

# A survey of large mammals in the central Annamite mountains of Laos

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# Abstract

Large mammals were surveyed using direct observation in montane Laos during April-May 1996 in little-disturbed evergreen forest in and around the Nakay-Nam Theun National Biodiversity Conservation Area (NBCA). Survey focussed on one road, where low hunting pressure and excellent viewing conditions gave the truest representation of relative species status at any Lao site yet surveyed. More large mammal species have been found there than in some entire NBCAs; the total of 15 species of carnivore is especially noteworthy. Nocturnal contact rates (if lorises are excluded from the comparison) were the highest of any Lao site yet surveyed. Encounter rates by day were also high. Totals of nine Globally Threatened, three Data Deficient and six Nationally At Risk species are of outstanding conservation importance. Many have large populations and some have not otherwise been seen in the field on a recent survey programme in Laos. A few additional species were found on another road where survey conditions were less good. Results from the area, compared with those from lowlands and foothills in southern Laos, suggest the following altitudinal distributions: (1) sympatric species in the genera *Petaurista, Rhizomys*, and *Manis* are separated altitudinally; (2) *Arctonyx collaris, Paguma larvata*, and *Herpestes urva* are submontane or montane; (3) *Nycticebus coucang* is commoner in the lowlands than at 1000 m.

Key words: Laos, mammalian species, altitudinal zonation

# Introduction

The Annamite mountains along the border of Laos with Viet Nam are a centre of mammalian endemism. However, prior to 1996, no direct field observations of nocturnal large mammals (those identifiable without capture) had been made in Laos above 550 m altitude. Historically, very little work on mammals took place in Laos, and much of this consists of anecdotal writings by hunters (summarised in DEUVE 1972 and citations therein). The political situation prevented any new work from 1972 until 1989. Mammal surveys by night in Laos since then were in the lowlands and foothills and direct searching by day was also limited (SALTER 1993; WCS unpubl. data, summarised in DUCKWORTH 1997). Work in the Annamites targetted certain species and used mainly trophy examination, village interviews and signs: Pseudoryx nghetinhensis Dung, Giao, Chinh, Tuoc, Arctander and Mackinnon, 1993 (Saola) (Schaller and RABINOWITZ 1995); Megamuntiacus vuquangensis Tuoc, Dung, Dawson, Arctander and MacKinnon, 1994 (Giant Muntjac) (SCHALLER and VRBA 1996; TIMMINS et al. 1998); Sus bucculentus Heude, 1892 (Vietnamese Warty Pig) (GROVES et al. 1997) and an undetermined muntjac Muntiacus sp. (TIMMINS et al. 1998). During recent surveys throughout Laos (sites summarised in DUCKWORTH 1997), large mammals were problematical to record: they are shy (due to widespread hunting) and many species are nocturnal, yet identification from indirect evidence (signs and vil-

lage information) is difficult as most groups contain several similar species. Few modern publications cover a wide range of large mammal species in Laos: DUCKWORTH et al. (1994), BERGMANS (1995), RUGGERI and TIMMINS (1996), and DUCKWORTH (1996, 1997).

The Nakay-Nam Theun National Biodiversity Conservation Area (NBCA) and the Nam Theun Extension occupy a large area in the Annamites. A survey in 1994 concentrated on mammal signs and birds (Evans and TIMMINS 1998; WCS unpubl. data). To expand on this, large mammals were surveyed by direct observation in both areas during April–May 1996. Problems with permission curtailed work in Nam Theun Extension and heavy rain reduced the ability to observe mammals while there.

This study compares the two communities with other sites in Laos, using mainly the large amount information published as internal reports to the Lao government by the Wildlife Conservation Society (WCS). Statements summarising recent records consider fieldwork until October 1996 (largely summarised in DUCKWORTH 1997).

# Material and methods

#### Study area

The Nakay-Nam Theun NBCA  $(17^{\circ}34'-18^{\circ}23' \text{ N} 105^{\circ}02-46' \text{ E})$  is, at 3445 km<sup>2</sup>, the largest protected area in Laos. It is mostly within the Annamite mountains. At the heart, 800 km<sup>2</sup> of mountains rise mostly above 1000 m, with the summit ridge (forming the international border) exceeding 2200 m. Route 8 crosses from Laos to Viet Nam and constitutes the northern border of the NBCA. North of



**Fig. 1.** Survey area. Inset shows location of survey area within Laos. Only major rivers are shown. Ban Lak (20) is the only major town in the area of the figure. Small villages not referred to in the text are not shown.

++++ survey road; ~ river; - - - boundary of protected area; IIII international boundary

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this road, approximately 550 km<sup>2</sup> of forested Annamites (at 18°20-45'N 104°56'-105°12'E) form the proposed Nam Theun Extension. The area is shown in figure 1. Both NBCAs contain extensive little-degraded evergreen forest. The low Annamite spine in the Nam Theun Extension (mostly 600–900 m) allows winds from both east and west and so rain falls in most months; in contrast, most of Nakay-Nam Theun has a dry season in November–April. Recently constructed roads run from the border through little-degraded forest into each area. These roads allow more frequent sighting of mammals than in unbroken forest, so all observation was conducted from roads.

#### Nakay-Nam Theun NBCA at 17°57-18°03' N 105°18-26' E; 24 April-14 May 1996

A road from the village of Ban Navang into Nakay-Nam Theun was aimed towards the headwaters of the Nam Xot. Construction occurred intermittantly from late 1993 to March 1995, when the road extended about 18.5 km east of Ban Navang (R. J. TIMMINS verbally 1994–1996). The road has not been used for its intended purpose, to transport the extremely valuable *Fokienia* logs. The road traversed primary montane seasonally dry evergreen forest. No people lived along it and hunting pressure was low; occasional rattan collecting trips, using a lorry, kept the road open. Two patches were surveyed: the extensive block from the road tip back west for about 5 km (1000–1300 m altitude), and, west of this, a large patch at 700–900 m; forest links these away from the road.

#### Nam Theun Extension NBCA at 18°25-30' N 105°04-07' E; 13-22 April 1996

Construction for six months to April 1996 extended a road 28 km from Ban Nahoua; the last 9 km ran through little-disturbed wet evergreen forest. Several dozen labourers camped in the middle of the survey area and some hunting probably occurred. The road was still under construction and about a dozen vehicles passed daily. The eastern extent, at 1 000–1 300 m altitude, passed through wet evergreen forest containing many *Fokienia* trees (then being felled), but to the west these trees were absent; most of this area was at 800–1 000 m, with an isolated summit of 1 250 m.

The Nam Theun Extension road ran along steep hills and heavy traffic has incised it deeply, so that for much of its length ground-living mammals must negotiate 1–4 m slopes of unfixed soil to reach the road. Most of the Nakay-Nam Theun road is level with adjacent land and thus, irrespective of the actual mammal communities, ground-living mammals would be more likely to use it than the Nam Theun Extension road. The relatively low and broken canopy was observed easily from both roads.

## Observations

Nocturnal mammals were counted while walking equipped with a headtorch and high power spotlamp, following the methodology of DUCKWORTH et al. (1994). Work was not performed under a bright moon in case encounter rates were reduced. Results are presented as the number of observations related to search time, with no attempt to calculate population densities.

Extensive diurnal observations were made along the road in Nakay-Nam Theun. The observer spent periods of 1–5 hours sitting inconspicuously at points with a clear view of a long stretch of road or, in one case, down a landslip. When rain had dampened the leaf litter, the observer walked silently along the road. Few diurnal observations were made in Nam Theun Extension as time was short.

Notable observations from other biologists visiting during 1994–1996 are presented. Their records are asterisked (\*) in the text as, to allow comparison of the main survey with future work, diurnal survey effort (number of days in the field) must be clear. Other people's time should not be included in this as they were not primarily searching directly for mammals.

# Results

Taxonomic limits, scientific nomenclature and systematic sequence follow REEDER and WILSON (1993). Key species of mammals refer to those Globally Threatened, Globally Near-Threatened, and Data Deficient, following IUCN (1996), or Nationally at risk, following SALTER (1993).

#### Table 1. Mammal species recorded along the two roads

Species	Threat	NNTroad		NTX road	
		1996	1994	1996	1994
Tupaia belangeri (Wagner, 1841); Northern treeshrew		F	Р	F	С
Nycticebus coucang (Boddaert, 1785); Slow loris	NAR	Ο	Р	0	
[Nycticebus pygmaeus Bonhote, 1907; Pygmy loris]	GT	[0]		[0]	
Macaca arctoides I. Geoffroy, 1831; Stump-tailed macaque	GT	Ō	Р		Pd
Macaca assamensis M'Clelland, 1840; Assamese macaque	GT	F	[P]		
Pygathrix nemaeus (Linnaeus, 1771); Douc langur	GT	С	Ϋ́Ρ		[Pr]
[Trachypithecus phayrei (Blyth, 1847); Phayre's langur]	DD	[0]			ĽĴ
Hylobates leucogenys Ogilby, 1840/H. gabriellae Thomas, 1909; Gibbon	DD	C	С	С	0
Prionailurus bengalensis (Kerr, 1792); Leopard cat	NAR	Р	[Ps]		
Neofelis nebulosa (Griffith, 1821); Clouded leopard	GT	Р			
Panthera pardus (Linnaeus, 1758); Leopard	NAR	Р			
Panthera tigris (Linnaeus, 1758); Tiger	GT	Р	Ps		[Pr]
Pardofelis marmorata (Martin, 1837); Marbled cat	DD	Р			
Herpestes urva (Hodgson, 1836); Crab-eating mongoose		Р			
Arctonyx collaris F. G. Cuvier, 1825; Hog badger		Р		Р	
Martes flavigula (Boddaert, 1785): Yellow-throated marten		F	Р	Р	Р
Mustela sibirica Pallas, 1773; Siberian weasel		Р			
Mustela strigidorsa Gray, 1855; Back-striped weasel	GT		Р		
Arctogalidia trivirgata (Gray, 1832); Small-toothed palm civet		С	Р		
Paguma larvata (Smith, 1827); Masked palm civet		0		Р	
Paradoxurus hermaphroditus (Pallas, 1777); Common palm civet		С	Р	F	Р
Prionodon pardicolor (Hodgson, 1842); Spotted linsang	NAR	Р	Р		
Viverra zibetha Linnaeus, 1758; Large Indian civet		F			
Sus sp(p).; Pig		Р	Ps		Ps
Tragulus javanicus (Osbeck, 1765); Lesser mousedeer					[Ps]
Cervus unicolor Kerr, 1792; Sambar			[Ps]		
Muntiacus muntjak (Zimmermann, 1780); Indian muntjac		Р	Pdv		Р
Megamuntiacus vuquangensis Tuoc et al., 1994; Giant muntjac	n/a	[P]	[P]		Pdv
Muntiacus/Megamuntiacus spp.		Ċ	Ċ	0	Р
Bos frontalis Lambert, 1804; Gaur	GT	Р	[Ps]		
Manis pentadactyla Linnaeus, 1758; Chinese pangolin	GNT			Р	
Callosciurus erythraeus (Pallas, 1778); Pallas's squirrel		С	С	С	С
Callosciurus inornatus (Gray, 1867); Inornate squirrel	GT		Р	Р	
Ratufa bicolor (Sparrman, 1778); Black giant squirrel	NAR	С	Р	Р	Р
Dremomys rufigenis (Blanford, 1878); Red-cheeked squirrel		С	С	С	С
[ <i>Tamiops maritimus</i> (Bonhote, 1900); Chinese striped squirrel]		n/a	[C]	n/a	[P]
Tamiops rodolphei (Milne-Edwards, 1867); Cambodian striped	NAR	n/a	C	n/a	P
squirrel					
Tamiops sp(p).		С	n/a	С	n/a
Hylopetes sp.; Small flying squirrel		Р			
Petaurista elegans (Mueller, 1840); Lesser giant flying squirrel		LF	Р	F	
Petaurista philippensis (Elliot, 1839); Indian giant flying squirrel		LF		F	
Rhizomys pruinosus Blyth, 1851; Hoary bamboo-rat				Р	
Hystrix brachyura Linnaeus, 1758; Hodgson's porcupine		Р			

Threat: GT, Globally Threatened; GNT, Globally Near-Threatened; DD, Data Deficient (all after IUCN 1996); NAR, Nationally At Risk (after SALTER 1993) n/a, species discovered too recently for categorisation. Status: records in brackets are provisional identifications of species; n/a = not applicable;

C = common; F = frequent, O = occasional; P = Present, abundance not assessed; L (prefix) = distribution was uneven. 1996 records are based on direct field sightings, except for *Sus* sp., for which one skull was found. 1994 records come mainly from direct observation, with other methods indicated by suffixes: s = sign; d = remains (v = those in village); r = villagers' report.

#### Mammals from Nakay-Nam Theun NBCA

The total of 37–40 large mammal species living along the Navang road (Tab. 1) is high for a single site in Indochina, rivalling those from several entire NBCAs (approximate totals: Xe Pian NBCA: 37; Dong Hua Sao NBCA: 30; Phou Xang He NBCA: 35; Xe Bang-Nouan NBCA 29; Nam Kading NBCA: 41; Nakay-Nam Theun NBCA: 54; Phou Xiang Thong NBCA 22; DUCKWORTH et al. 1994; EVANS et al. 1996; WCS unpubl. data). The richness of carnivores (15 species) and primates (seven) is particularly notable; this is the only Lao site with direct sightings of more than one species of cat or weasel. At least two muntjac species are present.

By day, species such as *Martes flavigula*, *Ratufa bicolor*, monkeys, gibbons and muntjacs were seen more often than at other surveyed sites in Laos. Primates were notably confiding, sometimes allowing the observer under their tree. General hunting pressure on the road is evidently negligable.

Contact frequencies of nocturnal species (Tab. 2) were high, but lower than at two other recently-constructed roads through little-disturbed evergreen forest (Tab. 3, after WCS unpubl. data). This difference is due solely to lorises; when they are excluded from the comparative figures, the Navang road crosses the most productive forest yet surveyed in Laos (Tab. 3). The low hunting pressure (much lower than on these other roads) means that contact frequencies at Nakay-Nam Theun are probably the truest representation of relative species status gained at any Lao site.

Table 2. Nocturnal animals recorded along the two roads.

Figures are for the number of contacts. The number of individuals, where this differed, is in parentheses. c, casual record, not during timed count. Evans (1994) records are from WCS (unpubl. data). Murid rodents and bats are omitted. All unidentified muntjacs were heard and not seen. Ease of survey refers to the ease and detection of mammals, in two categories: those on or near the ground and those in the mid and upper storeys of the trees.

Species	NTX road		NNTroad		
		main forest	west forest	Evans (1994)	
Nycticebus coucang	1	2	1	1	
N. pygmaeus	с	с			
Prionailurus bengalensis		2			
Neofelis nebulosa		1			
Arctogalidia trivirgata		6(8)	2	1	
Paguma larvata	4	2			
Paradoxurus hermaphroditus	5	4		1	
Prionodon pardicolor		с		1	
Viverra zibetha		3	1		
Muntiacus muntjak		1			
Muntjacus/Megamuntiacus sp.	2	1	- 1	1	
Manis pentadactyla	1				
Hylopetes sp.			1		
Petaurista elegans	2	5		1	
Petaurista philippensis	3		4		
Rhizmys pruinosus	1				
Hystrix brachyura			1(2)		
Unidentified	1	2	4	3	
Hours searching	39 <sup>1</sup> / <sub>4</sub>	45 <sup>1</sup> / <sub>4</sub>	14 <sup>3</sup> / <sub>4</sub>	8 <sup>1</sup> / <sub>2</sub>	
Total contacts	20	29	15	9	
Ease of survey: ground	difficult	easy	easy	easy	
Ease of survey: trees	easy	easy	easy	easy	

 Table 3. Contact frequencies of nocturnal mammals along various roads in Lao through evergreen or semi-evergreen forest surveyed in March–May.

The contact frequency is the no of hours per contact. The lower the figure the more productive the site. All time figures are rounded to the nearest quarter-hour.

Sources: NNT and NTX, this study; T-H, Xe Namnoy, WCS (unpubl. data); Phou Xang He, DUCK-worth et al. (1994); Phou Xiang Thong, Evans et al. (1996).

Site	Hours effort	Total contacts	Contacts (lorises excluded)	Contact frequency (lorises excluded)
NNT road, main forest	$45^{1}/_{4}$	29(31)	27	$1^{3}/_{4}$
NNT road, west block	$14^{3}/_{4}$	15	14	1
NNT road, 1994	$8^{1}/_{2}$	9	8	1
NTX road	$39^{1}/_{4}$	20	19	2
Theun-Hinboun access road	$20^{1}/_{2}$	19(20)	9(10)	$2^{1}/_{4}$
Middle Xe Namnoy road	$12^{1}/_{2}$	19(20)	6(7)	2
Phou Xang He Corridor	$78^{1}/_{4}$	73	40	2
Phou Xiang Thong	12	13(15)	6(8)	2

The difference in rates between the main forest and the west block (Tab. 3) means little as the latter was visited on only two nights; brief observations in 1994 gave an overall contact frequency in the main forest similar to that in the west block in 1996.

### **Mammals from Nam Theun Extension**

The low species total (18) of large mammals reflects the brevity of the work and the limited observation by day, but it was mirrored by low numbers of individuals (except squirrels) seen by day, and low contact frequencies by night (Tab. 2). These are the lowest for any forest road surveyed in Laos, although discounting lorises the Nam Theun Extension road is as productive as are various other sites (Tab. 3). The scarcity of large mammal sightings here compared with the Nakay-Nam Theun road was reflected in small mammal trapping rates (C. M. FRANCIS pers. comm. 1996). Recording of all mammals was probably hampered by the frequent storms, but it is unlikely that this is the sole explanation for the low sighting and trapping rates.

## Altitudinal distribution patterns among mammals in Laos

These roads are the only areas surveyed above 550 m in Laos, but they are in the same catchment so care should be taken when relating to altitude the differences in mammal status between them and lower sites.

Species in the genus *Petaurista* are separated by altitude. In Nakay-Nam Theun, five records of *P. elegans* at 1000–1200 m contrasted with four of *P. philippensis* at 700–900 m. In Nam Theun Extension, there were two records of *P. elegans* at 1000–1200 m and three of *P. philippensis* at 800–1000 m. *P. elegans* has not recently been found elsewhere in Laos, but *P. philippensis* occurs widely in lowlands and foothills (DUCKWORTH et al. 1994; WCS unpubl. data). *P. elegans* is primarily montane elsewhere (PAYNE et al. 1985; CORBET and HILL 1992).

Two geographically sympatric species of pangolin may also be separated altitudinally. The only recent records of *Manis pentadactyla* in Laos are from the Nam Theun Extension and, freshly-caught, in a remote village in Nakay-Nam Theun at 600 m (R. J. TIMMINS pers. comm. 1997). Pangolins at lower altitude in the Nam Theun catchment (at 380 m in Nam Kading NBCA and at 520 m on the Nakay Plateau; WCS unpubl. data) were *M. javanica* Desmarest, 1822 (Sunda Pangolin).

Paguma larvata, Arctonyx collaris, and Herpestes urva were found at one or both sites. Other documented Lao specimens and recent observations of them are also from montane or hill areas (DUCKWORTH 1997), although in other countries they are not always montane: e.g. *P. larvata* occurs commonly at sea-level in Borneo (PAYNE et al. 1985).

The *Rhizomys pruinosus* is the only recent sighting of a wild or freshly-captured animal in Laos but *R. sumatrensis* (Raffles, 1821) (Large bamboo-rat) has been seen commonly around Vientiane at 200–600 m (DUCKWORTH 1996; WCS unpubl. data). Elsewhere *R. pruinosus* is mainly montane, occurring at 1 000–4 000 m (CORBET and HILL 1992).

*Nycticebus coucang* was much less common at these two sites than in the lowland sites of Phou Xang He NBCA, the middle Xe Namnoy valley, Nam Kading NBCA and Phou Xiang Thong NBCA (DUCKWORTH et al. 1994; EVANS et al. 1996; WCS unpubl. data). It was also scarce on the Nakay Plateau at mid-altitude (520 m) (WCS unpubl. data).

#### **Key species accounts**

Species identified provisionally are bracketed. Records are from 1996 unless otherwise stated. Authors are given only for species not in table 1.

*Manis pentadactyla* – Chinese pangolin NTX: one at 03h00 on 15 April.

*Nycticebus coucang* – slow loris NTX and NNT: small numbers (Tab. 2).

[*Nycticebus pygmaeus* – pygmy loris

NNT and NTX: singles on 13 April\* and 20 April\* respectively.

There have been few other recent records in Laos (DUCKWORTH 1994 a; BERGMANS 1995; WCS unpubl. data; note that the locality of Xe Pian NBCA listed by BERGMANS (1995) was erroneous, as a result of poor phraseology in DUCKWORTH 1994b).]

## Macaca arctoides - stump-tailed macaque

NNT: sightings on 8 May\* and 13 May\* in the main forest probably involved the same troop, of at least 30 animals.

*Macaca assamensis* – Assamese macaque NNT: up to two troops observed almost daily in the main forest.

#### Pygathrix nemaeus – douc langur

NNT: up to two troops (some over 30-strong) observed almost daily in the main forest.

All were the red-shanked (sub)species, P. (n.). *nemaeus*, as were all other recent Lao records (WCS unpubl. data).

#### [*Trachypithecus phayrei* – Phayre's langur

NNT: at least two on 8 May\* in the main forest.

These were identified as this species rather than as *T. cristatus* (Raffles, 1821) on the basis of latitude (see FOODEN 1996; RUGGERI and TIMMINS 1996).]

#### *Hylobates* sp. – gibbon sp.

NNT: up to four groups seen almost daily in the main forest.

NTX: one group seen on 14 April at 09h00. Calling was much less prominent than along the Nakay-Nam Theun road, presumably reflecting a lower population.

On range, these animals are likely to be *H. gabriellae siki* or *H. leucogenys*. The pale patch of fur on the cheeks of males was observed closely but even so conclusive identification was not possible; the taxonomy and distribution of the forms recently recorded in Laos remains unclear (RUGGERI and TIMMINS 1996).

*Prionailurus bengalensis* – leopard cat NNT: two singles (Tab. 2).

# *Neofelis nebulosa* – clouded leopard

NNT: one at 00h50 on 14 May in the forest.

This is the only recent field sighting of the species in Laos. Skins reportedly from the NBCA were seen in Nakay-Nam Theun in 1994 and 1995 (WCS unpubl. data). Villagers' reports (widespread in Laos; SALTER 1993; WCS unpubl. data) cannot be confirmed records, and signs are not identifiable with certainty (G. B. SCHALLER pers. comm. 1996).

#### Panthera pardus – leopard

NNT: two fighting in a roadside tree at 09h30 on 12 April\*. One resting sunlit on the road at 16h00 on 27 April\*.

These are the only recent sightings in Laos; the widespread villagers' reports (SALTER 1993; WCS unpubl. data) cannot be regarded as confirmed records.

## Panthera tigris – tiger

NNT: singles on 11 February (17h00)\*, 27 April (15h00)\*, and 29 April (08h00), all within 5 km of each other, perhaps involved only one animal.

The first was watching the observer from a crouched position, the second was flushed by the car from its sunlit resting spot, and the third was walking down the road and fled immediately it noticed the observer. These are the only recent field sightings of tiger in Laos, although remains and/or footprints have been seen in a few places, and villagers report the animal widely (SALTER 1993; DUCKWORTH et al. 1994; BERGMANS 1995; WCS unpubl. data).

## Pardofelis marmorata - marbled cat

NNT: one at 14h50 on 9 May.

The only other recent record in Laos is of a freshly-killed animal in the Phongsaly area in early 1996 (W. G. ROBICHAUD pers. comm. 1996). A skin reportedly from Nakay-Nam Theun was seen on the Nakay Plateau in 1995 (WCS unpubl. data).

## *Mustela strigidorsa* – back-striped weasel

NNT: one on 15 April 1994\* (Evans et al. 1994).

Only one other recent Lao record was traced by DUCKWORTH (1997).

## Prionodon pardicolor – spotted linsang

NNT: one at 21h30 on 11 April 1996\* and one at 20h40 on 12 April 1994\* (Evans et al. 1994).

These are the only recent field observations from Laos traced by DUCKWORTH (1997); two market specimens from south Laos were mentioned by BERGMANS (1995).

### Bos frontalis – gaur

NNT: one at 03h30 on 12 May in an area of dense roadside ruderals.

There are only two other recent direct sightings of gaur in Laos (DUCKWORTH et al. 1994; WCS unpubl. data).

*Callosciurus inornatus* – inornate squirrel NNT: one at 1100 m on 17 April 1994\*.

NTX: singles on 20 April and 21 April\* were separated by at least 2 km.

This squirrel occurs only east of the Mekong; it has not been found commonly at any recently surveyed Lao site (DUCKWORTH et al. 1994; DUCKWORTH 1996; WCS unpubl. data). Although not listed directly as Globally Threatened by IUCN (1996), this source lists Laos within the range of *C. pygerythrus* (I. Geoffroy, 1832); *C. inornatus* was included as a subspecies of the former, which does not otherwise occur in Laos, by ELLERMAN and MORRISON-SCOTT (1951).

#### Ratufa bicolor - black giant squirrel

NNT: up to five groups heard daily, with up to three (of 1–2 animals) seen on most days. NTX: one on 17 April at 910 m\*.

At sites across Laos, *Ratufa* seems as susceptible to human pressure as are diurnal primates (DUCKWORTH et al. 1994; DUCKWORTH 1996; WCS unpubl. data) and at these two sites its status again matches that of primates. Furthermore, as with gibbons and monkeys, giant squirrels along the roads were notably easily approached compared with animals at most other Lao sites. The paucity of records from NTX mirrors several other species which were not recorded (notably *Arctogalidia* and monkeys) or scarce (gibbon).

# Tamiops rodolphei - Cambodian striped squirrel

NNT and NTX: common in 1994 and presumably in 1996.

These squirrels were not identified to species in 1996; a thorough taxonomic review of the genus in Laos is needed to clarify the number of forms involved and the field characters of each.

#### Other species of interest

Mustela sibirica – Siberian weasel

NNT: one at 16h00 on 9 May.

No other documented Lao record was traced by DUCKWORTH (1997).

Arctonyx collaris – hog badger

NNT: singles on 27 April at 05h10 and on 2 May at 09h05.

NTX: one at 11h30 on 20 April\*.

The only other recent field sightings in Laos traced by DUCKWORTH (1997) are from the Nam Theun catchment at lower altitude.

## Muntiacus and Megamuntiacus spp. - muntjacs spp.

NNT: nine single muntjacs were observed by day and one at night. Additional animals were heard on most days. One was seen in 1994.

NTX: animals were heard, but by no means daily.

Two muntjac species occur in the Nakay-Nam Theun area in addition to *Muntiacus muntjak*: *Megamuntiacus vuquangensis* and a dark species not yet described to science (SCHALLER and VRBA 1996; TIMMINS et al. 1998). Field characters of these two (other than head and antler structure) are based on too few individuals for the range of natural variation within them to be clear. Thus, identifications of the nine animals observed are not yet possible, so descriptions of each are lodged in the WCS Vientiane office to allow possible identification in the future. Two animals of the 11 seen were clearly *M. muntjak* (which occurs in the general area; TIMMINS et al. 1998), but the other nine lacked the rufous pelage tone diagnostic of this species and at least one had a black dorsal aspect to the tail.

# Discussion

#### Importance of the two areas for mammal conservation

The Navang logging road has the highest recorded species total of any site in the country, the more impressive in view of the relative brevity of the survey. The high sighting rates could reflect genuinely high densities of mammals (and thus a high conservation importance), or they might arise from some other factor (not necessarily indicating real importance of the site), such as the excellent visibility along the road. Some forest animals probably avoid roads but others, e.g. cats, positively select them for transit (e.g. RABINOWITZ 1990). On the present survey, resting big cats and foraging civets and muntjacs were clearly associated with the road. Hunting may depress populations and make animals shyer. The low hunting pressure along the road is doubtless important in producing the frequent mammal sightings, but the relative importance of the two effects is unclear.

The high encounter rates along the Navang road stem partly from the excellent viewing, but certainly reflect a community of great conservation importance. Observations at other areas equally as remote, within Nakay-Nam Theun and outside (such as Xe Pian NBCA) would perhaps be equally productive were there barely-used roads into their centres. The results from the Navang road profile an area typical in habitat of much of the Nakay-Nam Theun NBCA, where the road allows a more complete survey than is possible elsewhere.

The Navang road supports at least nine Globally Threatened species, three Data Deficient, six Nationally at risk and probably two muntjac species which, if known prior to publication of IUCN (1996), would have been considered Globally Threatened. It provides the only recent field sightings in Laos by biologists of clouded leopard, marbled cat, leopard, tiger, Siberian weasel, spotted linsang, and an undetermined muntjac. The true significance of these records is obscure, as most of these species cannot be surveyed except by direct sighting or camera trapping; only tigers can be unequivocally identified by signs or villagers' descriptions. The area is also notable for its healthy populations of gibbons, douc langurs, and probably of giant muntjac. By comparison with the data in SCHREIBER et al. (1989), Nakay-Nam Theun becomes the second most important reserve in the Indomalayan realm for conservation of small carnivores (DUCKWORTH 1997).

The survey of the Nam Theun Extension road was too brief to assess the importance of the area, particularly as human presence is much higher than along the road in Nakay-Nam Theun, but it seems to have a naturally lower density of large mammals.

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### Zusammenfassung

#### Eine Kartierung der Großsäugetierfauna in den zentralen Annamite-Bergen in Laos

Von April bis Mai 1996 wurde eine Kartierung der Großsäugetierfauna in wenig gestörtem, immergrünem Bergwald in und um die Nakay-Nam Theun National Biodiversity Conservation Area (NBCA), Laos, mittels direkter Beobachtung durchgeführt. Die Kartierung erfolgte auf einer Straße, welche wegen des geringen Jagddrucks und der guten Sichtbedingungen die beste Repräsentation des relativen Artenstatus erbrachte, im Vergleich mit allen anderen bislang kartierten Gebieten in Laos. Es wurden mehr Säugetierarten gefunden als in vielen anderen gesamten Regionen der NBCA. Besonders hervorzuheben sind 15 Arten der Ordnung Carnivora. Die nächtlichen Kontaktrate waren höher als in jedem anderen kartierten Gebiet (wenn Plumploris aus dem Vergleich herausgenommen werden). Sichtraten am Tag waren gleichfalls hoch. Insgesamt fielen neun Arten unter die Kategorie "Globally Threatened", drei unter "Data deficient" und sechs unter "Nationally At Risk", was auf eine besondere Bedeutung zur Erhaltung des Gebiets hinweist. Viele dieser Arten weisen große Populationen auf, und einige wurden während eines kürzlich begonnenen Kartierungsprogramms gar nicht gesehen. Auf einer anderen Straße, auf der die Kartierungsbedingungen weniger gut waren, wurden nur einige wenige Arten entdeckt. Im Vergleich mit Kartierungen in Tieflandgebieten und an dem Fuße der bergigen Regionen in Südlaos lassen die Resultate aus der Nakay-Nam Theun National Biodiversity Conservation Area folgende Schlußfolgerungen hinsichtlich der Höhenverteilung der Arten zu: (1) Sympatrische Arten der Gattungen Petaurista, Rhizomys und Manis sind altitudinal getrennt; (2) Arctonyx collaris, paguma larvata und Herpestes urva sind submontan oder montan; (3) Nycticebus coucang kommt häufiger im Tiefland als in 1 000 m Höhe war.

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