

## Conservation importance of Nakai-Nam Theun National Protected Area, Laos, for small carnivores based on camera trap data

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**Abstract.** Laos supports at least 21 species of small carnivores (Viverridae, Prionodontidae, Mustelidae, and Herpestidae) and is considered to be globally important for the conservation of many of these, yet for most species, baseline data on diversity, distribution, conservation, and taxonomic status remain limited. Nakai-Nam Theun National Protected Area (NPA), central-eastern Laos, is ranked among the highest priority of the country's NPAs for national and global biodiversity importance and is one of the largest remaining contiguous forest blocks in Indochina. A wildlife monitoring programme based on camera trap surveys debuted in the area in 2006. From 2006–2011, 10 blocks were sampled covering 900 km<sup>2</sup> and totalling 20,452 camera trap days. Excluding Felidae, 10 species of small carnivores were photographed during this survey, including the first confirmed record in the wild of Owston's civet *Chrotogale owstoni* for the area and the second for Laos. This long-term camera-trap programme is one of only two long-term wildlife monitoring programmes in Laos and as such provides some of the most comprehensive data available on small carnivores for the country. The frequency of records for each species, local distribution, and general behaviour observed are presented. Other species known to occur in the area but unrecorded by this camera trap survey are discussed. In total, at least 15 species of small carnivores occur in Nakai Nam Theun NPA. Although small carnivore species may be more resilient to hunting activities than larger mammals, the intensity of hunting with ground snares in the area is likely to result in dramatic population declines if it is not better controlled. Nakai-Nam Theun NPA should be considered as a priority area for the conservation of small carnivores, notably for Vulnerable Owston's civet and its otter species.

**Key words.** viverrids, prionodontids, mustelids, herpestids, Lao PDR, snare-hunting

### INTRODUCTION

More than two decades ago, part of the Indochinese region (namely, 'Northern Vietnam [including adjacent areas in China, Laos, and Thailand]'; Schreiber et al., 1989: 75) was listed as one of the most important areas for the global conservation of small carnivores (mustelids and viverrids). The authors of this report notably recommended increasing research on the distribution, status, and taxonomy of these species, which has generally remained lacking in the region. Within Laos, up until now, the diversity, distribution, and status of small carnivores (here defined as viverrids, prionodontids, mustelids, and herpestids) remain little known. Countrywide wildlife surveys conducted in the 1990s

provided preliminary information on the group (Duckworth, 1997; Duckworth et al., 1999), although survey intensity and methodology were unlikely to record all species possibly present at any given site visited (Duckworth, 1997). At least 21 species are currently known to occur across Laos (Table 1), including five Globally Threatened and three Near Threatened species (IUCN, 2012). The paucity of data on small carnivores makes it difficult to update their conservation status. However, over the past decade, camera traps were used in some national protected areas (Johnson & Johnston, 2007; Dersu, 2008; Johnson et al., 2009; Duckworth et al., 2010; WCS Lao Programme, unpublished data) and have been proven effective to provide baseline data on many ground-dwelling species. The publication of such long-term data provides invaluable information to increase our understanding of the geographical and ecological distribution of these species and insights into their general behaviour.

Nakai-Nam Theun National Protected Area (NNT NPA), central eastern Laos, has been ranked among the highest priority of the country's NPAs for national as well as global biodiversity importance based notably on species richness, distinctiveness, and endemism (Robichaud et al., 2001), and still remains one of the largest blocks of contiguous forest in mainland Southeast Asia. However, it supports the high levels of hunting typical of much of Laos and Vietnam. To assess the impact of NPA management—primarily law enforcement—on the conservation of the area's terrestrial

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Table 1. Confirmed small carnivore (excluding Felidae) species in Laos. Abbreviations: N, north; C, center; S, south.

Species	Scientific Name	Documented National Distribution*	Global Status (IUCN, 2012)	National Status (1999)**	Lao Hunting Regulation Category (NA, 2008)***
<b>Mustelidae</b>					
yellow-bellied weasel	<i>Mustela kathiah</i>	N, S	Least Concern	Little Known	not listed
Siberian weasel	<i>Mustela sibirica</i>	C	Least Concern	Little Known	not listed
stripe-backed weasel	<i>Mustela strigidorsa</i>	N, C	Least Concern	Little Known	Prohibited
yellow-throated marten	<i>Martes flavigula</i>	N, C, S	Least Concern		not listed
hog badger	<i>Arctonyx collaris</i>	N, C, S	Near Threatened	Little Known	Managed
large-toothed ferret badger	<i>Melogale personata</i>	C, S	Data Deficient	Little Known	Managed
small-toothed ferret badger	<i>Melogale moschata</i>	N, C	Least Concern	Little Known	Managed
Eurasian otter	<i>Lutra lutra</i>	N	Near Threatened	At Risk	Prohibited
smooth-coated otter	<i>Lutrogale perspicillata</i>	N, S	Vulnerable	At Risk	Prohibited
Oriental small-clawed otter	<i>Aonyx cinereus</i>	N, C, S	Vulnerable	At Risk	Prohibited
<b>Viverridae</b>					
large Indian civet	<i>Viverra zibetha</i>	N, C, S	Near Threatened		Managed
large spotted civet	<i>Viverra megaspila</i>	N, C, S	Vulnerable	At Risk	Prohibited
small Indian civet	<i>Viverricula indica</i>	N, C, S	Least Concern		Managed
common palm civet	<i>Paradoxurus hermaphroditus</i>	N, C, S	Least Concern		Managed
masked palm civet	<i>Paguma larvata</i>	N, C, S	Least Concern		Managed
binturong	<i>Arctictis binturong</i>	N, C, S	Vulnerable	At Risk	Managed
small-toothed palm civet	<i>Arctogalidia trivirgata</i>	N, C, S	Least Concern		Managed
Owston's civet	<i>Chrotogale owstoni</i>	N, C, S	Vulnerable	Little Known	Prohibited
<b>Prionodontidae</b>					
spotted linsang	<i>Prionodon pardicolor</i>	N, C, S	Least Concern	Little Known	Prohibited
<b>Herpestidae</b>					
small Asian mongoose	<i>Herpestes javanicus</i>	N, C, S	Least Concern		Managed
crab-eating mongoose	<i>Herpestes urva</i>	N, C, S	Least Concern		Managed

References used: Duckworth et al., 1999 (includes historical records, i.e., pre-1990s); Tizard, 2002; Robichaud, 2010; Sivily et al., 2011; R. J. Timmins, pers. comm.; J. W. Duckworth, pers. comm.

\* Additional locations where the species do occur may still remain undocumented

\*\* National status not indicated means that the species is considered secure in the medium-long term (Duckworth et al., 1999)

\*\*\* Prohibited: hunting of the species is not allowed at any time and place; Managed: hunting is permitted in specified zones and seasonally only (National Assembly Lao PDR, 2008)

mammals, a long-term wildlife monitoring programme using camera traps was initiated in 2006 in NNT NPA, implemented by the Nam Theun 2 Watershed Management and Protection Authority (WMPA), with technical supervision by the Lao Program of the Wildlife Conservation Society (WCS; Johnson et al., 2005; Johnson & Johnston, 2007). We present for the first time results of this survey for small carnivores (excluding small cats) for the period 2006–2011.

## MATERIAL AND METHODS

**Study area.** Nakai-Nam Theun National Protected Area (NNT NPA; Fig. 1) covers ca. 4,000 km<sup>2</sup> (including recent extensions) with altitudes ranging from ca. 500 to >2200 m asl (above sea level). Around 80% of the NPA remains forested (Robichaud et al., 2009). The NPA is dominated by old growth, largely undisturbed, dry-evergreen forest, with other localised habitat including pine, semi-evergreen, upper-montane and wet-evergreen forest (Timmins & Evans, 1996). Thirty-one villages are located within the NPA; each village is allocated subsistence-use forest areas where villagers are allowed to collect non-timber forest products, including

some common wildlife species according the Wildlife and Aquatic Law and the Forestry Law (National Assembly Lao PDR, 2007a, 2007b).

**Camera trap data.** Camera trap data were obtained from systematic surveys during 2006–2011 conducted in NNT NPA by the Nam Theun 2 Watershed Management and Protection Authority (NT2 WMPA) staff and a technical advisor assigned by WCS. The sampling programme was designed by WCS, which also provided training to NPA staff for the long-term implementation of the programme (Johnson et al., 2005; Johnson & Johnston, 2007). From March 2006–January 2011, camera traps were set in 10 survey blocks (4–109 km<sup>2</sup> c.f. Table 2; Fig. 1), selected to represent the different habitats within NNT NPA and to monitor the status of ground animal populations as an indicator of the impact of management strategies in place (Johnson & Johnston, 2007). Three to 50 passive infrared film or digital cameras were set in a survey site (one camera per locality), with cameras being ca. 1 km apart. Cameras were positioned on trees at a height of ~45 cm (targeted for large mammals), beside animal trails or small streams, and/

Table 2. Details of camera-trapping survey effort in Nakai-Nam Theun NPA from 2006 to 2011. Abbreviation: CTD, camera trap day.

Survey Blocks (Number on map)	Altitudinal Range of Camera-Traps (m)	Time Period	Total Cameras <sup>a</sup>	CTD	Survey Block Size (km <sup>2</sup> ) <sup>b</sup>
Khamkeut–Nam San (1)	574–1942	March–May 2006	49	2233	84
Nam On–Boualapha (2)	707–998	October–November 2006	49	1406	92
Nam On–Gnomalath (3)	580–886	December 2006–February 2007	49	1754	88
Khamkeut–Thong Pae (4)	661–1621	March–May 2007	48	2181	76
Nam Chae–Makfuang (5)	532–1046	November 2007–January 2008	50	2359	96
Nam Chae–Navang (6)	559–1149	January–March 2008	47	1894	107
Phou Vang–Houay Nam Heuy (7)	—	April–August 2008	32	1719	4
Thong Xet (8)	558–1007	November 2008–January 2009	22	1242	90
Nam Mon–Thongkacheng (9)	—	March 2009–May 2009	3	186	—
Nam Theun–reservoir (10)	531–577	November–December 2009	40	1676	53
Nam Mon–Thongkacheng (9)	784–1786	March–May 2010	45	2450	109
Khamkeut–Nam San (1)	590–1671	December 2010–January 2011	33	1352	84
<b>TOTAL</b>		<b>March 2006–January 2011</b>	<b>467</b>	<b>20,452</b>	<b>883</b>

<sup>a</sup> Faulty cameras are excluded; for (9) in 2009, only data from three cameras were available from the database.

<sup>b</sup> Determined with a minimum convex polygon around all camera-traps in ArcGIS 9.3.

Note: Elevation for (9) in 2009 and (7) were missing from the database.

or at other arbitrary open understorey locations. No lures or bait were used. Each camera was programmed to operate 24 hours per day and to take photos at 20-second intervals whenever it was automatically triggered by an object passing in front of it. Most of the cameras (96.8%) had a maximum capacity of 36 photos, therefore survey effort ceased when 36 photos had been taken. The remaining cameras were digital with a capacity of >600 photos, which was never exceeded before removal of the camera. Survey effort for each camera was calculated from the day the camera was set to the day of the last photo taken (for the 36 photos capacity-cameras), or the day of camera removal (for the >600 photos capacity-cameras). Total survey effort (in camera trap days, CTD) is the sum of days cameras were operating, for all cameras. Data from faulty cameras (i.e., cameras for which only the first test-photo was taken, and was found not to be working when collected) were excluded from analysis, as it was not possible to quantify their camera trap days. For each camera, available data included GPS coordinates of location (datum UTM, Indian Thailand), elevation (m asl taken with Garmin GPS60 or Garmin 12 units) and the date and time of each photo.

Of all photos analysed ( $n = 9,265$ ) during the survey period, small carnivore (excluding Felidae) photo records were identified with the assistance of J. W. Duckworth. To derive the number of photograph records for each species and reduce the risk of double counting, only ‘independent photos’ were included, defined here as consecutive photographs of individuals/social units of the same species taken more than 30 minutes apart (except when the same individual/social unit could be identified and was photographed consecutively for over 30 minutes) and non-consecutive photos of individuals/social units of the same species (following O’Brien et al., 2003). Camera trap localities and record details for each camera-locality are presented. We also present the relative encounter rate (i.e., total independent photos of small carnivore species/total camera trap days for the period\*100) of carnivore species and survey effort (i.e., camera trap days)

pulled per month. Additional records of small carnivore species from incidental observations during foot surveys conducted by CNZC and CN in 2011–2012 are tabulated.

## RESULTS

Ten blocks were sampled (Fig. 1) over the survey period, totalling 20,452 camera trap days (Table 2). Ten small carnivore species (‘species’ sensu lato – ferret badger species

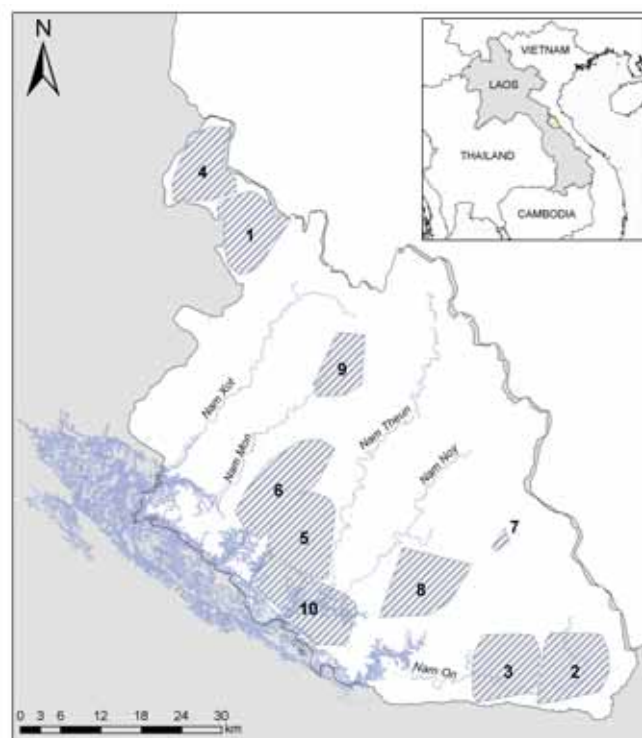


Fig. 1. Camera-trap sampling effort within Nakai–Nam Theun NPA in 2006–2011 (c.f. Table 1; Johnson et al., 2007) at 10 survey blocks; in chronological order of survey: (1) Khamkeut – Nam San; (2) Nam On – Boualapha; (3) Nam On – Gnomalath; (4) Khamkeut – Thong Pae; (5) Nam Chae – Makfuang; (6) Nam Chae – Navang; (7) Phou Vang – Houay Nam Heuy; (8) Thong Xet; (9) Nam Mon – Thongkacheng; (10) Nam Theun – reservoir.

Table 3. Number of independent images taken for each species over the 20,452 camera-trap days period, elevation and percentage of them taken at dusk (1700–1900 hours), night (1900–0500 hours), dawn (0500–0700 hours), and in day time (0700–1700 hours). Note: Dusk and dawn may vary across seasons in the area.

Species	No. of Independent Photographs	No. of Camera Localities <sup>a</sup>	No. of Survey Blocks	Elevation Range (m)	% Dusk	% Night	% Dawn	% Day
large Indian civet	79	39	6	531–1707	6	87	7	0
common palm civet	100	54	10	549–1792	5	89	6	0
masked palm civet	55	36	6	629–1792	2	94	2	2
Owston's civet	60	15	5	1033–1675	2	98	0	0
binturong	1	1	1	828	0	100	0	0
spotted linsang	5	4	3	839–1594	0	60	40	0
yellow-throated marten	18	15	8	562–1792	6	0	11	83
ferret badger sp(p).	101	34	6	583–1675	1	94	5	0
hog badger	80	42	9	547–1622	8	60	22	10
crab-eating mongoose	40	27	8	531–1792	8	3	15	75

<sup>a</sup> Number of camera-trap-locality (a single camera-trap per locality) where recorded, out of the 469 camera-trap-sites set.

are not identifiable from images and therefore considered as *Melogale* sp(p.) were photographed (Table 3). Ferret badger sp(p). were the most frequently recorded (101 independent photos), followed by common palm civet (100), hog badger (80), large Indian civet (79), Owston's civet (60), masked palm civet (55), crab-eating mongoose (40), yellow-throated marten (18), spotted linsang (5), and binturong (1).

The elevation range at which each species was recorded (Table 3) fell into the documented range in Laos (Duckworth et al., 1999; Johnson et al., 2009; Sivilay et al., 2011).

The 24-hour activity cycle varied between species. Yellow-throated marten and crab-eating mongoose were largely recorded from dawn through day time (0500–1700 hours); whereas the other eight species were predominantly recorded from dusk through night time (1700–0500 hours). Spotted linsang, yellow-throated marten, hog badger, and crab-eating mongoose were the most regularly recorded at dawn (0500–0700 hours; >10% of images; Table 3).

The months of April, December, January, March and November received the maximum survey effort (in camera trap days: 4010, 3749, 2764, 2820, and 2515 respectively; Fig. 2). Relative encounter rates for all species combined (i.e., total independent photos of small carnivore species/total camera trap day for the month) were expectedly the lowest during the poorly surveyed months of the wet season (June–September). However, despite high survey effort in January and December, relative encounter rate was relatively low during both months (0.4 and 0.7 respectively). Conversely, although the months of October and May were surveyed less (585 and 1407 camera trap-days respectively), the relative encounter rate for these two months were among the highest (1.9 and 1.6 respectively). Overall, relative encounter rates were the highest for the months of March (3.0), April (1.9), October (1.9), and May (1.6; Fig. 2). Pulled by seasons, the relative encounter rate was the lowest during the cold-dry season (November–February; 0.69), followed by the warm-wet season (April–September; 1.48) and highest for the two

intermediate months (March and November; 2.79). Other factors may however influence these results such as habitat type and hunting pressure.

Distribution of records was not uniform across the areas sampled between the different species (Figs. 3, 4; Appendix). Common palm civet was the only species recorded at all 10 survey blocks and was recorded from the highest number of camera trap localities (n=52). Encounter rate and localities were the fewest for spotted linsang and binturong.

Large Indian civet, masked palm civet, Owston's civet, crab-eating mongoose and yellow-throated marten were photographed one (large Indian civet) to four times (crab-eating mongoose) with conspecifics (two to three animals). Only crab-eating mongoose was recorded in groups of over two individuals (Table 4; Appendix 3).

During survey work in 2011–2012, additional records for six species (five of which recorded from the camera trap surveys) were documented from incidental observations in the wild or from hunter camps or snare traps (Table 5; Appendix 1).

## DISCUSSION

During a five-year camera trap programme in the NNT NPA, 10 species of small carnivores were recorded of which two are classified by the IUCN Red List of Threatened Species as Globally Threatened (Vulnerable) and two as Near Threatened (IUCN, 2012; Table 1). Nine species had previously been confirmed in the area (Duckworth, 1997; Duckworth et al., 1999; Robichaud & Stuart, 1999; Robichaud, 2010). Of the small carnivores captured on camera the Owston's civet is the first confirmed field record for the NPA (Johnson & Johnston, 2007), and the second for the country (Johnson et al., 2009; see below).

In 1994 and 1996, 10 small carnivore species were directly observed within one part of NNT NPA (Duckworth, 1998), of which three were not recorded from this study (Siberian

Table 4. Details of photographs that captured groups ( $\geq 2$  individuals) of animals (c.f. Appendix 3).

Species / Location	No. of Individuals	Age	General Behaviour	Date	Time (hours)
<b>large Indian civet</b>					
Nam Mon (Thongkacheng)	2	adult-sized	2 individuals sniffing each other's perineal region	1 April 2010	2200
<b>masked palm civet</b>					
Khamkeut (Nam San)	2	adult-sized	travelling side by side, looking down	27 April 2006	0042
Khamkeut (Thong Pae)	2	adult-sized	travelling side by side (3 consecutive photos)	4 April 2007	0543
Nam Mon (Thongkacheng)	2	adult-sized	travelling side by side	9 March 2010	1959
<b>Owston's civet</b>					
Khamkeut (Thong Pae)	2	adult-sized	travelling side by side, looking down	6 April 2007	0154
Khamkeut (Thong Pae)	2	adult-sized	travelling side by side, looking down	3 May 2007	2146
<b>crab-eating mongoose</b>					
Khamkeut (Nam San)	2	adult-sized	travelling side by side, looking down	16 April 2006	1146
Nam On (Boualapha)	2	adult-sized	travelling side by side, looking down	10 November 2006	0647
Nam On (Boualapha)	3	adult-sized	travelling side by side, 2 sniffing the air, 1 looking down	17 November 2006	1008
Nam Theun reservoir	3	adult-sized	travelling side by side, 2 sniffing the ground, 1 looking up	3 December 2009	1504
<b>yellow-throated marten</b>					
Khamkeut (Nam San)	2	adult-sized	travelling side by side, looking down	27 March 2006	1552
Phou Vang	2	adult-sized	standing side by side, looking up	13 March 2008	1000

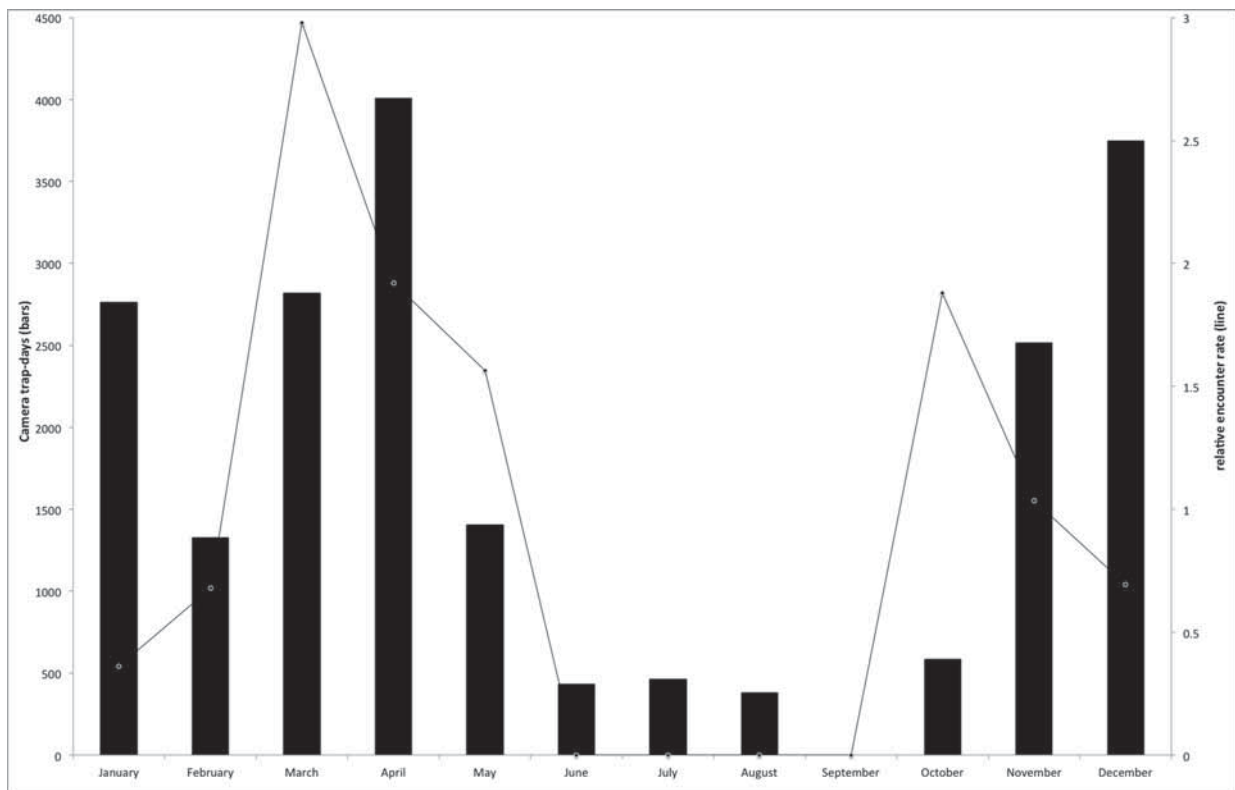


Fig. 2. Total survey effort (in camera trap days) per month over the 2006–2011 survey period (bars) and relative species encounter rate (i.e., total independent photos of small carnivore spp./total camera trap day for the month). Relative encounter rates were highest during the warmest and well-surveyed months—peaks are observed in March (start of the warm season) and October (still within the warm season). Despite high survey effort in January and December (cold season), encounter rates were low.

weasel, stripe-backed weasel, small-toothed palm civet; see below). This highlights, in part, the differing adequacy of methodologies and survey designs for recording some species. Indeed, the characteristics of the camera trapping methodology, here focusing on a broad range of larger and ground-dwelling mammals or large birds rather than being species-specific means that results do not present the comprehensive species diversity occurring in NNT NPA. For instance, weasels, otters, and arboreal species were unlikely to be recorded in this survey design due to their characteristic habitat use (dense undergrowth; along large rivers; up in the canopy, respectively), not well (or at all) represented by the locations of cameras. In Nam-Et Phou Louey NPA, northern Laos, 10 species were also recorded during a long-term camera trap survey (8,499 camera trap days) of which eight are in common with NNT NPA (Johnson et al., 2009). Compared to other Southeast Asian countries, the number

of species recorded by camera traps in NNT NPA falls in the upper range (5–12) of small carnivore species richness (excluding cats and otters) recorded from intensive camera trap surveys (>1,000 camera trap days) at single sites (e.g., Grassman, 2003; Kawanishi & Sunquist, 2004; Than Zaw et al., 2008; Holden & Neang, 2009; Chen et al., 2009; Cheyne et al., 2010; Wilting et al., 2010; Jenks et al., 2011).

When deploying camera traps, taking into consideration the respective ecology and behaviour of small carnivore species can increase detectability. For instance, placing additional cameras in trees or other microhabitats may record species that are semi- or mainly arboreal or strongly associated with specific microhabitat features. In addition, using baits at camera locations and/or increasing survey effort during seasons when species activity increases are likely to result in higher encounter rates (Sollmann et al., 2013). Our study

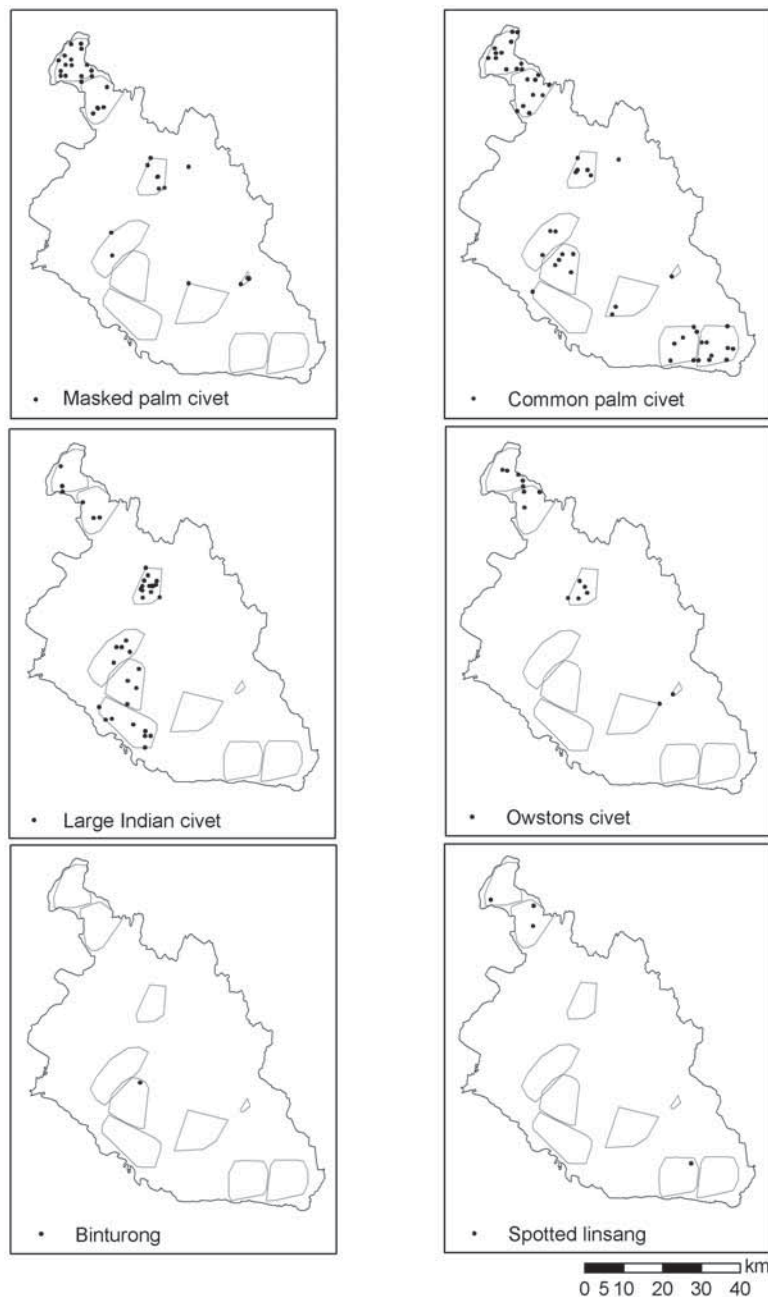


Fig. 3. Distribution of camera-trap records for Viverridae and linsang in Nakai-Nam Theun NPA from 2006–2011.

shows that species encounter rate may be, in part, influenced by season in NNT NPA, with a catch rate highest during the warm season, when animals tend to increase their activity levels, as had been previously suggested (Duckworth, 1997). However, other factors may also influence the differing encounter rates between sampling blocks, such as habitat type and hunting pressure. In highly heterogeneous habitats such as NNT NPA, species records and encounter rates at any one site are unlikely to be representative of the presence/absence of each species or of their relative abundance due to the inconstant detection probability across time, space, and species (Sollmann et al., 2013). Sampling design (e.g., camera set-up, camera model, sample size) and species' behavioural ecology (e.g., home range, habitat use), which in turn can vary across space and time, influence encounter

rates in camera trap studies (Sollmann et al., 2013), which prevents drawing any conclusions on species abundance between survey sites in this study. Our camera trap survey was not initially intended as an estimate of species abundance between sampling blocks, but rather to use the data to evaluate change in occupancy of terrestrial mammals within a sampling block over time as a result of the NPA management (largely zoning and law enforcement; Johnson et al., 2005).

**Viverridae.** Five civet species were photographed in NNT NPA (Table 3) including Owston's civet, the first confirmed field record for the NPA. The common palm civet and large Indian civet were the most widely recorded species and found over the largest altitudinal ranges, which concurs with sighting records of the two species across Laos (Duckworth,

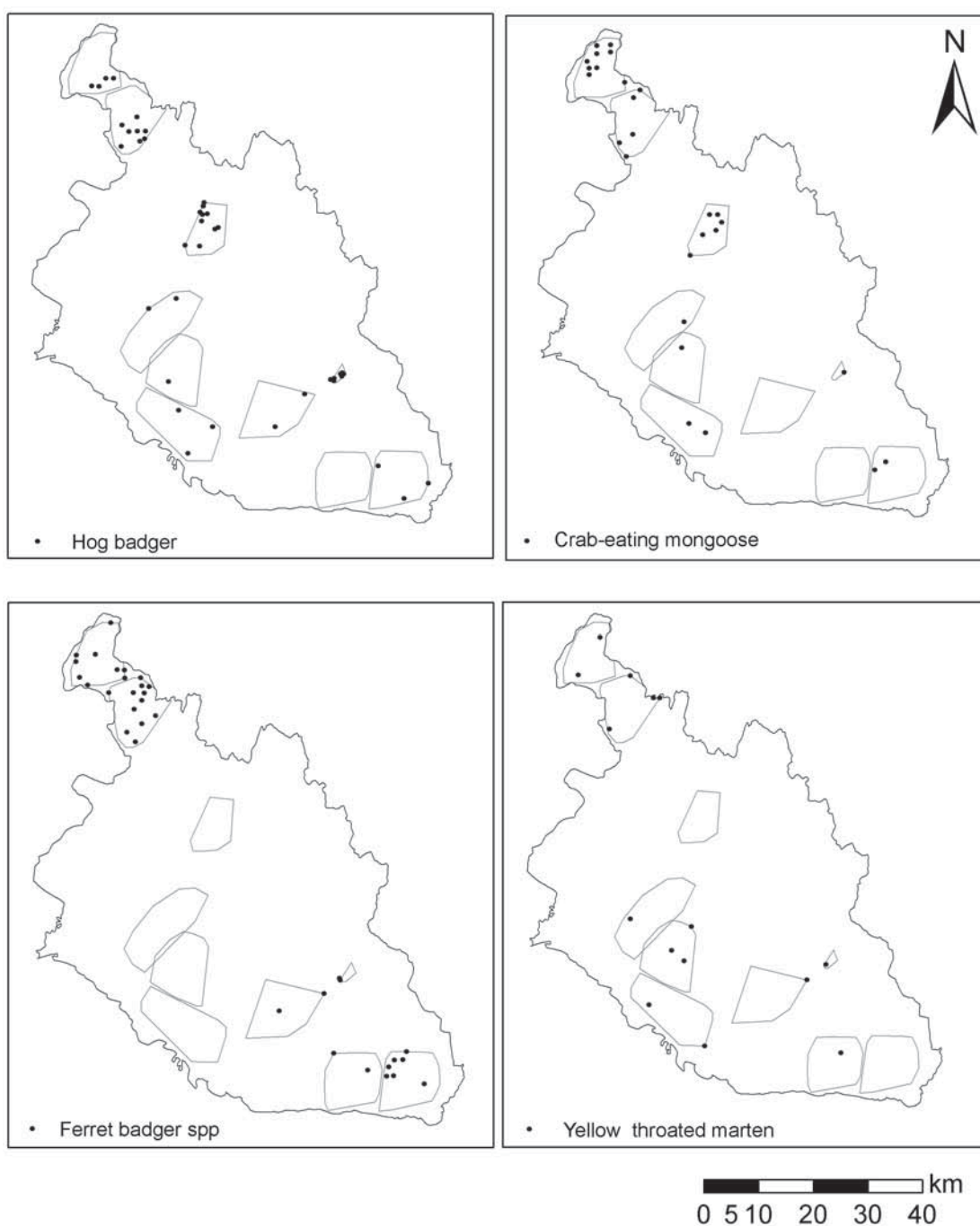


Fig. 4. Distribution of camera-trap records for Mustelidea and Herpestidea in Nakai-Nam Theun NPA from 2006–2011.

Table 5. Other incidental records of small carnivores in Nakai-Nam Theun NPA foot surveys conducted by CNZC and CN in 2011–2012 in 10 survey sites (see Appendix 1).

Species	Details	Date	Area	Geographic Coordinates (projected WGS 1984 datum)	Elevation (m asl)
hog badger	remains in snares: skull	March 2011	Maka	17°58'N 105°30'E	~700
hog badger	remains in snares: skull	July 2011	Thong Xet	17°46'21.630"N 105°30'47.876"E	973
masked-palm civet	captive at Vietnamese camp; released	July 2011	Thong Xet	17°46'17.559"N 105°31'18.574"E	n/a
spotted linsang	remains: tail in poacher camp (c.f. Appendix 1)	January 2012	Nam Chae	17°48'2.099"N 105°17'5.075"E	n/a
otter sp.	tracks along large river (Nam Theun; c.f. Appendix 1)	January 2012	upper Nam Theun	18°0'52.971"N 105°27'28.249"E	675
crab-eating mongoose	sighting	January 2012, 0754 hours	upper Nam Theun	18°5'40.596"N 105°30'17.827"E	1006
binturong	remains: spine and hair	March 2012	Nam Mon	18°1'2.323"N 105°20'14.896"E	1255

1997) and another camera trap survey in northern Laos (Johnson et al., 2009). The distribution of records for the other three civet species was more restricted, which may reflect their affinity to higher elevations within NNT NPA. Masked palm civet is considered to range only above 500 m asl in Laos (Duckworth, 1997; Duckworth et al., 1999). There were few or no records of masked palm civet from sampling areas at lower elevations (Table 3). It is possible the species' semi-arboreality may render its camera capture under-represented. In Myanmar, in some areas where captive or dead specimens of masked palm civets were often recorded, relatively high camera trap efforts (~300–2,000 camera trap-days) failed to record images of this species (Than Zaw et al., 2008).

Little is known about the distribution and status of Owston's civet across its range; it is only known from China, Vietnam, and Laos (Robertson et al., 2008). Our records in NNT NPA (17°47'N to 18°19'N) fall within the range of the known distribution. Additional records in the wild from Laos come from only two other locations (Nam-Et Phou Louey NPA, northeastern Laos, ~20°N: Johnson et al., 2009 and Phou Chomvoy Provincial Protected Area, central eastern Laos, 18°29'N: Sivily et al., 2011) at elevations >1,000 m asl. The species is yet to be confirmed south of NNT NPA in Laos but the current southernmost record in Vietnam (12°21'N; Dang & Le, 2010) would suggest the species also occurring in southern Laos in suitable habitat. The species has never been recorded in Cambodia, but it is believed that if present, it would only have a restricted range in the northeast within suitable habitat and climatic conditions (Holden & Neang, 2009). Across its range, the species has been recorded via camera traps from elevations of 400 to ca. 1,700 m asl (Rozhnov et al., 1992; Grieser Johns, 2000; Johnson et al., 2009; Dang & Le, 2010; Sivily et al., 2011). The species

in Laos may however be restricted to the upper elevation range. Records from the Vietnamese side of the Annamite Mountains go below the lowest altitude of NNT NPA, e.g., in nearby Pu Mat Nature Reserve, Vietnam, Grieser Johns (2000) camera trapped it down to 400 m. However, habitat is significantly different between the two aspects of the Annamite Mountains, notably in terms of dry-season: this is benign in the east (Vietnam side) but long and harsh in most of the west (Timmins & Trinh, 2001), and this may explain the differing altitudinal distribution of the species between the two sides.

The single record of binturong during this survey may in principle be due to arboreality, rarity, and/or the positioning of cameras. One individual was observed and filmed in daylight in the canopy during a visit around Phou Vang survey block in March 2011 (Robichaud, W.G. pers. data). This species is mainly arboreal but regularly comes to the ground when it cannot cross the canopy (Widmann et al., 2008). Elsewhere in Asia, camera trap surveys at sites where binturongs occur captured few or no photographs of the species (e.g., Datta et al., 2008; Than Zaw et al., 2008; Holden & Neang, 2009; Cheyne et al., 2010; Wilting et al., 2010; Jenks et al., 2011; Samejima & Semiadi, 2012).

Virtually all known Asian civets are nocturnal (Jennings & Veron, 2009), and this was reflected in our study results. All civet photographs were recorded between 1731–0543 hours, with 91% of photographs during night time (1900–0500 hours). Sociality of these species is poorly known; they are all classified as solitary but occasionally are found with conspecifics, as shown in a few photographs in this study with duos of adult-size individuals of masked palm civet, large Indian civet, and Owston's civet, all taken during March–May (Table 4). This is the end of the dry season in Laos, and



the concentration of the photographs suggests it possibly coincides with the mating season, although it is unclear from the images of what age and sex the individuals were. During foot surveys in Laos, groups (2–5 individuals) of masked palm civet and common palm civet were occasionally sighted (Duckworth, 1997; Johnson et al., 2009), and in Cambodia, 2–5 common palm civets were regularly photographed at a salt lick (Edwards, 2012). Our single image of a pair of large Indian civets where the individuals are sniffing each other's perineal region, may indicate they are engaging in mating behaviour. In Cambodia, in May 2011, a pair of *Viverra/Viverricula* (species unconfirmed) was observed in trees ~10 m above ground; the authors speculated that the animals were possibly involved in a reproductive behaviour, as these species are almost always observed to be solitary and on the ground (Iseborn et al., 2012). The species has been reported to breed throughout the year (Lekagul & McNeely, 1988), although this has never been studied in wild populations. Similarly, little is known of the breeding seasons of masked palm civet and Owston's civet in the wild. Common palm civet was not photographed in pairs/group in this study. This species has been sighted copulating in the wild (though near human settlement) in March and September (Borah & Deka, 2011).

**Prionodontidae.** Four photos were taken of the spotted linsang. This low frequency of photo-capture of linsang *Prionodon* spp. is common during camera trap surveys across their range, when the species is not targeted (e.g., Datta et al., 2008; Than Zaw et al., 2008; Holden & Neang, 2009; Cheyne et al., 2010; Wilting et al., 2010; Jenks et al., 2011). Camera traps generally exclude postulated preferred micro-habitats of the species; as an ambush hunter, it may spend most of its ground-level time hidden in thick understory vegetation (J. W. Duckworth, pers. comm.) where camera traps are rarely set. Linsangs are semi-arboreal species, possibly primarily ranging in dense understory from one metre above the ground to above canopy (Kuznetsov & Baranaukas, 1993; Van Rompaey, 1995). The species remains poorly known but it has been found in various forest types and over a wide altitudinal range where it occurs and seems resilient to degraded habitat (Robertson et al., 2008). The species seems mainly active at dusk and night (e.g., Johnson et al., 2009; Redford et al., 2011; Baker et al., 2012; Ghose et al., 2012) but has been sighted active in the wild during daytime in Assam, India (Borah, 2010).

**Mustellidae.** Four mustelid taxa were camera trapped. Unidentified ferret badgers were the most frequently camera trapped taxa, although they were not evenly recorded throughout the sampled areas. The distribution of *Melogale* spp. in Laos and neighbouring countries remain uncertain. Two species of ferret badgers have been recorded in Laos: large-toothed *M. personata* and small-toothed *M. moschata* ferret badgers (Duckworth et al., 1999), and a third, *M. cucphuongensis*, has recently been named from neighbouring Vietnam (Nadler et al., 2011), and could plausibly inhabit Laos (if valid taxonomically). Despite intensive camera trap survey in Nam Et-Phou Louey NPA, northeastern Laos, no images were taken of the genus (Johnson et al., 2009),

suggesting the possibility of this being a true reflection of their status in the area, given the comparatively high frequency at which it was recorded in NNT NPA. However, other factors such as differences in camera positioning might also contribute to this pattern.

On current knowledge, species identification requires observation of the skull and dentition (Schank et al., 2009; Robichaud, 2010), therefore few records across Laos have been identified to species. Both *M. moschata* and *M. personata* have been confirmed to occur in NNT NPA from records of one skull for each species found in a snare and a poacher camp, respectively (*M. moschata*: Robichaud, 2010; *M. personata*: Coudrat & Nanthavong, 2013). Our photographs of the genus in NNT NPA show variation in the individuals' fur colouration, from light brown to grey (see Appendix 2). This variation may be found within single species (e.g., Schank et al., 2009; Nadler et al., 2011) as is also observed in other small carnivore species (Veron et al., 2004). Photographs corroborate the genus as nocturnal in NNT NPA.

Hog badger was recorded widely in terms of altitude, geography, and photo-capture frequency. Records (and field observations from NNT NPA) suggest the species can be active during day and night time, as has previously been found in Myanmar (Than Zaw et al., 2008).

Activity cycle, altitudinal range, and sociality of yellow-throated marten recorded from this survey is consistent with previous studies, in which the species has been recorded primarily by day and often travellings in small groups (e.g., Duckworth, 1997; Parr & Duckworth, 2007; Datta et al., 2008; Holden & Neang, 2009).

**Herpestidae.** The photos of crab-eating mongoose in duos or groups of 3–4 individuals are consistent with previous observations that this species regularly travel with conspecifics (Duckworth, 1997; Than Zaw et al., 2008; Johnson et al., 2009). The species was primarily recorded from 0500–1700 hours, consistent with previous records across its range, where no pictures/sightings have been made later than 1830 hours and earlier than 0430 hours (e.g., Duckworth, 1997; Than Zaw et al., 2008; Chen et al., 2009; Holden & Neang, 2009; Edwards, 2012).

**Other species not recorded during the camera trapping.**

Five species previously documented in NNT NPA (Timmins & Evans, 1996; Duckworth, 1997; Dersu, 2008) were not recorded in this study. Both the stripe-backed weasel *Mustela strigidorsa* and the Siberian weasel *M. sibirica* have been sighted at least once in NNT NPA (Duckworth, 1997; Duckworth, 1998; Abramov et al., 2008; Streicher et al., 2010; Coudrat CNZ, pers. obs., 2014). Little is known of their ecology and habitat use. On 31 January 2014, 6:46 am, the first author (CNZC) observed an individual of *M. strigidorsa* at 17°51'55.36"N 105°15'16.00"E, 969 m a.s.l. during a visit in NNT NPA. The animal came a metre away from the observer and was foraging on the ground in thick vegetation, in dry evergreen forest. Both species have been

recorded in various habitat types across their range; however, stripe-backed weasel probably occurs mainly in hill and mountain regions with forest towards the evergreen end of the forest spectrum for which NNT NPA is typical; but the regional habitat use of Siberian weasel remains poorly understood (Lekagul & McNeely, 1988; Duckworth et al., 1999; Abramov et al., 2008).

The small-toothed palm civet *Arctogalidia trivirgata* is at least locally common in NNT NPA (Duckworth, 1997), but is a strictly arboreal species (Duckworth & Nettelbeck, 2007), which explains its absence from image records from ground-level camera trapping.

At least two otter species have been previously reported from the area: Oriental small-clawed otter *Aonyx cinereus* and a larger unidentified otter species (see Timmins & Evans, 1996; Duckworth, 1997; Dersu, 2008). Otters were not recorded during our study, as no camera traps were positioned along large riverbanks. Tracks of otters were commonly observed along large rivers in the area in 1996 (Timmins & Evans, 1996), and surveys in the lowland (<500 m asl) western part of the NPA (referred to as Nakai plateau) in 2006–2008 recorded at least two species of otter (largely on the basis of signs) in association with most river stretches surveyed (Dersu, 2008), and several tracks (unidentified species) were observed along the Nam Theun in 2012 (Coudrat, 2012). Future camera trap surveys in NNT NPA should focus on the identification of otter species occurring in the area and be positioned along large rivers.

Various small carnivores known from Laos remain unrecorded from NNT NPA except from the Nakai plateau, part of which has, since 2008 (Illangovan, 2011), been inundated by the reservoir from the hydroelectric dam Nam Theun 2. Two of these species are tied in Laos to highly deciduous and/or degraded habitats: small Indian civet, *Viverricula indica*; and small Asian mongoose *Herpestes javanicus* (see Duckworth et al., 1999; Dersu, 2008; Duckworth et al., 2010). For these, there is presently little, if any, suitable habitat in the NPA. Large-spotted civet probably occurs, or used to, on the Nakai plateau (Khounboline, 2005), but this seems to be about its upper altitudinal limit in Laos (Duckworth et al., 1999) and it is likely to be extremely local, if present at all, in the NPA. The yellow-bellied weasel *Mustela kathiah*, not recorded from the NPA, is known to inhabit highlands (over 1,000 m) both north and south Laos (Tizard, 2002; Duckworth & Robichaud, 2005) and presumably occurs along the intervening Annamite spine, although there are as yet no records. Like other weasels in Southeast Asia, it seems to be poorly recorded by camera traps (Supparatvirkorn et al., 2012), so it may well inhabit NNT NPA. Two other species have not been confirmed in the NPA, but are so difficult to identify that they may have been detected but not identified: smooth-coated otter and Eurasian otter.

**Threats.** In Laos, of all small carnivore species discussed here, civets are the most commonly found sold in markets as food, processed products for traditional medicine, trophies or pets, and are also traded with Vietnam (Duckworth et al.,

1999; Nooren & Claridge, 2001). In NNT NPA, the extent of small carnivore hunting—whether for local consumption or trade with Vietnamese—is unknown. However the large number of snares set by Lao and Vietnamese poachers in the protected area (Robichaud et al., 2009; Coudrat, 2012) undoubtedly catch voluminous amount of these animals, targeted or not. Some villagers in NNT NPA have reported that civet meat is favoured, while meat from yellow-throated marten, badger species and weasels is disliked (WMPA, unpublished data). Interviews of rural households in Lao uplands in the north and south of Laos have revealed that wild meat, including several small carnivore species, traditionally formed a large part of upland Lao people's diet, but unsustainable harvest has led to the decrease of these species' wild populations (Krahn, 2005; Krahn & Johnson, 2007). From these interviews, it was found that annual kill rates of viverrid species have dramatically decreased (Krahn, 2005) with a switch to smaller-bodied animals (such as squirrels and rats) now reportedly more commonly hunted (Krahn & Johnson, 2007). The intensity of snare hunting in the area put these species at high risk of critical population decrease in the future. Small carnivores species, however, may be relatively resilient to hunting compared to larger mammals. In adjacent forest areas in Vietnam where hunting is much more intense and forest blocks more fragmented, small carnivores are still found at relatively high numbers (e.g., Timmins & Trinh, 2001). In comparison, the hunting-sensitive wild cats have already been dramatically reduced in NNT NPA from snares hunting (Coudrat et al., in press).

Overall, 15 species of the 21 species confirmed to occur in Laos are found in NNT NPA. As small carnivore species remain very poorly known, a wide variety of new techniques for placement of cameras should be considered in future camera trap that are intended for species identification. NNT NPA is one of the largest remaining forest blocks in Indochina, and as such is still one of the most important for the conservation of small carnivore species, notably for Vulnerable Owston's civet (Schreiber et al., 1989), and at a regional level also is very significant for its two/three species of otters (Dersu, 2008).

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APPENDICES

Appendix 1. a, Otter tracks along the Nam (=river) Theun; b, spotted linsang tail found at a poacher camp in Nam Chae (Houay Thong) area (c.f. Table 5).



Appendix 2. Variation in coat colourations of *Melogale* sp(p). photo-captured in NNT NPA: a, 18°11'19.453"N, 105°13'17.962"E; b, 18°13'48.065"N, 105°15'19.163"E; c, 18°16'40.559"N, 105°13'55.902"E; d, 18°22'41.963"N, 105°10'50.923"E.



Appendix 3. Animal associations: a, large Indian civet, 18°3'20.430"N, 105°20'17.156"E; b, masked palm civet, 18°17'31.607"N, 105°8'25.696"E; c, Owston's civet, 18°3'20.588"N, 105°21'14.476"E; d, yellow-throated marten, 17°39'51.106"N, 105°35'35.912"E; e, crab-eating mongoose, 17°39'11.088"N, 105°38'20.522"E.



Appendix 4. Camera-trap records of small carnivores in Nakai-Nam Theun National Protected Area from 2006 to 2011 (only the first photograph taken for each camera is presented). Note: empty cells are missing data for the camera/photograph (projected with WGS 1984 datum).

Species	Area	Site	Longitude	Latitude	Date	Time (hours)	Elevation (m)	
Large Indian Civet	Khamkeut	Nam San	105.192299	18.253809	15 April 2006	1943	770	
	Khamkeut	Nam San	105.232228	18.217421	12 April 2006	0223	629	
	Khamkeut	Nam San	105.217444	18.216697	21 April 2006	0534	716	
	Khamkeut	Thong Pae	105.141786	18.279287	18 May 2007	0234	1191	
	Khamkeut	Thong Pae	105.140471	18.292113	14 April 2007	2024	1199	
	Khamkeut	Thong Pae	105.137566	18.338744	3 April 2007	0155	661	
	Nam Chae	Makfueng	105.300027	17.779554	20 December 2007	2147	585	
	Nam Chae	Makfueng	105.322785	17.817571	27 November 2007	0056	964	
	Nam Chae	Makfueng	105.328931	17.860341	16 December 2007	0300	855	
	Nam Chae	Makfueng	105.301233	17.834671	21 December 2007	1947	757	
	Nam Chae	Navang	105.296622	17.927920	20 March 2008	1912	822	
	Nam Chae	Navang	105.267037	17.876018	4 February 2008	0204	819	
	Nam Chae	Navang	105.272984	17.913195	11 February 2008	1849	867	
	Nam Chae	Navang	105.286012	17.912525	3 March 2008	1845	839	
	Nam Chae	Navang	105.306614	17.901792	18 February 2008	0041	856	
	Nam Mon	Thongkacheng	105.333891	18.048615	14 March 2009	0347		
	Nam Mon	Thongkacheng	105.335000	18.050556	28 April 2009	0210		
	Nam Mon	Thongkacheng	105.337400	18.045825	14 March 2010	0424	784	
	Nam Mon	Thongkacheng	105.338199	18.028497	5 March 2010	2343	1097	
	Nam Mon	Thongkacheng	105.370035	18.059305	27 March 2010	0540	1622	
	Nam Mon	Thongkacheng	105.351493	18.081637	18 March 2010	2028	1352	
	Nam Mon	Thongkacheng	105.346142	18.099742	29 March 2010	2147	1175	
	Nam Mon	Thongkacheng	105.341613	18.069426	29 March 2010	2218	1033	
	Nam Mon	Thongkacheng	105.338099	18.055675	30 March 2010	0435	957	
	Nam Mon	Thongkacheng	105.380337	18.029774	9 March 2010	2256	1421	
	Nam Mon	Thongkacheng	105.358850	18.041999	7 March 2010	2301	1243	
	Nam Mon	Thongkacheng	105.364321	18.056107	9 March 2010	1424		
	Nam Mon	Thongkacheng	105.360222	18.057018	14 March 2010	1931	1282	
	Nam Mon	Thongkacheng	105.372549	18.068664	7 April 2010	0116	1707	
	Nam Mon	Thongkacheng	105.362525	18.055469	18 March 2010	2051	1369	
	Nam Mon	Thongkacheng	105.354021	18.055719	13 March 2010	0412	1379	
	Nam Theun	reservoir	105.314897	17.731553	18 December 2009	2219	541	
	Nam Theun	reservoir	105.343833	17.716193	21 November 2009	2134	531	
	Nam Theun	reservoir	105.342671	17.705385	15 December 2009	2255	548	
	Nam Theun	reservoir	105.261983	17.744385	23 November 2009	1807	573	
	Nam Theun	reservoir	105.246512	17.742959	20 November 2009	2311	539	
	Nam Theun	reservoir	105.343006	17.677870	22 November 2009	2345	565	
	Nam Theun	reservoir	105.357231	17.704726	8 December 2009	0500	551	
	Nam Theun	reservoir	105.230468	17.772969	4 December 2009	0114	549	
	Masked Palm Civet	Khamkeut	Nam San	105.207102	18.204064	24 March 2006	0147	901
		Khamkeut	Nam San	105.232228	18.217421	21 March 2006	0133	629
		Khamkeut	Nam San	105.217444	18.216697	5 April 2006	0205	716
		Khamkeut	Nam San	105.218171	18.215522	23 December 2010	1907	824
		Khamkeut	Nam San	105.178777	18.277665	24 January 2011	2037	652
		Khamkeut	Nam San	105.241563	18.265259	31 December 2010	0021	1609
		Khamkeut	Thong Pae	105.128729	18.291489	5 April 2007	2100	1242
		Khamkeut	Thong Pae	105.140471	18.292113	4 April 2007	0543	1199
Khamkeut		Thong Pae	105.128708	18.302434	7 April 2007	2116	1247	
Khamkeut		Thong Pae	105.178159	18.366602	3 March 2007	0158	891	
Khamkeut		Thong Pae	105.154780	18.315728	23 April 2007	0429	1332	
Khamkeut		Thong Pae	105.203416	18.303499	14 April 2007	0304	1189	
Khamkeut		Thong Pae	105.178355	18.290916	28 April 2007	2017	826	
Khamkeut		Thong Pae	105.192624	18.316715	23 March 2007	1839	1621	
Khamkeut		Thong Pae	105.204318	18.290221	19 April 2007	0211	1245	
Khamkeut		Thong Pae	105.140974	18.316498	17 May 2007	1940	1069	
Khamkeut		Thong Pae	105.178260	18.354310	4 May 2007	2103	1792	
Khamkeut		Thong Pae	105.122925	18.327049	24 April 2007	2215	761	
Khamkeut		Thong Pae	105.154583	18.328500	2 April 2007	2104	1344	
Khamkeut		Thong Pae	105.137566	18.338744	9 April 2007	0209	661	
Khamkeut		Thong Pae	105.154379	18.365141	2 May 2007	0100	796	
Khamkeut		Thong Pae	105.250711	17.926277	11 May 2007	0258	769	

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Nam Chae	Navang	105.252826	17.872593	6 March 2008	0203	1063	
Nam Chae	Navang	105.364321	18.056107	21 February 2008	1935	651	
Nam Mon	Thongkacheng	105.346142	18.099742	11 March 2010	2306	1424	
Nam Mon	Thongkacheng	105.339183	18.083864	23 March 2010	0332	1175	
Nam Mon	Thongkacheng	105.380337	18.029774	20 March 2010	2313	1221	
Nam Mon	Thongkacheng	105.366351	18.028012	9 March 2010	1959	1421	
Nam Mon	Thongkacheng	105.364321	18.056107	14 March 2010	0027	1380	
Nam Mon	Thongkacheng	105.362525	18.055469	1 April 2010	night	1424	
Nam Mon	Thongkacheng	105.581386	17.820001	11 March 2010	0121	1369	
Phou Vang	Nam Heuy	105.565148	17.805903	15 March 2008	0209		
Phou Vang	Nam Heuy	105.583900	17.818620	30 March 2008	0254		
Phou Vang	Nam Heuy	105.583334	17.818368	9 March 2008	0323		
Phou Vang	Nam Heuy	105.438904	18.079560	6 March 2008	2253		
Thong Xet		105.438236	17.808407	28 December 2008	2226	686	
Common Palm Civet	Khamkeut	Nam Sane	105.207102	18.204064	20 March 2006	0528	901
	Khamkeut	Nam Sane	105.255323	18.230018	28 April 2006	0140	1634
	Khamkeut	Nam Sane	105.244531	18.277068	11 May 2006	0227	1675
	Khamkeut	Nam Sane	105.192299	18.193559	29 March 2006	1856	1278
	Khamkeut	Nam Sane	105.236266	18.266268	6 April 2006	0203	1649
	Khamkeut	Nam Sane	105.221656	18.188737	6 April 2006	2334	981
	Khamkeut	Nam Sane	105.217971	18.267149	17 April 2006	2254	1425
	Khamkeut	Nam Sane	105.270446	18.253759	10 April 2006	2236	1437
	Khamkeut	Nam Sane	105.231243	18.230474	8 April 2006	0005	1359
	Khamkeut	Thong Pae	105.180812	18.378323	15 April 2007	0154	929
	Khamkeut	Thong Pae	105.193524	18.377171	1 April 2007	0340	906
	Khamkeut	Thong Pae	105.166632	18.290537	2 May 2007	2323	1015
	Khamkeut	Thong Pae	105.203416	18.303499	08 May 2007	2027	1189
	Khamkeut	Thong Pae	105.204318	18.290221	29 March 2007	0345	1245
	Khamkeut	Thong Pae	105.178260	18.354310	30 March 2007	0228	1792
	Khamkeut	Thong Pae	105.140974	18.316498	20 April 2007	1925	1069
	Khamkeut	Thong Pae	105.154583	18.328500	5 April 2007	2333	1344
	Khamkeut	Thong Pae	105.191838	18.290758	3 April 2007	2243	974
	Khamkeut	Thong Pae	105.137566	18.338744	17 April 2007	1947	661
	Khamkeut	Thong Pae	105.141011	18.327209	11 May 2007	2011	845
	Khamkeut	Thong Pae	105.122776	18.316556	24 March 2007	2040	1152
	Nam Chae	Makfueng	105.302453	17.858892	17 November 2007	0304	799
	Nam Chae	Makfueng	105.322785	17.817571	21 December 2007	2216	964
	Nam Chae	Makfueng	105.328931	17.860341	6 December 2007	1925	855
	Nam Chae	Makfueng	105.284886	17.834135	17 November 2007	1904	864
	Nam Chae	Makfueng	105.293004	17.846244	17 November 2007	0216	957
	Nam Chae	Navang	105.253049	17.856983	12 March 2008	2132	742
	Nam Chae	Navang	105.272984	17.913195	8 February 2008	0109	867
	Nam Chae	Navang	105.286012	17.912525	25 February 2008	2225	839
	Nam Mon	Thongkacheng	105.339183	18.083864	21 March 2010	0452	1221
	Nam Mon	Thongkacheng	105.338099	18.055675	12 March 2010	0304	957
	Nam Mon	Thongkacheng	105.371513	18.042951	4 March 2010	1923	1398
	Nam Mon	Thongkacheng	105.362525	18.055469	3 April 2010	0209	1369
	Nam On	Boualapha	105.701894	17.640339	13 October2006	0244	831
	Nam On	Boualapha	105.698811	17.613280	1 November 2006	0056	823
	Nam On	Boualapha	105.663114	17.622695	16 November 2006	0136	778
	Nam On	Boualapha	105.714056	17.638379	31 October2006	0208	924
	Nam On	Boualapha	105.656698	17.613135	23 November 2006	0420	757
	Nam On	Boualapha	105.650763	17.653394	18 October2006	0104	791
	Nam On	Boualapha	105.701225	17.691544	13 October2006	1934	914
	Nam On	Boualapha	105.630784	17.612054	9 November 2006	1731	742
	Nam On	Boualapha	105.639034	17.653080	13 November 2006	2147	787
	Nam On	Gnomalath	105.593309	17.664196	8 January 2007	2133	702
	Nam On	Gnomalath	105.562920	17.611726	6 January 2007	1940	623
	Nam On	Gnomalath	105.619181	17.612136	26 December 2006	2001	657
	Nam On	Gnomalath	105.572712	17.650446	9 January 2007	2233	692
	Nam On	Gnomalath	105.626903	17.678111	15 January 2007	1847	850
	Nam On	Gnomalath	105.620257	17.689638	20 January 2007	0240	839
	Nam Theun	reservoir	105.230468	17.772969	19 November 2009	2248	549
	Phou Vang	Nam Heuy	105.566945	17.807227	11 March 2008	2109	
	Phou Vang	Nam Heuy	105.335000	18.050556	28 March 2008	0222	
	ThongXet		105.438904	18.079560	25 December 2008	1954	686



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	ThongXet		105.422513	17.718733	3 December 2008	2212	626
	ThongXet		105.430394	17.737092	18 January 2009	1901	688
Owston's Civet	Khamkeut	Nam San	105.566945	17.807227	24 March 2006	0153	1155
	Khamkeut	Nam San	105.338199	18.028497	13 April 2006	1849	1675
	Khamkeut	Nam San	105.341613	18.069426	2 May 2006	2149	1370
	Khamkeut	Thong Pae	105.358850	18.041999	11 April 2007	0043	1189
	Khamkeut	Thong Pae	105.354021	18.055719	24 March 2007	0020	1527
	Khamkeut	Thong Pae	105.313005	18.030130	24 March 2007	0255	1621
	Khamkeut	Thong Pae	105.207069	18.240751	3 April 2007	2111	1245
	Khamkeut	Thong Pae	105.244531	18.277068	19 April 2007	2037	1344
	Phou vang	Houay Nam Heuy		105.206195	18.277556	7 March 2008	1954
	Nam Mon	Thongkacheng	105.203416	18.303499	27 March 2010	2112	1097
	Nam Mon	Thongkacheng	105.165739	18.326719	25 March 2010	0147	1033
	Nam Mon	Thongkacheng	105.192624	18.316715	16 March 2010	2046	1243
	Nam Mon	Thongkacheng	105.204318	18.290221	15 March 2010	0304	1379
	Nam Mon	Thongkacheng	105.154583	18.328500	13 March 2010	2122	1034
	Thong Xet	Thong Xet	105.535110	17.785326	16 December 2008	2339	904
Spotted Linsang	Khamkeut	Nam San	105.232195	18.277933	18 April 2006	0529	1594
	Khamkeut	Nam San	105.231243	18.230474	3 April 2006	0459	1359
	Khamkeut	Thong Pae	105.128729	18.291489	18 April 2007	0258	1242
	Nam On	Gnomalath	105.613360	17.677340	2 January 2007	0411	839
Yellow Throated Marten	Khamkeut	Thong Pae	105.357872	17.676470	7 April 2007	1257	1792
	Khamkeut	Thong Pae	105.261983	17.744385	12 April 2007	1519	1199
	Khamkeut	Nam San	105.593309	17.664196	27 March 2006	1552	1437
	Khamkeut	Nam San	105.178260	18.354310	27 April 2006	1806	1358
	Khamkeut	Nam San	105.140471	18.292113	18 April 2006	0553	1305
	Khamkeut	Nam San	105.270446	18.253759	17 May 2006	0643	1548
	Nam Chae	Navang	105.281637	18.253553	11 February 2008	0859	758
	Nam Chae	Makfueng	105.193954	18.202433	26 December 2007	1638	964
	Nam Chae	Makfueng	105.230272	18.290878	8 December 2007	0836	1036
	Nam On	Gnomalath	105.567779	17.811111	21 January 2007	0918	702
	Nam Theun	reservoir	105.230152	17.887499	12 November 2009	0715	562
	Nam Theun	reservoir	105.322785	17.817571	23 November 2009	0948	573
	Phou Vang	Nam Heuy	105.335498	17.874069	13 March 2008	1000	
	Phou Vang	Nam Heuy	105.301233	17.834671	18 March 2008	1614	
	Thong Xet		105.535110	17.785326	9 December 2008	1042	904
Ferret Badger	Khamkeut	Nam San	105.232183	18.254822	5 April 2006	0233	1377
	Khamkeut	Nam San	105.207102	18.204064	21 March 2006	2318	901
	Khamkeut	Nam San	105.255323	18.230018	24 April 2006	0414	1634
	Khamkeut	Nam San	105.244531	18.277068	29 April 2006	2142	1675
	Khamkeut	Nam San	105.236266	18.266268	2 April 2006	2021	1649
	Khamkeut	Nam San	105.232195	18.277933	2 April 2006	0158	1594
	Khamkeut	Nam San	105.221656	18.188737	26 March 2006	2112	981
	Khamkeut	Nam San	105.232228	18.217421	22 March 2006	2325	629
	Khamkeut	Nam San	105.217971	18.267149	4 April 2006	0110	1425
	Khamkeut	Nam San	105.230272	18.290878	1 April 2006	2039	1548
	Khamkeut	Nam San	105.177319	18.266893	8 April 2006	0317	583
	Khamkeut	Nam San	105.219300	18.240855	24 December 2010	1901	1271
	Khamkeut	Thong Pae	105.128729	18.291489	24 April 2007	0057	1242
	Khamkeut	Thong Pae	105.141786	18.279287	2 May 2007	0121	1191
	Khamkeut	Thong Pae	105.180812	18.378323	11 May 2007	0118	929
	Khamkeut	Thong Pae	105.203416	18.303499	4 April 2007	0447	1189
	Khamkeut	Thong Pae	105.191503	18.303773	4 April 2007	1947	1108
	Khamkeut	Thong Pae	105.204318	18.290221	8 April 2007	0501	1245
	Khamkeut	Thong Pae	105.122925	18.327049	1 April 2007	1856	761
	Khamkeut	Thong Pae	105.154583	18.328500	25 April 2007	0033	1344
	Khamkeut	Thong Pae	105.122776	18.316556	6 May 2007	2104	1152
	Nam On	Boualapha	105.701894	17.640339	21 October2006	0353	831
	Nam On	Boualapha	105.642574	17.667666	12 November 2006	0516	827
	Nam On	Boualapha	105.666271	17.679093	17 October2006	2209	728
	Nam On	Boualapha	105.650763	17.653394	19 October2006	0252	791
	Nam On	Boualapha	105.651854	17.679015	28 October2006	0231	882
	Nam On	Boualapha	105.672071	17.692016	30 October2006	0308	933
	Nam On	Boualapha	105.639034	17.653080	20 November 2006	0105	787
	Nam On	Gnomalath	105.551027	17.689898	24 January 2007	2231	780

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	Nam On	Gnomalath	105.607616	17.662760	19 February 2007	0007	708
	Phou Vang	Nam Heuy	105.561112	17.809720	4 March 2008	2227	
	Phou Vang	Nam Heuy	105.562500	17.806941	5 March 2008	0430	
	Thong Xet		105.460385	17.758138	29 November 2008	2019	846
	Thong Xet		105.535110	17.785326	6 December 2008	0328	904
Hog Badger	Khamkeut	Nam San	105.205559	18.227014	16 April 2006	0159	1050
	Khamkeut	Nam San	105.204279	18.191802	24 April 2006	0226	820
	Khamkeut	Nam San	105.244306	18.204291	15 April 2006	0055	1481
	Khamkeut	Nam San	105.217444	18.216697	19 March 2006	0954	716
	Khamkeut	Nam San	105.236423	18.200578	22 March 2006	0259	1001
	Khamkeut	Nam San	105.245904	18.217278	30 March 2006	0515	1356
	Khamkeut	Nam San	105.232228	18.217421	18 April 2006	0508	629
	Khamkeut	Nam San	105.231728	18.240045	15 April 2006	2020	1383
	Khamkeut	Thong Pae	105.191503	18.303773	4 April 2007	0440	1108
	Khamkeut	Thong Pae	105.166632	18.290537	7 May 2007	2342	1015
	Khamkeut	Thong Pae	105.153784	18.291533	14 May 2007	0554	911
	Khamkeut	Thong Pae	105.178321	18.303678	1 May 2007	0047	897
	Nam Chae	Makfueng	105.284597	17.806377	23 November 2007	0039	612
	Nam Chae	Navang	105.250711	17.926277	12 March 2008	0449	1063
	Nam Chae	Navang	105.297883	17.942742	10 March 2008	0320	1052
	Nam Mon	Thongkacheng	105.338199	18.028497	2 April 2010	0556	1097
	Nam Mon	Thongkacheng	105.370035	18.059305	9 March 2010	0711	1622
	Nam Mon	Thongkacheng	105.351493	18.081637	21 April 2010	0624	1352
	Nam Mon	Thongkacheng	105.344760	18.094131	17 April 2010	2012	1152
	Nam Mon	Thongkacheng	105.346142	18.099742	22 March 2010	0134	1175
	Nam Mon	Thongkacheng	105.339183	18.083864	27 March 2010	0404	1221
	Nam Mon	Thongkacheng	105.343221	18.079926	17 April 2010	0000	1065
	Nam Mon	Thongkacheng	105.341613	18.069426	11 March 2010	0626	1033
	Nam Mon	Thongkacheng	105.364321	18.056107	11 March 2010	night	1424
	Nam Mon	Thongkacheng	105.313005	18.030130	17 March 2010	1836	1034
	Nam On	Boualapha	105.686033	17.614192	7 November 2006	0430	885
	Nam On	Boualapha	105.642574	17.667666	29 October 2006	1913	827
	Nam On	Boualapha	105.727737	17.639305	19 October 2006	1918	954
	Nam Theun	resevoir	105.317868	17.688786	14 November 2010	0431	577
	Nam Theun	resevoir	105.359577	17.732498	21 November 2009	1724	547
	Nam Theun	resevoir	105.301730	17.759621	25 November 2009	1755	550
	Phou Vang	Nam Heuy	105.581490	17.820326	31 March 2008	day	
	Phou Vang	Nam Heuy	105.583334	17.818368	21 March 2008	0505	
	Phou Vang	Nam Heuy	105.580567	17.814797	16 March 2008	1922	
	Phou Vang	Nam Heuy	105.579725	17.817222			
	Phou Vang	Nam Heuy	105.581670	17.820552	20 March 2008	0409	
	Phou Vang	Nam Heuy	105.578332	17.818338	12 March 2008	0401	
	Phou Vang	Nam Heuy	105.566945	17.807227	6 March 2008	1106	
	Phou Vang	Nam Heuy	105.561112	17.809720	19 March 2008	2258	
	Phou Vang	Nam Heuy	105.567779	17.811111	26 March 2008	1244	730
	Thong Xet		105.466893	17.732209	12 December 2008	0954	725
	Thong Xet		105.516940	17.785709	19 December 2008	1724	725
Crab-eating Mongoose	Khamkeut	Nam San	105.206023	18.179463	2 May 2006	1016	630
	Khamkeut	Nam San	105.218817	18.277759	4 April 2006	1640	1430
	Khamkeut	Nam San	105.193954	18.202433	10 April 2006	1746	1305
	Khamkeut	Nam San	105.230272	18.290878	16 April 2006	1146	1548
	Khamkeut	Nam San	105.217444	18.216697	27 March 2006	1542	716
	Khamkeut	Thong Pae	105.178159	18.366602	1 May 2006	0931	891
	Khamkeut	Thong Pae	105.154651	18.352117	28 April 2006	1148	1031
	Khamkeut	Thong Pae	105.203416	18.303499	24 April 2007	0748	1189
	Khamkeut	Thong Pae	105.178260	18.354310	27 April 2007	1037	1792
	Khamkeut	Thong Pae	105.140974	18.316498	23 April 2007	0548	1069
	Khamkeut	Thong Pae	105.154583	18.328500	2 May 2007	1547	1344
	Khamkeut	Thong Pae	105.137566	18.338744	2 April 2007	0804	661
	Khamkeut	Thong Pae	105.141011	18.327209	11 May 2007	0500	845
	Khamkeut	Thong Pae	105.154379	18.365141	4 May 2007	0957	796
	Nam Chae	Makfueng	105.302453	17.858892	15 December 2007	1546	799
	Nam Chae	Navang	105.306614	17.901792	18 February 2008	1440	856
	Nam Mon	Thongkacheng	105.351493	18.081637	23 March 2010	1146	1352
	Nam Mon	Thongkacheng	105.317444	18.013727	1 April 2010	1628	798
	Nam Mon	Thongkacheng	105.372549	18.068664	13 April 2010	0925	1707

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	Nam Mon	Thongkacheng	105.365480	18.081674	27 March 2010	0820	1494
	Nam Mon	Thongkacheng	105.362525	18.055469	13 March 2010	0645	1369
	Nam Mon	Thongkacheng	105.339484	18.048316	5 March 2010	1030	934
	Nam On	Boualapha	105.658080	17.666693	10 November 2006	0647	719
	Nam On	Boualapha	105.639034	17.653080	17 November 2006	1008	787
	Nam Theun	reservoir	105.314897	17.731553	15 December 2009	1136	541
	Nam Theun	reservoir	105.343833	17.716193	3 December 2009	1504	531
	Phou Vang	Nam Heuy	105.585698	17.817024	11 March 2008	1556	
Binturong	Nam Chae	Makfueng	105.322402	17.871840		0118	828