koh Trong Island on the Mekong River (© Gordon Congdon, left) and Koh Bong Island off the coast of Cambodia (© Jeremy Holden, right). The species on the left is thought to be *P. lylei* and the species on the right *P. hypomelanus*.

confirmed by checking roost trees with a spotlight after the dispersal count at each site. Due to the density of bats and brevity of the evening dispersal, in some instances bats were counted in groups of 10 as they dispersed. The higher count from the two methods was rounded down to the nearest hundred and accepted as the estimated population size for a given site. Interviews were also undertaken by the first author with local authorities and residents at roost sites to determine: (i) the status of the colony (permanent or seasonal); (ii) annual breeding periods (defined as birth periods); (iii) whether the colony receives any protection; (iv) conservation threats at each site; and (v) local perceptions concerning the flying fox colony.

Over the course of the rapid field survey, 12 roost sites were located and assessed (Table 1, Fig. 2). Based on our experience and discussions with

site-based conservationists around the country, it appears likely these comprise most of the flying fox colonies in Cambodia. (The possibility that other colonies might be discovered in the future cannot be excluded, however, particularly in poorly surveyed coastal regions and areas surrounding the Tonle Sap Lake). At least one interview was completed at each site. According to local informants, all of the colonies assessed were present year-round. Offspring were largely reported by respondents as appearing in April each year, and this is supported by monthly observations at the Wat Pi Chey Sa Kor (Kandal Province) and Wat Bay Dam Ram (Battambang Province) colonies where mating takes place in November and parturition primarily occurs in April (Hul, 2013; J. Cappelle, unpublished data).

Most of the roost sites were situated inside the grounds or within the vicinity of a religious or govern-

Table 1 Summary characteristics of 12 flying fox colonies in Cambodia. Key: * Site where hunting of bats was reported or observed; ¹ DC = Direct Census, ND = Night Dispersal, n/a = not applicable; ² Value given is the highest figure from the count methods, rounded down to the nearest hundred.

#	Site Name (Province)	Latitude, Longitude	Census Date	Roost Environment	Census Methods ¹	Population Estimate ²
1	Ang Trapeang Thmor (Banteay Meanchey)	13.804 N, 103.261 E.	14 Aug 2013	One roost tree on small island in reservoir.	DC	≈200
2	Wat Bay Dam Ram (Battambang)	12.993 N, 103.161 E.	23 Jun 2013	Pagoda. Three roost trees in site vicinity.	DC / ND	≈1,400
3	Royal Gardens * (Siem Reap)	13.363 N, 103.859 E.	10 Aug 2013	Official site. 14 roost trees in urban park.	DC / ND	≈5,000
4	Kampong Thom * (Kampong Thom)	12.714 N, 104.883 E.	8 Aug 2013	Official site. Three roost trees along roadside.	DC / ND	≈6,000
5	Koh Trong Island (Kratie)	12.507 N, 105.993 E.	26 Aug 2013	Pagoda. Two roost trees on site perimeter.	DC	≈200
6	Koh Chreng Island * (Kratie)	12.361 N, 106.044 E.	27 Aug 2013	Pagoda. 17 roost trees on site perimeter.	DC	≈900
7	Wat Srey Santaor * (Kampong Cham)	11.915 N, 105.183 E.	8 Aug 2013	Pagoda. Small forest on site perimeter.	n/a	Extrapolated
8	Council for Development of Cambodia (Phnom Penh)	11.577 N, 104.924 E.	18 Oct 2013	Official site. One roost tree on site perimeter.	DC / ND	≈1,800
9	Wat Prek Chey Lech * (Kandal)	11.465 N, 105.235 E.	1 Aug 2013	Pagoda. Five roost trees on site perimeter.	DC / ND	≈500
10	Wat Pi Chey Sa Kor * (Kandal)	11.200 N, 105.058 E.	15 Jan 2014	Pagoda. 21 roost trees on site perimeter.	DC / ND	≈4,000
11	Wat Veal Lbang (Prey Veng)	11.173 N, 105.310 E.	17 Jan 2014	Pagoda. 12 roost trees in site vicinity.	DC	≈700
12	Koh Bong Island (Sihanoukville)	10.759 N, 103.265 E.	1 Feb 2014	Three roost trees in forest on small private island.	DC	≈200

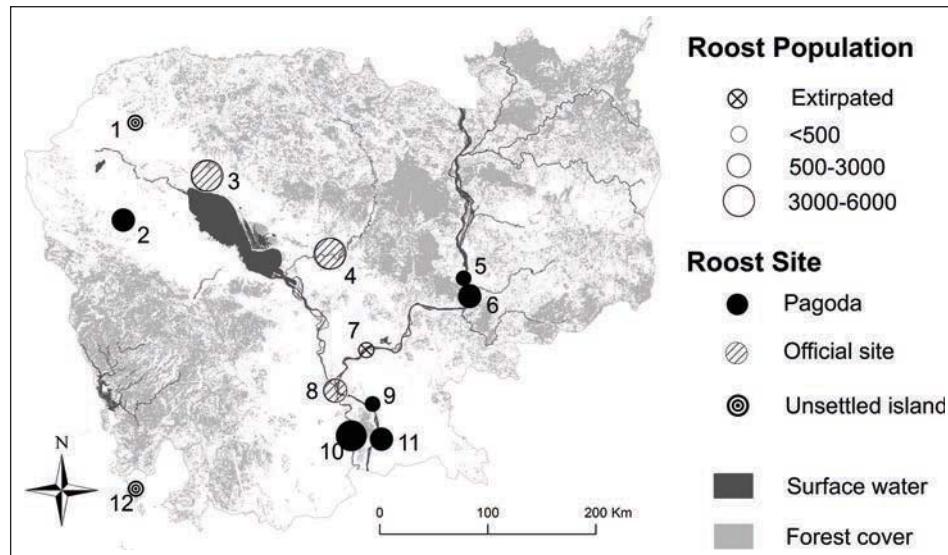


Fig. 2 Locations and relative sizes of 12 flying fox colonies in Cambodia.

ment building, which apparently afforded them some protection from hunting (seven roosts were near a pagoda and three were near a government building). Only two roosts were protected by a natural barrier: the very small uninhabited islands of Ang Trapaeng Thmor and Koh Bong in the country's Northwest and Southwest respectively (Table 1, Fig. 2). This situation is similar to Thailand—another predominantly Buddhist country—where many flying fox colonies are near pagodas (Wacharapluesadee *et al.*, 2010), but differs from the Philippines—a largely Christian and Muslim country—where most colonies are in forest areas (Mildenstein, 2012). Religion may therefore play an important role in flying fox conservation in Cambodia, and a better understanding of local perceptions of bats could aid the design of more effective conservation initiatives.

Despite the potential influence of religious views however, hunting of bats for bushmeat, trade and/or medicinal use was reported at half of the 12 sites in Table 1. In fact, one colony in Srey Santaor (Kampong Cham Province) was recently extirpated by large-scale hunting, despite protests from local monks (Prak Bali, pers. comm.), and colonies at other sites could well be declining. Even though most of the remnant flying fox colonies in Cambodia now appear to be confined to sites which afford some measure of protection, the bats are still actively hunted while foraging or occur in non-protected areas (Timmings, 2008; present study). Thus, while there is a clear need for further surveys—preferably entailing synchronized counts employing standard methods at all known colonies to establish seasonal variation and population trends—our data nonetheless suggest that flying fox colonies in mainland Cambodia are heavily threatened and by no means nationally common.

This poses an obvious concern, not least because flying foxes can cease to be effective seed dispersers long before they become rare (McConkey & Drake, 2006). Besides their ecological services to humans, flying foxes may also play a role as reservoir of pathogens of public health importance in Cambodia. Evidence of Nipah virus circulation was reported in national flying fox populations some years ago (Reynes *et al.*, 2005), but very little information is available on the risk of transmission to domestic animals and humans in the country. Further research on the status and ecology of Cambodian *Pteropus* is therefore central to overcoming current challenges to reliable field identification and designing conservation plans and public health risk mitigation strategies. Campaigns to raise awareness are also required in

colony areas to eliminate misconceptions regarding their medicinal values and to generate local support for their protection. To this end, a website (www.facebook.com/CFFCPH) has been developed to gain public information about flying fox colonies in Cambodia, which we hope will help to stimulate greater conservation interest in these charismatic and inherently vulnerable animals.

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References

- Bates, P., Francis, C., Gumal, M., Bumrungsri, S., Walston, J., Heaney, L. & Mildenstein, T. (2008) *Pteropus vampyrus*. In *IUCN Red List of Threatened Species*. [Http://www.iucnredlist.org/details/18766/0>](http://www.iucnredlist.org/details/18766/0) [accessed 2 July 2014].
- Bumrungsri, S., Suyanto, A. & Francis, C. (2008) *Pteropus lylei*. In *IUCN Red List of Threatened Species*. [Http://www.iucnredlist.org/details/18734/0>](http://www.iucnredlist.org/details/18734/0) [accessed 2 July 2014].
- Cox, P.A., Elmquist, T., Pierson, E.D. & Rainey, W.A. (1991) Flying foxes as strong interactors in South Pacific island ecosystems: a conservation hypothesis. *Conservation Biology*, **5**, 448–454.
- Francis, C.M. (2008) *A Guide to the Mammals of Southeast Asia*. Princeton University Press, Princeton, New Jersey, USA.
- Francis, C., Rosell-Ambal, G., Bonaccorso, F.A., Heaney, L., Molur, S. & Srinivasulu, C. (2008) *Pteropus hypomelanus*. In *IUCN Red List of Threatened Species*. [Http://www.iucnredlist.org/details/18729/0>](http://www.iucnredlist.org/details/18729/0) [accessed 2 July 2014].
- Fujita, M.S. & Tuttle, M.D. (1991) Flying foxes (Chiroptera: Pteropodidae): threatened animals of key ecological and economic importance. *Conservation Biology*, **5**, 455–463.
- Hul V. (2013) *Ecology of flying fox (Pteropus species) and assessment of the risk of emergence of Nipah virus in Battambang and Kandal Provinces, Cambodia*. MSc thesis, Royal University of Phnom Penh, Cambodia.
- Kunz, T.H., Thomas, D.W., Richards, G.C., Tidemann, C.R., Pierson, E.D. & Racey, P.A. (1996) Observational techniques for bats. In *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals* (eds D.E. Wilson, F.R. Cole, J.D. Nichols, R. Rudran & M.S. Foster), pp. 105–114, Smithsonian Institution Press, Washington D.C., USA.

- MAFF—Ministry of Agriculture, Forestry & Fisheries (2007) *Prakas on Classification and List of Wildlife Species. Ministry of Agriculture, Forestry and Fisheries*, No. 020 PR. Ministry of Agriculture, Forestry & Fisheries, Phnom Penh, Cambodia.
- McConkey, K.R. & Drake, D.R. (2006) Flying foxes cease to function as seed dispersers long before they become rare. *Ecology*, **87**, 271–276.
- Mickleburgh, S.P., Hutson, A.M. & Racey, P.A. (1992) *Old World Fruit Bats: an Action Plan for their Conservation*. IUCN, Gland, Switzerland.
- Mildenstein, T.L. (2012) *Conservation of endangered flying foxes in the Philippines: effects of anthropogenic disturbance and methods for monitoring*. PhD thesis, University of Montana, USA.
- Reynes, J.M., Counor, D., Ong, S. & Faure, C. (2005) Nipah virus in Lyle's flying foxes, Cambodia. *Emerging Infectious Diseases*, **11**, 1042–1047.
- Struebig, M.J., Harrison, M.E., Cheyne, S.M., Limin, S.H. (2007) Intensive hunting of large flying foxes *Pteropus vampyrus natunae* in Central Kalimantan, Indonesian Borneo. *Oryx*, **41**, 390–393.
- Timmins, R. (2008) Large mammals. In *Biological Surveys of the Mekong River between Kratie and Stung Treng Towns, Northeast Cambodia, 2006–2007* (eds M.R. Bezuijen, R. Timmins & Seng T.), pp. 82–89. WWF Cambodia Country Programme, Cambodian Fisheries Administration & Cambodian Forestry Administration, Phnom Penh, Cambodia.
- Wacharaplaesadee, S., Boongird, K., Wanghongsa, S., Ratanasetyuth, N., Supavonwong, P., Saengsen, D., Gongal, G.N. & Hemachudha, T. (2010) A longitudinal study of Nipah virus in *Pteropus lylei* bats in Thailand: evidence for seasonal preference in disease transmission. *Vector-borne and Zoonotic Diseases*, **10**, 183–190.