BACKGROUND NOTES FOR THE LAO PDR NATIONAL TIGER ACTION PLAN

Status of tigers and their conservation in Lao PDR

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List of acronyms

CITES – Convention on International Trade in Endangered Species
CTD – Camera trap day
DAP – Dong Ampham NPA
DHS – Dong Huasao NPA
DKT – Dong Khanthung
DPV - Dong Phouvieng NPA
GOL – Government of Laos
HNN – Hin Nam Nor NPA
KML – Khammuoan Limestone
NPA – National Protected Area
IP – Independent photos
LLV – Lavin-Laveung PPA
LNTA – Lao National Tourism Administration
NEPL – Nam Et-Phou Loeuy NPA
NHA – Nam Ha NPA
NKD – Nam Kading NPA
NKG – Nam Kong PPA
NKN – Nam Kan NPA
NNT – Nakai-Nam Theun NPA
NPA – National Protected Area
NPU – Nam Phoun (Poui) NPA
NXM – Nam Xam NPA
PCV – Phou Chomvoy PPA
PDD – Phou Dendin NPA
PKK – Phou Khao Khouay NPA
PKT PNPA – Phou Kathong Proposed NPA
PPA – Provincial Protected Area
PPN – Phou Phanang NPA
PXH – Phou Xanghe NPA
PXT – Phou Xiengthong NPA
TCL – Tiger Conservation Landscape
TPZ – Totally protected zone
XBN – Xe Bangnouan NPA
XKP – Xe Khamphor
XPN – Xe Piane NPA
XSP – Xe Sap NPA

EXECUTIVE SUMMARY

Over 93% of tiger habitat has been lost globally in the last 100 years. Tigers today, with uncertainty in their population numbers, exist in small isolated and fragmented patches of forest across 14 range countries. At present, those small and isolated tiger populations that survive are continuing to decline due to hunting for tiger body parts, depletion of prey, and persecution by angry farmers.

Despite this decline, Lao PDR still contains extensive habitat in several tiger conservation landscapes that could potentially harbor viable tiger populations, but the status of the tiger population in almost all of these landscapes remains known. The paucity of information may be due to the fact that tigers have received little conservation attention in the past due to a lack of national capacity and financial support. However, the existing data from field surveys during 1990s, recent research and monitoring in a few national protected areas and anecdotal reports from others indicate that wild tigers do still occur in Lao PDR, but at very low numbers.

Tigers are adaptable to a wide range of habitat and can live wherever there is sufficient prey. So, despite the low abundance of tigers in the country at the present time, there are enormous opportunities to make the recovery and conservation of wild tiger populations possible in the Lao PDR. This is because, i) the current human population is relatively low (22 people/km^2) compared to neighboring tiger range countries, ii) there are 21 established national protected areas that may serve as core source populations for tigers in the existing landscapes, and iii) of particular importance, there are national policies that promote biodiversity conservation and sustainable development in place, as well as the dissemination of national laws addressing wildlife protection. Given these opportunities and the potential for tiger populations to rebound, tiger recovery is possible in many parts of Laos as long as we can maintain and increase habitat and prey, and protect tigers from illegal poaching.

The primary objective of these background notes is to assist participants in the preparation of the National Tiger Action Plan by providing basic information about tigers including tiger behavior and ecology, current tiger population status, threats to tigers and areas significant to tiger conservation in Laos. In addition, it describes the role of tigers in biodiversity conservation and human livelihoods, the opportunities and constraints for tiger conservation, and recommended actions to consider for implementation to achieve the goal of tiger conservation in Lao PDR.

1. TIGER NATURAL HISTORY AND SIGNIFICANCE

1.1 Why conserve tigers?

Tiger is the largest mammalian predator in Asian tropical ecological systems. In their role as top predator, tigers serve as a flagship of Lao ecosystems. The presence of viable populations of top predators is indicative of the integrity of entire ecosystem; if lost it may generate the disruption of food web that affects the structure of ecological community[1,2]. This means when tigers are removed, prey populations can explode leading to the decline of plant communities on which many species depend. Therefore, protection of the tiger symbolizes the protection of the nation's forest and biodiversity that is important to human well-being in the forms of "ecological services" provided by a healthy ecosystem.

Biodiversity, in addition to providing for food, fuel, shelter, medicine and livelihoods, provides the critical 'ecosystem services' on which socio-economic development depends. These services include air and water purification, soil conservation, disease control, and reduced vulnerability to natural disasters such as floods, droughts, landslides and pest epidemics[3]. Biodiversity loss exacerbates poverty, and likewise, poverty is a major threat to biodiversity. So poverty reduction will only be achieved with the maintenance of the nation's biodiversity.

Unfortunately, tigers are in rapid decline throughout the forests of Laos; to reverse the declining trend of tigers is an obligation of Lao citizens. The Law on Aquatics and Wildlife states clearly that tigers are protected so hunting and trading in tigers/tiger parts is banned. As a signatory to the international Convention on International Trade in Endangered Species (CITES), the government of Lao PDR is committed to work with the international community to prevent the illegal trade of tigers.

1.2 Status of tigers at global, regional and national level

Tigers (*Panthera tigris)*, once widely distributed across Asia, today have rapidly declined in number and distribution (Figure 1). They are listed globally as "critically endangered" throughout their range[4]. They are restricted to small and isolated remnant forest patches covering only 7% of their historical range and their population status is uncertain across this distributional range (Figure 2). Of the eight tiger subspecies, three of them have been driven to extinction. They include the Caspian (*P.t. virgata*), the Bali (*P.t. balica*), and the Javan (*P.t. sondaica*). The Indochinese tiger (*P.t. corbetti*), was once widely distributed across Indochina, namely Laos, Vietnam, Cambodia, Thailand, Malaysia and Myanmar. The most well-known factors driving the decline of the current tiger population worldwide include direct poaching of tigers for commercial trade, depletion of prey due to over-hunting by humans, and habitat loss

and fragmentation resulting from human land-use practices, and tiger-human conflict.

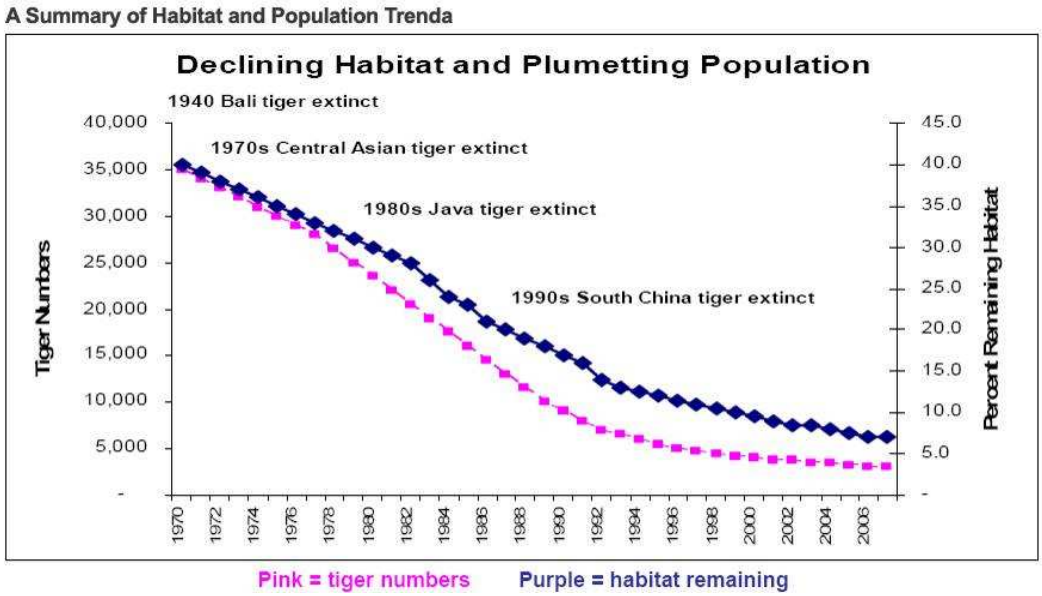

Figure 1. Trend in population status of tigers and habitat throughout its range (Source: Damania et al. 2008, www.wds.worldbank.org)

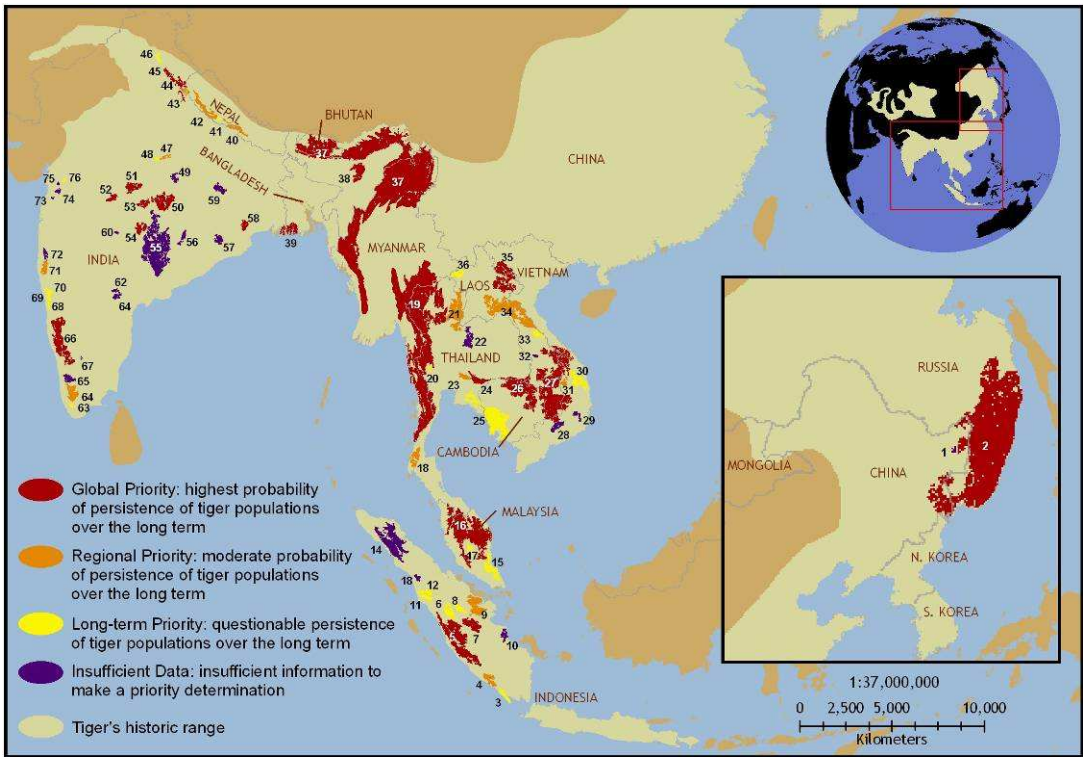

Figure 2. Map showing historical and current geographical distribution of tigers, and priority areas for tiger conservation. (Source: Dinerstein et al. 2006, www.savethetigerfund.org)

1.3 Natural history

1.3.1 Description

Tiger is the world's largest cat and is a specialized predator that preys on ungulates – any animal with hooves such as bovids (wild cattle), deer, pigs and serow. Tigers have black stripes with the background coloration of reddish orange to reddish ochre and white under parts. The pelage of tropical tigers seems to be darker than those that occur in temperate habitat. The largest adult tigers weighing up to 300 kg are recorded in Far East Russia with the smallest adult tigers weighing about 140 kg in peninsular Malaysia and Indonesia. Tigers are greatly adaptable to a wide range of habitat types, even in altered landscape. The only prerequisites for survival of tigers are sufficient prey, plant cover, and water. Tigers live wherever there is an adequate supply of prey, and preferably large prey species[7,8].

1.3.2 Reproductive capability

A tigress comes into heat at intervals of around 3 to 9 weeks, and is receptive for about 3 to 6 days within that period. Gestation is short, only 103 days, and a litter usually has a range of 2 to 5 cubs. In nature, a tigress produces a new litter only after her young have all dispersed, usually after 18-20 months. However, if a litter was lost after birth, the interval between litters is only 7-8 months. Females breed relatively early at about 3 years of age, whereas males breed at about 4 years of age. Reproductive lifespan is about 6 years for females and only 3 years for males in nature. Based on their high fecundity, tigers are able to recover rapidly from substantial losses in many places as long as the habitat and prey population remain intact[9].

1.3.3 Feeding ecology

Tigers are a top predator in the ecosystem so almost any terrestrial vertebrates are potential prey for this animal. However, in order to survive and reproduce tigers need large prey to meet their energetic requirements[10]. Large ungulates, such as cervids (deer), make up nearly 75% of the biomass contribution to tiger diets in most parts of tiger range[9]. So, the depletion of large prey species is a critical threat to the long-term persistence of tigers[10]. A tigress consumes 5-6 kg of meat per day on average, which translates to 1,760 to 2,112 kg per year. If a mother with cubs, it would need 50% more food[9]. So to survive, an individual tiger needs to feed on a deer-sized prey approximately every week, consuming about 50 animals per year (Figure 3). Tigers crop about 10% of available prey base, which generally corresponds to the rate at which the prey population grows. Therefore, a total prey population of 500

deer-sized animals is needed to produce the 50 deer that a single tiger must consume annually to survive [12] (Figure 3).

In Laos, large prey (i.e. bovids and cervids) have been heavily hunted; muntjac and wild pig are now probably the key prey[13]. In the present situation, tigers are likely approaching to a hypothetical 'muntjac-only scenario', where small prey (<25kg) make up the majority of the tiger diet (Sunquist 1999). If this is the case, a tigress needs to kill one 20-kg muntjac every 2-3 days or 183-365 muntjacs/year. If feeding on wild pig only, an average male (120kg) and female (100kg), a tiger would consume annually at least 87 and 104 wild pigs respectively. Thus, the muntjac and wild pig population at a site would need to be several times larger than this to produce sufficient prey for a single individual tiger.

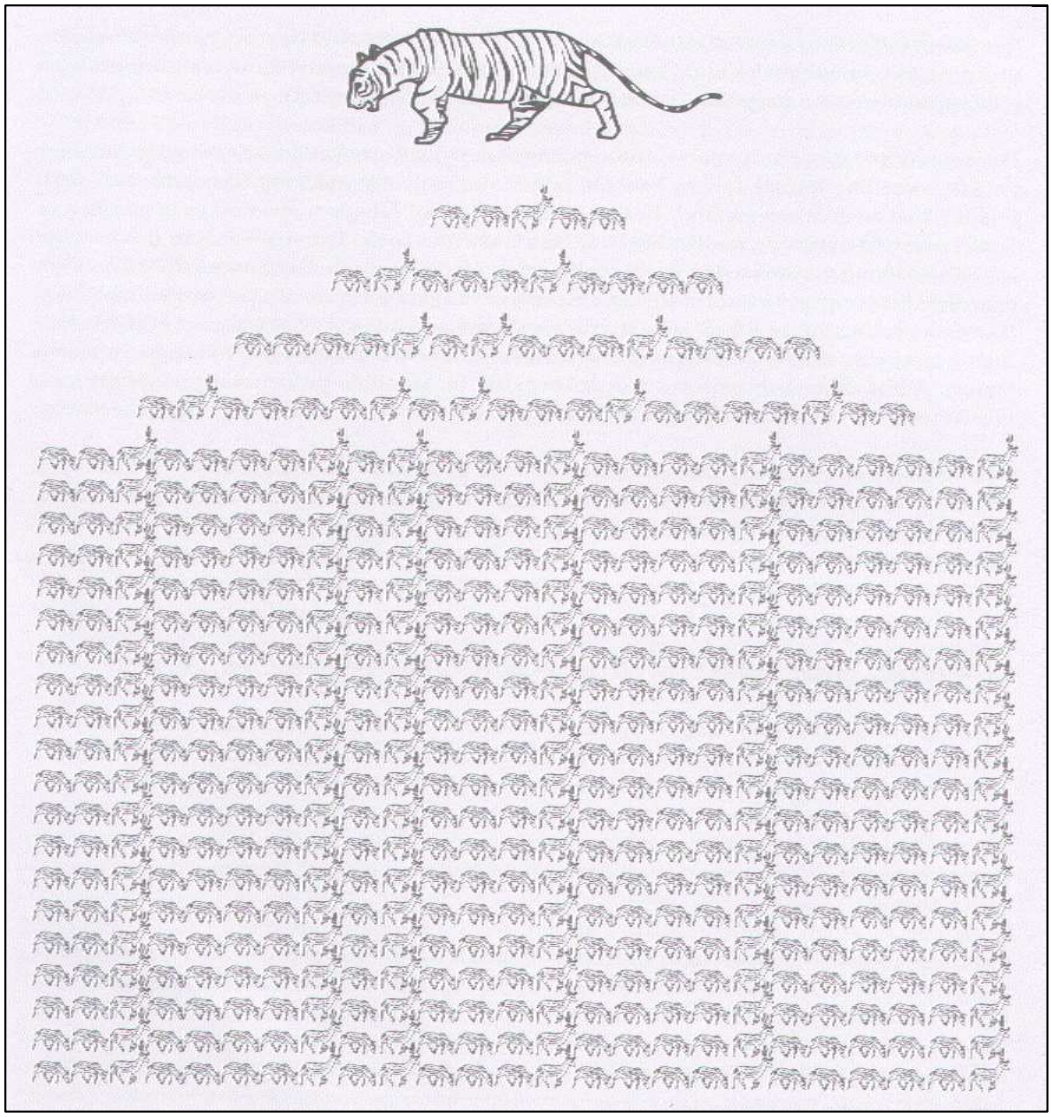

Figure 3. Tiger needs to feed on a deer-sized prey approximately every week, consuming about 50 animals per year. Tigers crop about 10% of available prey base, which generally correspond to the rate at which the prey population grows. Therefore, a prey population of 500 deer-sized animals is needed to support a single tiger (Source: Karanth and Nichols 2002)

1.3.4 Home range and territory

Tigers are solitary outside of the mating season, and when young are fully dependent on their mothers[14]. In order to meet their requisites or ecological requirements (i.e. food, water, and cover) tigers roam a large area that encompasses a wide range of habitat types or ecosystems. A male's home range is greater than the female, overlapping with several female territories (Figure 4). However, the size of territories or home range of tigers varies greatly with prey density. For example, a typical home range size for resident breeding females in prime areas in Nepal and India ranges in size from 10 to 15 km^2 where they support prey densities of around 25-50 ungulates per km^2 [14,15], whereas in the Russian Far East that supports prey densities less than 5 ungulates per km^2, female tigers have territories that range in size from 200 to 400 km^2 [16].

Tigers move around within their home ranges for three main reasons; hunting, maintaining social communication with other tigers and avoiding the enemy they fear – i.e. man. Daily movement distance varies considerably with prey abundance. If prey is abundant, they move over short distances as probabilities of encountering prey are high. For example, in Chitawan National Park in Nepal, tigers move only 2-11 km as prey densities are high with 68 ungulates/km^2 [15,17]. If prey is scarce, tigers may travel for several kilometers. This is likely the case for tigers in much of Laos today. In these cases, tigers may travel far beyond the protected area boundaries, which can lead to tiger-human conflict, mainly due to tiger depredation of livestock or direct confrontation with humans[18]. If problems occur, tigers are often killed by humans in a revenge of loss of their property.

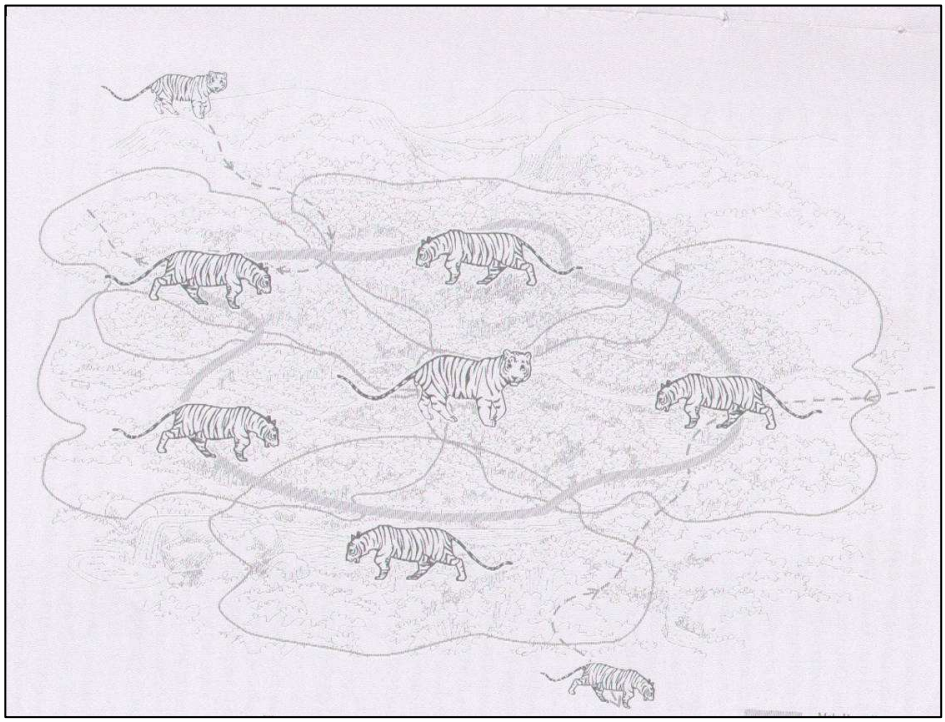

Figure 4. A male's home range is greater than the female, overlapping with several female territories (Source: Karanth and Nichols 2002).

1.3.5 Population density and prey

Prey abundance is a critical determinant of tiger numbers. Tiger population densities are strongly correlated with prey densities. For example, in Kaziranga National Park in India with high prey densities of 68 animals per km^2, and associated biomass of 5,200 kg per km^2, tiger density is 17 tigers per 100 km^2 [19]. At Sikhote Alin Zapovednik Reserve in Russia where ungulate biomass is lower than 500 kg per km^2, tiger density is less than 1 tiger per 100 km^2. The situation in Russia is similar to tropical habitats such as Lao PDR where large prey has been heavily hunted out. For example, in Malaysia tiger density ranged from 1.1 to 1.9 tigers/km^2 with the estimated prey biomass of 270 to 430 kg/km^2 [20]. In the Nam Et-Phou Louey National Protected Area in Laos, the estimated density of tigers was 0.2 to 0.7 tigers/100 km^2 and the crude estimate of prey was about 3.25 ungulates/km^2, of which muntjac and wild pig were the most common while detections of sambar and gaur were much lower[13].

2. TRENDS IN TIGER DISTRIBUTION AND POPULATIONS IN LAO PDR

2.1 Past records (to 2005)

2.1.1 Sources of data and methods for past records

Historical records of tigers before 2005 were mainly derived from existing reports for the following periods of time:

1988-1993. Salter 1993[21] analyzed village questionnaire data on wildlife distribution gathered between 1988-1993.

1932-1998. Duckworth and Hedges 1998[22] assessed the status of tigers in Laos by reviewing five sources of data, which included published papers from 1932 to 1998, wildlife survey reports, reports of other surveys, media articles and personal communication.

1991-1998. Duckworth, Khounboline and Salter 1999[23].provided a baseline on the status of tigers in Laos by summarizing data compiled from field surveys for large mammals for periods exceeding a week during 1991-1998 in 32 different areas of the country.

2003-2004. Johnson, Vongkhamheng et al., 2006[13] used camera traps set in five 100 km^2 sampling blocks across NEPL NPA from 2003 to 2004. Each 100 km^2 sampling block divided into 25 4-km^2 grid cells, in which a pair of cameras was placed to photograph both sides of individual tigers in optimal locations. Cameras were mounted on trees at 45 cm and set to operate for 24 hours per day and left in the forest for over 30 days. The software program "CAPTURE" was used to generate tiger density estimate as tigers could be identified to individual tigers by their distinct stripes. As prey could not be identified to individuals by their markings, index of prey abundance was used, i.e. number of photos per 100 camera trap days (CTD). CTD was calculated from the time the camera was mounted until the date of the final photo for a total effort of 3,588 total CTD.

1995-2005. Dinerstein et al. 2006[6] delineated tiger conservation landscapes based on tiger records from 1995-2005, current forest cover, and human influence.

2.1.2 Results from past records (see Appendix 4 showing locations of NPAs in Lao PDR)

1988-1993. Salter[21] reported tigers present in 87% of interviews (n=328) spread across 18 NPAs of Laos.

1932-1998. Duckworth and Hedges[22] mapped 64 tiger records spread over the country, of which only 21 were confirmed records based on

sightings or remains of tigers. Based on tiger data and habitat availability they suggested only five areas that showed particular potential for harboring viable tiger populations. These areas were:

i) *Northern Laos* including three non-contiguous areas: Nam Et-Phou Louey NPAs, Nam Kan NPA and Nam Phoun NPA
ii) *Central Laos* in the Nam Theun basin including the contiguous area between Nakai-Nam Theun (including Nakai Plateau), Nam Kading, Khammouan Limestone and Hin Namno NPAs.
iii) *Southern Laos* including the contiguous area on the slopes of the Bolaven Plateau between Xe Pian, Dong Hua Sao and Don Ampham NPAs, Xe Khampho and Nam Kong PPAs and the Xe Kong basin.

1991-1998. Duckworth et al. (1999) [23] reported tiger as present in 18 of 32 areas surveyed during 1991-1998, however it was thought that their population densities were at low numbers . These areas were:

i) *Northern Laos* from five of the 11 areas surveyed, which were Nam Et-Phou Louey, Nam Ha, Nam Phoun, and Nam Theun Extension
ii) *Central Laos* from five of the seven areas surveyed, which were Nakai-Nam Theun including Nakai Plateau and the Nam Theun Corridor, Hin Nam Nor and Phou Xang He, and
iii) *Southern Laos* from eight of the 14 areas surveyed, which were Xe Bang Nouan, Dakchung Plateau, Phou Xieng Thong, Don Amphan, Nam Kong, Dong Huasao, Xe Piene and Dong Khanthung.

Provisional records were noted for another six areas including Nam Xam, Phou Khao Khoay and Nam Kading NPAs in northern Laos and Xe Sap, Phou Khathong and Bolaven Plateau in southern Laos.

2003-2004. The camera trap surveys in NEPL NPA [13] found that the NPA supported a small viable tiger population with an estimated density of 0.2 to 0.7 tigers per 100 km^2 and a population estimate ranging from a minimum of 7 to as many as 23 tigers in the sampled area. An index of prey abundance ranged from 0.08 independent photos (IP) per 100 CTD for gaur, 0.25 IP per 100 CTD for sambar, 0.27 IP per 100 CTD for serow, 0.40 IP per 100 CTD for wild pig, and 2.77 IP per 100 CTD for muntjacs.

1995-2005. Dinerstein et al. (2006) [6] mapped approximately 175 tiger point locations recorded from 1995-2005 in Laos, which included no records of evidence of breeding (see map Appendix 1).

From these records combined with recent land cover and human influence data, the following areas of priority for tiger conservation and surveys in Laos were identified:

Class 1 Landscapes[(1)](see maps Appendices 2 and 4):

(TCL#35) Northeastern Laos including areas within and adjoining the Nam Et-Phou Loeuy and Nam Xam NPAs, and extending into northern Vietnam.

[(1)] Class 1 landscapes have habitat to support at least 100 tigers, evidence of breeding, minimal-moderate levels of threat, and conservation measures are in place. [24]

(TCL#27) Southern Laos including the areas within and adjoining Dong Huasao, Xe Piene, Dong Amphan, Xe Sap and Dong Phouvieng NPAs and the Xe Khampho, Bolvan Southwest and Phou Khathong PPAs. This area adjoins contiguous habitat in central Vietnam and northeastern Cambodia.

Class 2 Landscapes[2] (see maps Appendices 2 and 4):

(TCL#34) Central Laos in the Nam Theun basin including the areas within and adjoining Nakai-Nam Theun, Nam Kading, and Phou Khao Khouay, Khammuoan Limestone NPAs and Phou Chom Voy PPA and the Nam Chouan and Nam Ngeum Watershed Management Areas.

(TCL#26) Dong Khanthung PPA with adjoining areas in northern Cambodia and southwestern Thailand.

Class 3 and Potential Landscapes[3] (see maps Appendices 2, 3 and 4)

(TCL#33) Areas within and adjoining Hin Nam Nor NPA

- Also areas west of Phou Xang He NPA including the following PPAs: Phou Sor to the northwest, Xenoy-Xaba to the northeast, and Laving-Laveung to the east.

(TCL#36) Areas within and adjoining the Nam Ha and Nam Kan NPAs

- Areas within and adjoining Nam Phoun and Phou Phanang NPAs
- Areas within Phou Den Din NPA
- Areas within and adjoining Xe Bangnouan and Phou Xiengthong NPAs

2.2 Current records (2005-present)

2.2.1 Sources of data for current records

Current records of tigers in Lao PDR, after 2005, are compiled from two sources:

i) Results of field research projects and,

[2] Class 2 landscapes have sufficient habitat for 50 tigers, moderate levels of threat, and a basis for conservation that needs to be improved. [24]

[3] Class 3 landscapes have habitat to support some tigers, but with moderate-high levels of threat, and minimal conservation investment. In this document, potential landscapes include both "survey priority landscapes" that are large areas of potential habitat under low human impact where tiger status is unknown (or that have not been surveyed since 1995) and "restoration landscapes" that are similarly large areas of potential habitat under low human impact but where survey efforts since 1995 have not revealed evidence of tigers. [24]

ii) Standardized interviews conducted in September 2009 with local wildlife conservation workers including protected area staff, foresters, and/or NGO staff who have worked or have experience in particular areas for at least two years. Pre-prepared data forms were faxed or e-mailed to those concerned people and then followed up by phone calls. The data form included questions about the evidence of:

- tiger signs/sightings with a detailed description of the evidence, location and date,
- tiger human conflict with a description of the human killing or type of livestock killed, description of the evidence for each case, and date,
- threats to tigers including direct killing and date, presence of hunting of prey or habitat loss and description.

The likelihood that reports represented actual tiger presence were ranked as follows:
Confirmed: tigers were photographed by camera traps or identified by DNA analysis of scats.
Likely: report of tiger killed; track width equal to or greater than 10cm or pad width equal to or greater than 7.5cm.
Possible: report of depredation of adult buffalo or a human killed
Uncertain: report of tracks less than 10cm wide or pad less than 7.5cm wide; report of a tiger sighting; report of other signs or depredation of a cow.

2.2.2 Current records: methods and results

Class 1 Landscapes (see map Appendix 4)

(TCL#35) Nam Et-Phou Louey - 25,978 km^2

Camera trapping for tigers and prey was conducted from 2004-2006 in 300 km^2 of the NPA[13] followed by camera trapping for tigers over 800 km^2 of the NPA from 2006-2007 (WCS unpublished data). A total of eight individual tigers were detected with camera traps in NEPL NPA from 2003-2007.

From 2006 to present, DNA extraction from large carnivore scats has been used to estimate a minimum number of tigers in the NPA. Nine individual tigers have been detected from analysis of 124 scats from 2006-2009. One tiger was seen in the NPA by enforcement staff in July 2009.

From January-June 2008, prey occupancy surveys were conducted in the NPA core zone[49]. The 2600 km^2 area was divided into 3.25 km^2 sub-grids based on biological information on home range of large ungulates. Teams walked approximately 3-6 km within each sub-grid to record presence/absence of ungulate signs every 300 meters. The survey found an estimated prey abundance of 3.25 ungulates per km^2 in the core zone, of which muntjac and wild pig were the most common, with much less detection of serow, sambar and gaur.

From January – June 2009, standardized surveys of local experts across 100-300km^2 grids and modern occupancy modeling was used to estimate the current occurrence and distribution of tigers and prey in a 30,000 km^2 landscape around the NEPL NPA (C. Vongkhamheng, unpublished data). The survey recorded reports of tiger presence within the past year in 70% of the grids across the 30,000 km^2 landscape. Most detections occurred inside and adjoining NPAs (NEPL and NXM). Habitat occupancy estimates ranged from 70% for gaur (SE = 0.05), 96% for Sambar deer (SE = 0.02) and up to 100% occupancy for muntjac, wild pig and serow. The probability of occurrence for muntjac, wild pig, and serow were more widely distributed than for gaur and sambar across the landscape.

(TCL#27) Southern Laos - 19,996 km^2

Questionnaire surveys for tigers and prey were conducted in 35 villages across Xe Pian NPA using grid-based sampling approach, by dividing the NPA into 14-300km^2 grid cells[25]. Approximately 70% of the 14 grid cells surveyed were reportedly occupied by tigers in the past five years. Of those, 25% of respondents (n=105) reported sightings of tigers, and 53% of respondents reported signs of tigers.

Tracks (13x14 cm) were reported in Dong Huasao on November 2006 and January 2007 (Table 1). Tracks (13x15 cm) were reported from July 2007 in the vicinity of Ban Angor. Tracks and scrapes were found in Phoulan (UTM 691786 1765413) and at Houy Kata (UTM 688826 1766165), Ta Oy district in Xe Sap NPA. Tracks of an adult tiger with cubs were reported in Dong Ampham NPA near Xekhaman hydropower on 7 September 2009 and another report from Huay Chingling in April 2009 (Table 1).

Class 2 Landscapes (see map Appendix 4)

(TCL#34) Central Laos – 36,317 km^2

Nam Kading NPA: From 2007-2009, ground dwelling mammals were monitored at a total of 200 camera trap points at a spacing of one camera point per 2 km^2 across 400 km^2 of the 1,600 km^2 NK NPA for a total effort of 6,357 camera trap days. The surveys detected no tigers (WCS / IEWMP; in prep.). Although large cat tracks are reported by NPA staff, it remains uncertain if these are from tiger. Prey including gaur, sambar, serow, wild pig and muntjac were recorded by camera traps but overall abundance is low.

Nakai-Nam Theun NPA: From 2006-2008, ground dwelling mammals were monitored at a total of 300 camera trap points at a spacing of one camera point per 2 km^2 across 600 km^2 (three blocks of 200 km^2 each) in the 3,532 km^2 NNT NPA for a total effort of 11,870 camera trap days[32, 48]. The cameras recorded no tigers and a relatively low level of large prey.

Khammouane Limestone NPA: Tracks (10x11 cm) and cattle depredation by tiger were recorded on 3 August, 2006 by NPA staff (Table 1).

Nam Ngeum watershed management area: Tracks of tiger were reported from southern Xiengkhuang province, at Phoun, Xaisomboun and Thathom districts in 2009 during the NEPL NPA landscape survey (J. Vongkhamheng pers. com.)

(TCL#26) Dong Khanthung – 2,526 km²

No reports have been received from this area since 2005.

Class 3 Landscapes (see map Appendix 4)

(TCL#33) Areas within and adjoining Hin Nam Nor NPA – 7,477 km²

Tracks (10x12 cm) and a buffalo carcass suspected of being killed by tiger were found on 25 August 2009 in the vicinity of Ban Nong Buao or near Phou Chuang (17°30'09" N 105°54'33" E) (Table 1). The area is located in the corridor between Hin Nam Nor and Nakai Nam Theun NPAs. Also a track (13x15 cm) was reported by NPA staff on 7 September 2009 in the vicinity of Ban Napao.

Areas west and north of Phou Xanghe NPA including Dong Phousor and Xenoi-Xeba, and Lavin-Laveun: Tracks (~11x12 cm) were recorded on May 2005 in the vicinity of Ban Doune, and a buffalo kill was reported during the dry season of 2007 in Phou Xenghe NPA (Table 1). Other reports of tracks were received from Lavin-Laveun PPA in 2009 near Xepone district

(TCL#36) Areas within and adjoining the Nam Ha and Nam Kan NPAs – 7,315 km²

Nam Ha NPA: Felid tracks were encountered by NPA staff, one (9x10 cm) on 16 August 2009 in the vicinity of Ban Nam Muay, Sing district, and another (10x11 cm) was reported in August 2008 in the vicinity of Ban Hatlieng, Luang Namtha district. Two cows were reportedly killed by tiger in these two villages in June 2007 and October 2008, respectively (Table 1). One large buffalo was reportedly killed by tiger in 2007 near UTM 755787, 2306957 in Luang Namtha district.

Nam Kan NPA: Tracks (10x11 cm) were found on 14 February 2007 by NPA staff in the vicinity of Ban Toop Phouvieng district (Table 1). Other recent reports of large cat tracks are from Chomsy, Nam Laem, Nam Touk, Nam Lin (Table 1).

Potential Landscapes (see map Appendix 4)

(TCL #32) Areas within and adjoining the Xe Bang Nouan and Phou Xiengthong NPAs – 6,948 km^2

Tracks (12x13 cm) were recorded on June 2007 in the vicinity of Ban Naxan and Nalan, Vapi district, Saravan province (Table 1). A buffalo and a cow were reportedly killed by tiger on December 2008. Tracks (11x12 cm) were recorded at Phou Xiengthong NPA on June 2007. A report of tiger depredation of a buffalo and cow in the vicinity of Ban Thongpha-thongxai, Khong district, Saravan province occurred in December 2008.

Areas within and adjoining Nam Phoun and Phou Phanang NPAs – 14,139 km^2

Tracks (11x12 cm) were recorded on 27 September 2008 in Navan village, Phieng district (Table 1). Also, a buffalo and cow were reportedly killed by tiger in the same area in the same year. No tigers are reported at present in Phou Phanang NPA.

Areas within Phou Den Din NPA – 4,581 km^2

Tracks (10x11 cm) were recorded on 1 June 2008 in the vicinity of Ban Hath Hin (Table 1).

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Table 1. Reports of tigers since 2005 from protected areas across Laos based on photographs (PHO) or DNA analysis of scat samples (DNA) or from interviews (n=35) reporting observations or reports of tracks (TG,TL) or other sign (SN), sightings (RS), evidence of large livestock depredation (BD, CD), of tigers killed (TK) or humans killed (HK).

No	TCL	Name of Protected Area	Prior to 2005[1]	2005 to present[2] (level of confidence)				Sources
				Confirmed	Likely	Possible	Uncertain	
I.		**Class 1 Landscapes**						
1	35	Nam Et-Phou Louey NPA	X	PHO,DNA	TK,TG	BD	TL,RS,SN,CD	NPA staff/WCS staff, camera traps, scat DNA
2	35	Nam Xam NPA	?	-	TK	-	-	NPA staff/village survey
3	27	Dong Phouvieng NPA		-	-	-	-	NPA staff
4	27	Xe Sap NPA	?	-	TK	-	SN,CD	NPA staff, IUCN staff
5	27	Dong Huasao NPA	X	-	TG	BD	CD	NPA staff, village reports
6	27	Dong Ampham NPA	X	-	TG	HK	RS	NPA staff/WWF staff
7	27	Xe Piane NPA	X	-	-	-	TL,RS,SN	NPA staff/WWF report
8	27	Nam Kong PPA	X	-	-	-	SN	IUCN staff
9	27	HHW/Xe Khampho		-	-	-	SN	IUCN staff
10	27	Dak Cheung plateau	X	-	-	-	-	
11	27	Phou Kathong PNBCA	?	-	-	-	-	
II.		**Class 2 Landscapes**						
12	34	Phou Khao Khouay NPA	?	-	-	-	-	NPA staff
13	34	Nam Kading NPA	?	-	-	-	TL,SN	NPA staff/camera traps
14	34	Nakai-Nam Theun NPA	X	-	TG	BD	RS,SN	NPA staff/camera traps
15	34	Khammouan Limestone NPA	?	-	-	-	TL,SN	NPA staff
16	34	Phou Chomvoy PPA		-	-	-	-	
17	34	Upper Nam Ngem Watershed		-	-	-	SN	WCS staff

No	TCL	Name of Protected Area	Prior to 2005[1]	2005 to present[2] (level of confidence)				Sources
				Confirmed	Likely	Possible	Uncertain	
18	34	Upper Nam Chouan Watershed		-	-	-	SN	WCS staff
19	34	Special Zone (Xaysomboun)		-	-	-	SN	WCS staff
20	26	Dong Khanthoung	X	-	-	-	-	
III.		**Class 3 Landscapes**						
21	36	Nam Ha NPA	X	-	TK,TG	BD	RS,CD	NPA staff
22	36	Nam Kan NPA	X	-	TK,TG	BD, HK	CD	NPA/DAFO staff
23	33	Hin Nam Nor NPA	X	-	TG	BD	RS	NPA /IUCN staff
24	33	Phou Xanghe NPA	X	-	TG	BD	TL,SN	NPA staff
25	33	Lavin-Laveun PPA		-	-	-	SN	Outhai (pers. com)
IV.		**Potential Landscapes**						
26	32	Xe Bangnouan NPA	X	-	TG,TK	BD	CD	NPA staff
27	32	Phou Xiengthong NPA	X	-	TG	BD	CD	NPA staff
28	-	Nam Phoun (Poui) NPA	X	-	TG,TK	BD	TL,CD	NPA, DAFO staff
29	-	Phou Phanang NPA	?	-	-	-	-	NPA staff
30	-	Phou Dendin NPA	?	-	TK	-	TL,CD	NPA staff

[1]Records prior to 2005 from Duckworth & Hedges (1998): ? - tiger presence based on provisional report, x - tiger presence based on signs, sighting

[2]Degree of confidence of tiger report from 2005 to present:
Confirmed: tigers were photographed by camera traps(PHO) or identified by DNA analysis of scats(DNA)
Likely: report of tiger killed(TK); tracks >10 cm wide or pad >7.5 cm wide(TG)
Possible: report of depredation of adult buffalo(BD) or a human killed (HK)
Uncertain: reports of cat tracks <10cm wide, pad<7.5cm wide(TL); report of sighting(RS); report of signs(SN) or cow depredation(CD)

2.3 Trends in tigers across Laos

Although tigers reportedly still occur in several landscapes at present, since 2005 tigers are confirmed from only one protected area (NEPL NPA) with likely evidence of their presence reported from thirteen other protected areas (Table 1). In the remaining areas, the presence of tiger is uncertain or absent. Given this information, tiger abundance appears be declining throughout Laos and they may now be extirpated in some areas based on the following evidence:

- *Rarity of sightings of tigers in the forest.* Out of 35 interviews with people working in landscapes in Laos, there were only 8 reports of sightings of tigers since 2005.
- *Rarity of camera-trap photos of tigers in key areas surveyed since 2005.* In Nakai Nam Theun NPA where sightings of tigers were once regularly reported by field workers during 1990s[23], no tigers have been photographed since 2006 despite extensive camera trap surveys (11,870 CTD). Likewise, in Nam Et-Phou Louey NPA, camera trap surveys for tigers over a three-year period from 2005-2007 photographed only four different individuals over 5,979 CTD of survey effort (WCS unpublished survey data).
- *Although tigers are protected by law, direct poaching of tigers has reportedly occurred in several protected areas throughout Laos since 2003* (Table 2). The number of tigers reported killed, as shown in Table 2, are only those that local authorities have strong evidence of. The number of actual kills across the country is uncertain. This is a concern given that scientific studies show clearly that a small population of about 30 individual tigers may become extinct within 15 years with only a 2% kill rate a year. Only a larger population of over 70 tigers could potentially sustain a loss of 10% a year or more[5]. So, based on the known number of tiger killed in each NPA or landscape, and if the trend still continues, it appears that tigers in Laos are presently vulnerable to extirpation.

Table 2. Reports of tiger poaching from national protected areas since 2003.

No	NPAs	# tiger killed	Date(s)	Source
1	Phou Den Din	2	Apr-06/July-07	NPA staff
2	Nam Ha	3	Dec-05/Apr-07	NPA staff
3	Nam Et-Phou Louey	17	Jan-03 to Oct-09	NPA staff
4	Nam Xam	1	Mar-08	NPA staff
5	Nam Phui	1	9-May-05	DAFO of Phieng district
6	Xe Bang Nouan	1	Dec-08	DAFO of Khong district
7	Xe Sap	1	Dec-08	DAFO of TaOy district
8	Nam Kan	2	Jun-05/ Nov-05	NPA staff

3. THREATS TO TIGERS IN LAO PDR

3.1 Direct killing of tigers

3.1.1 Poaching of tigers for trade

Although tigers are a legally protected species in Laos, they are poached with a variety of methods including snares, poison, and explosives across Laos. This is because of the high demand for tiger parts in international markets for traditional medicines associated with the weak protected area management in Laos. The current estimated price of a tiger ranges from US$ 10,000 up to US$ 70,000 [5,28]. In NEPL, tiger bones sold for up to US$ 11,528 in 2004[13]. Tiger parts, such as skins, teeth, bones and others, were one of the most-traded wildlife items in recorded in Lao PDR during the 1990s[26].

Since 2003, poaching of tigers for trade is reported in several NPAs (Table 2). For example, more than 15 tigers have been killed since 2003 in Nam Et-Phou Louey, two tigers were reportedly killed near Bor Keo-Luang Nam Tha provincial boundary in June 2005, two were killed in Nam Ha NPA on October 2007, and one tiger killed in Nam Xam in April 2008.

A tiger farm was established in Laos in 2002, with the first 20 breeding individuals originating from Taiwan. Now, the farmer claims there are 254 individual tigers in the farm and they will be ready for export in the near future[27]. Although the direct impacts of this tiger farm on wild tigers in Laos is uncertain, the potential threat to wild tigers caused by tiger farms is very high. It is well-known worldwide that the legalizing trade in farmed tiger products allows smugglers to exploit the loophole and take opportunities to sell wild tiger products. This problem occurs because there is no way to distinguish between parts of tigers from the farm and those from the wild, which makes law enforcement difficult.

From an economic perspective, the price of a wild tiger ranges from US$10,000 to US$70,000 in international markets[28], and approximately US$11,528 on local markets in northern Laos[13]. The high price is because customers perceive wild products to be more effective than the farmed ones and thus prefer the wild products over the farmed[29]. In a simple cost analysis of wild versus farmed tigers parts, the cost of raising a tiger to adulthood in captivity is at least US$ 4,000 (range from US$ 4000 to US$ 10,000) and as little as US$15-25 for a bullet to poach a wild tiger. Despite the cost of transportation and an occasional loss due to confiscation by authorities, it is a lucrative trade. This discrepancy provides substantial economic incentive for poachers and smugglers to undercut farmers in any legal markets despite the risks associated with being caught and penalized[30]. In short, tiger farms don't support wild tiger conservation even though farmers often claim that farms are a solution to wild tiger conservation arguing that the legally-supplied captive-bred tiger parts and products in markets would undercut the illegal supply from tiger

poachers. Some argue that tiger farmers have no interest in wild tiger conservation. If wild tigers do go extinct, farm investors stand to gain an economic advantage as they can control the supply of tiger parts for the global market[30].

3.1.2 Killing of tigers as the result of human-tiger conflict

Livestock depredation. Killing of tigers in revenge due to livestock loss has been recorded in many rural areas throughout Laos. About 43.8% of village interviews across Laos during 1988 to 1993 (n=317) reported livestock depredation by tigers, but the proportion of reports truly referring to tigers is unclear[23]. For example, one tiger was shot in Phou Khoun on the Luangphrabang/Vientiane province border in December 1998. Another was shot in Nam Et-Phou Louey on 18 December 1997 with the permission from Viengthong district authorities.

Of particular concern at the present time, given the high price of tiger parts and the associated negative attitude of humans toward tigers, is that when livestock are killed and tigers are suspected, tigers are targeted by the villagers, resulting in opportunistic killing of more tigers rather than taking revenge. For example, in the Nam Et-Phou Louey NPA, a systematic investigation of human-tiger conflict from 2003-2004 found that tiger poaching was closely tied to cattle grazing with farmers opportunistically using livestock to bait tigers more so than retaliation for livestock attacks[13]. Contrary to previous predictions that livestock loss was a widespread problem, the study found depredation affected only 12% of NPA villages and a small fraction of the total herd. Given the opportunity to report attacks in return for possible compensation, farmers lagged in both reporting and removing livestock to villages. NEPL farmers were willing to accept livestock loss and encouraged grazing in tiger habitat as it provided opportunities for tiger poaching to offset livestock loss, which was driven by the increasing lucrative trade in tiger bones.

Man-eating. Although tigers have had a bad reputation as man-eaters in many parts of Laos, very few cases have been reported across the country in recent years. For instance, there are only two cases reported prior to 2005[23] and another other two cases reported after 2005 (WCS unpubl. data). Actually, humans are not the primary or preferred food source for tigers. The occurrence of a human attack is usually in self-defense or protecting their infants, and those man-eaters are usually old, sick or injured[8]. If an incidence occurs, tigers are typically killed in revenge. An example of a recent incident occurred in August 2005 in Meung district, Bokeo province is the following report: "It started when a group of three men went fishing near Hua Nam Kha village. They heard a wild pig screaming and went to investigate, and saw it was a tiger. The tiger ran off when it saw the men. One of the men had a gun, so the other two waited while one man went after it with the intention to shoot it. He didn't come back and it was getting dark. They went back to the village and led a big search party next morning with many people. They found his gun and then him. All that was left was the head and one leg. There

were two sets of paw prints, one animal bigger than the other. They carried the bits back to the temple in Meung township."

3.2 Prey depletion

Hunting of ungulates (i.e. gaur, sambar, serow, wild pig and muntjac) for subsistence has long been practiced by rural residents in Laos. However, the picture began to change when the government of Laos introduced the "new economic mechanism (NEM)" during the late 1980s. Since the opening of free markets and the associated increase in the prices of wildlife on both domestic and international markets, hunting of wildlife for subsistence has become more commercially oriented. Various parts of ungulates including horns, antlers, gall bladders, meat and others were commonly traded domestically, and with Thailand, China, and Vietnam[31,26]. In recent years, wild meats are still sold in markets and restaurants in several townships across the country despite the fact that it contradicts the National Law on Aquatics and Wildlife.

The decline of ungulate populations in Laos is clearly evident from results of research in protected areas. For example, in Nam Et-Phou Louey NPA, a 2008 study found an ungulate abundance index of approximately 3.25 animals/km^2 [49]. Large prey (>100kg) are extremely low at only 0.02 and 0.31 animal/km^2 for gaur and sambar, respectively, whereas muntjac and wild pig are more abundant at 1.38 and 1.36 animals/km^2, respectively (C. Vongkhamheng, unpublished data). The results suggest that wild pig and muntjac are probably the principle prey available for tigers in Laos at the present time. Similarly, in Nakai Nam Theun and Nam Kading, the large prey abundance is very low and only muntjac and wild pig are found in moderate abundance[32].

3.3 Habitat loss and fragmentation

In Lao PDR, habitat loss and fragmentation is a less urgent threat to tigers than the two major threats of tiger poaching and prey depletion. This is based on the fact that Laos still has over 40% of suitable forest cover and a low human population of about 22 people/km^2 at present as compared to neighboring countries (263 people/km^2 for Vietnam, 128 people/km^2 for Thailand, 80 people/km^2 for Cambodia).

However, given the current trend of rapidly increasing human population and associated increases in rates of resource use, habitat loss and fragmentation will become a much more serious problem in the near future if there is poor land-use planning and management. This is because almost two thirds of country is geographically mountainous. Flat land suitable for permanent agricultural fields is found only in Mekong valley on the western side of the country and over 75% of the population is living in rural areas. Forest clearance for shifting cultivation by subsistence farmers is widespread in the upland areas.

Moreover, logging (legal and illegal), cash crop plantations along with the rapid increase in mining and hydropower development as well as transportation corridors across the country is contributing to habitat loss and fragmentation. Land use planning is needed to assure that appropriate habitat with sufficient protection is maintained to allow tigers to safely move within and between tiger conservation landscapes. If corridors are not maintained to connect source populations of tiger, the result will be smaller isolated populations that are genetically depauperate and face an even higher likelihood of human-tiger conflict. This will ultimately lead to extirpation of tigers from these fragments and threaten the long-term survival of tigers across Laos.

4. LEGISLATIVE PROTECTION OF TIGERS IN LAO PDR

The Lao PDR's Constitution (1991) states that "all organizations and citizens must protect the environment and the natural resources including: land, underground minerals, forests, fauna, water sources and the atmosphere" (Article 17)[45]. Legislative protection of tigers has long been taken into account by the government's decrees and regulations addressing tiger conservation (Table 3). More recently, the law on aquatic and terrestrial wildlife states that tigers and their larger prey species (gaur, banteng, sambar, serow) are listed as protected[44]. On the 3rd of April, 2007 the Prime Minister also signed an urgent agreement No. 25/PM, to increase effectiveness of forest management throughout the country. This agreement states how the nation's economic development is linked to the country's environmental status. Additionally, Lao is a signatory to several international conventions that support tiger conservation. These conventions enable the government to address problems affecting tiger conservation beyond the national jurisdiction, including the Convention on Biological Diversity (1994) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora since 2004[43].

Table 3. Principle legal instruments addressing tiger protection in Lao PDR.

Legal instruments	Key provision
National Legal Framework	
Decree of the Council of Ministers No. 185/CCM, in relation to the Prohibition of Wildlife trade, 21 October 1986	Prohibits export of all wildlife
Decree of the Council of Ministers No. 47/CCM, on the State Tax System, 26 June 1989	- Lists types of natural resources, including various species of wildlife, aquatic animals and parts thereof and their associated resource tax rates and special fees; 67 species or species group of wildlife are listed - Subsistence level users of natural resources are exempted from resource taxes - 1996 New Tax Law does not mention natural resource tax
Decree of the Council of Ministers No. 118/CCM, on the Management and Protection of Aquatic Animals, Wildlife and on Hunting, and Fishing, 5 October 1989	- Defines wildlife as state property with mandate to MAF to manage it (including through awareness programs) and local people to use it pursuant to regulation. - Allows import/export of wildlife with special authorization - Prohibits hunting and breeding of protected or endangered species, except where human life is endangered - Prohibit hunting by means of mass destruction (explosives, poisons, etc.)
Decree of the Prime Minister	- Established national protected areas and states that

Legal instruments	Key provision
No. 164, 29 October 1993.	hunting and fishing inside them is illegal - Explosives, chemicals, poisons and other substances harmful to wildlife are banned in NPAs - Measures (warn, fine) for anyone who disobeys the decree, confiscates illegal items
Order 54/MAF on the Customary Right and the Use of Forest Resources, 7 March 1996; followed by recommendations 377/MAF on the Customary Use of Forest Resources	- Secures legal rights for local people to use forest resources for subsistence, including hunting and fishing of non-protected species - Customary rights may be recognized by signed agreement or by law, and local people shall be compensated for loss of customary means of livelihood
Decree 1074 of the Ministry of Agriculture and Forestry, 11 September 1996	- Prohibits wildlife trade - Prohibits hunting of protected species including tiger and "such as Asian elephant, Banteng, Saola, Douc Langur, etc." - Prohibit hunting during a breeding season, and by dangerous methods, and/or by the use of weapons in NPAs and towns - Bans wildlife trade, except for research and conservation - Bans exporting wildlife used for food - Responsibility for PAFO to co-ordinate with other agencies to collect and register weapons used for hunting
Forestry Law, October 1996 and updated 24 December 2007.	- Grants state ownership of and authority to manage wildlife - Prohibits possession of wildlife without permission - Mandates state to define two categories of protected wildlife - Prohibits hunting during a breeding season and/or by means of mass destruction - Prohibits hunting of and trade in prohibited species, with certain exceptions - States that all guns and hunting equipment must be registered with certificates - Article 46, Part 5, establishes by law Wildlife Day on 13th July annually - Zoning NPAs to core (totally protected), managed (controlled use), and corridor zones
MAF Regulation No 0360 (2003) on management of NPAs, Aquatic Animals and Wildlife	- Provides guidelines on establishment and zoning of NPAs - Defines restricted activities on aquatic animals and wildlife - States duties of state agencies and funding support
Provincial and District regulation on management of PA, Wildlife, and Aquatic Animals (e.g. NEPL NPA Regulation 2008)	- Zoning of NPA into core, managed, and corridor zones and specify clearly activities in those areas - Prohibit hunting of all wildlife and aquatic animals in the core zone - prohibit trade in wildlife - Guns must be registered with special licenses
Wildlife and Aquatics Law, 24 December 2007	- Update lists of protected (Category 1) and managed (Category 2 and Category 3) species with tiger and large prey listed as Category 1 species that cannot be harvested anywhere in the country at any time.

Legal instruments	Key provision
	- State activities, management, and development on wildlife and aquatic animals
Prime Minister' agreement No.25/PM regarding forest management	- Assigned at least 15 staff in each NPA - Provide basic equipment and financial support for NPA management
International Commitments and Obligations	
United Nations Convention on Biodiversity (signed in 1996)	- Requires State Parties to prepare Biodiversity Strategies and Action Plan. - Laos has agreed; • To develop a national strategy for conservation and sustainable use of the nation's biological diversity • To develop regulatory provisions for protecting threatened species and populations • To integrate conservation and sustainable use of biological resources into national decision-making • To conduct an Environment Assessment (EA) of proposed development projects with a view to minimize harmful effects • To take measures for an equitable sharing of the results of research and development in genetic resources
ASEAN Agreement on the Conservation of Nature and Natural Resources (1985)	- Parties have agreed on development planning, the sustainable use of species, conservation of genetic diversity, endangered species, forest resources, soil, water, air and processes of environmental degradation and pollution. - Promotes joint and individual state action for the conservation of the natural resources in the ASEAN region.
Convention on International Trade in the Endangered Species of Fauna and Flora (signed in 2004).	- Provides international umbrella for management and control of trade in endangered fauna and flora. Tiger is listed as CITES Appendix 1 species for which all international trade is prohibited.

5. OPPORTUNITIES AND CONSTRAINTS FOR TIGER CONSERVATION IN LAO PDR

5.1 Opportunities for tiger conservation

Given the high resilience of tigers in the environment (adaptable to a wide range of habitat types, climates, and prey base) plus high fecundity (reproduction), there are several opportunities that allow for rapid recovery of tigers in Lao PDR even though tiger populations are at very low numbers at the present time.

Low human population
Laos has a low human population density (22 persons per km^2) as compared with other tiger range states in Indochina (263 people/km^2 for Vietnam, 128 people/km^2 for Thailand, 80 people/km^2 in Cambodia). Tigers require large home ranges to meet their ecological needs so availability of adequate space results in low human-tiger conflict.

High forest cover
The country has over 40% forest cover, which provides large extensive habitat that could support viable populations of tigers and prey.

Well developed protected area system
There are 21 established national protected areas, covering 14% of the country's land area, as well as provincial protected areas that can serve as core habitat for source populations of tigers and prey in tiger conservation landscapes.

Existence of key prey
Ungulates such as gaur, sambar deer, serow, wild pig, and muntjacs persist in most NPAs. Although ungulate population densities throughout the country are relatively low at present, protection of large prey from all hunting and of small prey from hunting for trade, which is illegal, will allow ungulate populations to rebound relatively quickly as habitat and other required resources (i.e. food) are still available.

The role of tigers in economic development and environmental protection
As a top predator, the existence of a viable populations of tiger indicates a healthy ecosystem, which is important to human well-being in forms of "ecological services", food, medicine, and shelter provided by a healthy ecosystem. Economically, tourism is one of the fastest growing industry in the country, contributing substantially to the overall growth of the national economy of Laos. Ecotourism development is a government priority[50] and there are initiatives underway in some protected areas (e.g., Nam Ha, Xe Pian, Nam Et-Phou Louey and Nam Kading NPAs) that could provide incentives for protection of wild tigers and their habitats.

Good legislation.
Law on aquatics and wildlife is already promulgated, providing important guidelines in management and conservation of wildlife in the country. Tigers and key large prey (gaur, sambar, and serow) are listed as

Category 1 -protected species[44]. In addition, Laos as a signatory to the CITES, agreed to prevent any trade in endangered species, which includes tiger.

Public attractiveness/support.
As they are perceived as powerful and charismatic, tigers are used for selling several commercial products such as Lao beer, water, Tiger beer as well as ecotourism products (e.g. Tiger Trails). Gaining support from these companies to ensure the survival of tigers in the wild may be possible.

5.2 Current constraints for tiger conservation

Beside opportunities, there are several important issues that we need to address to achieve our conservation goal for tigers; they include:

Lack of baseline data on tigers and prey
There is a lack of information on the population status and distribution of tigers and prey in existing TCLs and particularly in most provincial and national protected areas that could serve as source populations for tigers and prey. The paucity of this data makes conservation planning difficult.

Weak law enforcement
The policy, laws and regulations governing tiger and prey are sufficient. However, weak law enforcement and poor management of protected areas results in tiger poaching and illegal hunting of prey for the domestic and international wildlife trade.

A high demand for tiger parts in the international market
The demand for traditional Chinese medicine is driving poaching of tigers for trade. Cross-border cooperation to tackle this problem is urgently needed. A high demand for prey in domestic and international markets encourages illegal poaching of prey by local villagers to support the trade.

Limited human resources and financial support
Although there are 21 established national protected areas across the country and several more provincial protected areas, very few of these are currently being managed and are dependent on financial support from international organizations. The currently estimated level of support for the protected area system (national and provincial protected areas) is only $US0.09/hectare. It is estimated that at least eleven times that amount ($US1.00/hectare) is needed to achieve a minimum level of management in Lao's protected areas. As a result of limited financial support, all protected areas are understaffed and many of the staff lack training in the skills required to effectively manage the protected area and to recover and conserve wild tigers and their habitats.

Lack of cooperation and coordination among government agencies.
Weak law enforcement is mainly the result of a lack of cooperation and coordination among enforcement agencies including foresters, police, military, commercial and custom officers, and justice. In addition, although national sustainable development strategy shows clear links

between biodiversity and poverty reduction, unplanned development activities undermine biodiversity conservation, for example, building roads through NPAs, land concessions for cash crop plantations in NPAs, etc. They take little regard to the value of environmental protection and protected areas in economic development.

Weak understanding of linkages between poverty reduction, economic development goals and the status of the environment.
Although the government of Lao PDR considers the environment as an important component of socio-economic development[45] and recognizes that poverty and biodiversity are intimately linked, most funding however is allocated to development of infrastructure and other social sectors with little regard to the future consequences of the impacts on the environment. High priority is given to development activities such as road construction, hydropower, mining and plantation development, without serious consideration of real costs to the environment. It may be that the conceptual link between biodiversity and development is misunderstood by several high level decision makers who play key roles in planning and investment.

6. STATUS OF TIGER RESEARCH AND CONSERVATION ACTIVITIES IN LAO PDR

6.1 Past research and conservation (prior to 2000)

Research and monitoring

There was no specific research or monitoring of tigers in Lao PDR before 2000. Most records of tigers in Laos come from village questionnaires and general wildlife surveys during a period of 1990s (see more details in Section 2.1). For example, Salter (1993) conducted village interviews in all 18 established national protected areas across Laos between 1988 and 1993, provided baseline data on tiger occurrence and major threats to tigers. From 1992 – 1998, preliminary wildlife surveys conducted in most NPAs and some PNPAs provided confirmed data on tiger presence based on sightings, signs and local reports.

Conservation

During 1980s, tigers and other species were largely protected throughout the forest of Laos because the country was closed to international markets and the human population was low. During the 1990s, tigers may have benefited by legal establishment of 21 national protected areas, and by national decrees and laws addressing management of several species including tigers (see section 4). Also, during this time period, management initiatives took place in several NPAs for a few years, with technical and financial support provided by a range of international organizations in up to 19 of the 21 national protected areas[46]. After these projects ended, those NPAs that received financial support from government continued some conservation activities such as enforcement but a lack of monitoring systems made it difficult to assess conservation progress or success.

6.2 Current research and conservation (2000 to present)

Research and monitoring

Nam Et-Phou Louey NPA (2003-present)

From 2003-2004, the first systematic study on tigers and prey in the country was made by WCS-Lao Program in NEPL NPA, using camera traps. Following the first results, WCS-Lao has worked with the NEPL NPA management unit to initiate conservation interventions to ensure a protection for tigers and prey populations in the NPA, and to continue monitoring of tigers and prey. In 2008, an occupancy survey was conducted to assess tiger prey populations including gaur, sambar, serow, wild pig and muntjac in the NPA. Additional studies are focused on tiger diet to determine what prey are key to tiger survival in NEPL NPA and estimate a minimum number of tigers based on DNA extraction from large carnivore scats.

Nakai-Nam Theun NPA (2005-present)

In 2005, the WCS-Lao Program assisted the Watershed Management and Protection Authority (WMPA) to establish a wildlife monitoring program in the NT2 watershed including the NNT NPA[32]. The objective of the wildlife monitoring program is to provide a baseline for monitoring change in key wildlife populations (including tigers and prey) in the watershed as a result of management. A project from 2005-2007 was implemented to develop capacity within the NT2-WMPA and it's monitoring staff and teams so that the protocols, data collection and analyses can be done within the WMPA.

Monitoring is focused on a subset of key species of wildlife in the watershed that are exploited by hunting for domestic consumption, internal trade and unregulated export. The aim of the monitoring program is to detect improvement (positive changes) in wildlife populations exploited by hunting as a result of WMPA interventions to control wildlife harvest. The protocol for monitoring large terrestrial vertebrates (including tigers and prey) employs camera traps over 800 km^2 of the NNT NPA with one-200 km^2 sampling block surveyed annually. Since 2007, the WMPA has continued to implement this monitoring program with annual reports on the status of wildlife populations in the NPA[48].

Nam Kading NPA (2007-present)

In 2006, the WCS-Lao Program assisted the NKD NPA to establish a wildlife monitoring program[47]. The objective of the wildlife monitoring program is to detect change in the abundance of key species of wildlife (including tigers and prey) as a result of management. A project from 2007-2009 was implemented to develop capacity within the NKD NPA to implement the monitoring protocols, data collection and analyses. The protocol for monitoring large terrestrial vertebrates (including tigers and prey) employs camera traps over 400 km^2 of the NNT NPA with one-200 km^2 sampling block surveyed annually.

Xe Piane NPA and Dong Hua Sao (2007-present)
Since 2007, WWF-Laos has provided financial support to conduct preliminary tiger field surveys in these two NPAs[25].

Conservation

Nam Et-Phou Louey NPA (2000-present)

The NEPL NPA has been under active management since 2000 with ongoing international technical and financial support, first from IUCN until 2002, followed by WCS from 2003 to the present. In NEPL NPA, the goal is to increase tigers by 50% from 2005-2015 and the prey to support this

increase[33]. Since 2004, WCS-Lao has worked with the NEPL NPA management unit to provide technical and financial support for the NPA Management unit to implement conservation interventions to reach this goal by ensuring the protection of tigers and prey populations in the NPA. The principle management activities include:
Enforcement: the NPA has set up patrol substations in the forest (consisting of 6-7 rangers per substation) to conduct patrols over the 3,000 km^2 core zone, and 4 mobile teams of 3-4 officers to control illegal trade of wildlife to markets.
Outreach and land use planning: the NPA conducts public education and outreach in villages inside/outside NPA to build better understanding for local communities about NPA's regulations, the role of wildlife linked to local livelihoods, land use zoning and demarcating the boundaries of NPA's managed and core zones.
Livestock management to reduce tiger-human conflict: the NPA works with farmers to monitor incidents of carnivore depredation of livestock and assist farmers to relocate livestock grazing areas from the core zone to the village area. The NPA also coordinates with livestock development sectors to improve livestock husbandry techniques that maximize productivity without causing human-tiger conflict.
Ecotourism linked to wildlife protection**:** following a feasibility study of ecotourism in NEPL NPA[42], a business plan was developed to analyze the potential to generate economic benefits for NPA management and local communities. The plan is now being implemented to develop ecotourism products that are designed to improve local livelihoods, support NPA management, and provide incentives for the recovery and protection of wild tigers and their habitat.

Nakai-Nam Theun NPA (2005-present)

The Watershed Management and Protection Authority has implemented conservation interventions in the NNT NPA since 2005, primarily funded by a contribution from the Nam Theun 2 power company of US$ 1 million per annum. The goal is to maintain biodiversity in NNT NPA and reservoir. The management activities include:
Enforcement: NPA staff conduct patrols in Nam Theun reservoir, work with village conservation units to conduct forest patrols to reduce poaching of wildlife in the NPA. They work and coordinate with enforcement agencies to respond to reports of illegal activities and set up check points to stop trade in wildlife.
Outreach: the WMPA conducts public education activities for villages inside and outside the NPA to increase public understanding and support.
Land-use planning: the WMPA has conducted land allocation for villages inside the NPA, and set up village conservation unit to guard their designated areas. NPA core zones and managed zone are being established and will be complete by 2011.
Village micro-development: the WMPA provides financial and technical supports to villages inside and adjoining the NPA and reservoir in horticulture and livestock development.
Ecotourism: the NPA has conducted preliminary studies in ecotourism potential in NNT and the reservoir and has completed a strategy for ecotourism development.

Nam Kading NPA (2005-present)

In the NKD NPA, the stated goal is to increase the tiger population by 20% from 2005-2010[51]. Since 2005, WCS-Lao has worked with the NKD NPA management unit to provide technical and financial support for the NPA Management unit to implement undertake landscape level planning to design and implement conservation interventions to ensure protection for landscape species (including tigers and prey) in the NPA. The management activities include:
Enforcement: foot-patrols are conducted to reduce poaching of wildlife in the NPA. The NPA works with enforcement agencies to respond to wildlife crimes in townships, along roads, and other key checkpoints.
Outreach and land use planning: the NPA has an extensive conservation education and outreach program that conducts public education in villages inside and adjoining the NPAs, and in schools. This includes land use zoning and demarcating the boundaries of NPA's managed and core zones.
Village non-timber forest management: the NPA provides technical support to villages inside and adjoining the NPA to manage for sustainable offtake of non-timber forest projects.
Research and Training Center: the NPA has established the Tad Vanfong Training Center on the Nam Kading River to support scientific research and ecotourism in the NPA.

Xe Piane NPA (2000-present)

From 1998 to 2002, the FOMACOP project developed an NPA management plan, supported enforcement and outreach activities, village micro-development such as banks of rice and buffalo, and ecotourism. After the project ended, the government continued to support enforcement activities including checkpoints, mobile patrolling team to respond to wildlife crimes along the roads and target villages. Since 2007, WWF-Lao PDR has provided financial support to develop ecotourism products and conduct occasional enforcement foot-patrols. An expansion of tiger research and conservation activities is planned for this NPA and others in southern Laos (TCL#27).

7. GAP ANALYSIS AND RECOMMENDED ACTIONS

7.1 Set goals for recovery and conservation of tiger populations in Lao PDR for the next 10 years (2010-2020)

Gaps: To design effective management activities and to objectively measure the impact of these activities, it is essential to identify goals for the recovery and conservation of tigers in Lao PDR. At the present time, specific goals for the recovery of tiger populations are stated for only two protected areas (NEPL and NKD) within two of the priority landscapes.

Recommended Actions:

7.1.1 Set goals for recovery and conservation of viable tiger populations in each tiger conservation landscape. Based on what is known about the current status of tigers and their prey in Lao PDR (Section 2), consider the following goal for adoption (see map Appendix 4):

The goal of tiger conservation in Lao PDR is to recover and maintain viable populations of tigers and their prey in all the existing tiger conservation landscapes across the country including to:

i) Secure source tiger populations in core areas and expand breeding populations into Class 1 tiger landscapes
ii) Recover and secure source tiger populations in core areas in Class 2 tiger landscapes
iii) Enhance zones of connectivity within and between Class 1 and Class 2 landscapes.
iv) Manage to reduce threats to recover source tiger populations in Class 3 and Potential landscapes; enhance connectivity to Class 1 and 2 landscapes.
v) Identify and protect any unprotected breeding tiger populations remaining in Laos; enhance their connectivity to existing tiger landscapes.

7.2 Identify and demarcate totally protected zones (TPZs) in protected areas and corridors for connectivity between TPZs, protected areas and tiger conservation landscapes to protect wild tigers, prey and their habitat

Gaps: The national forestry law mandates demarcation of totally protected core zones (TPZs) and corridors for habitat connectivity within and between protected areas[44]. At the present time, only two protected areas (NEPL and NKD) within two of the priority landscapes have demarcated and are protecting TPZs, while one other (NNT) is in the process of demarcating TPZs.

The Wildlife Law states that all hunting is prohibited in the TPZ and harvest of tigers and large prey, including gaur, banteng, sambar and serow, is illegal throughout the country. Tiger survival is dependent on

establishing sizable core zones (>3000km^2) where tiger and prey are not hunted[12]. Although small tiger populations of 6-12 breeding individuals may be demographically viable in a 100-year time frame[11], the likelihood of extirpation resulting from conflict increases in small fragments[18]. Protected areas that may contain viable tiger populations in Laos are relatively large for Indochina with suitable habitat also remaining outside of protected areas, providing opportunities to demarcate sizable TPZs as well as connectivity corridors between them. Without this zoning, it will become increasingly difficult to maintain tigers and their prey within Laos.

Recommended Actions:

7.2.1 Following the 2007 Forestry Law, identify and demarcate large Totally Protected Zones and corridors of appropriate habitat in protected areas within Tiger Conservation Landscapes that are off-limit to hunting and public access.

7.2.2 Following the 2007 Forestry Law, identify and demarcate corridors to maintain connectivity between TPZs and within and between protected areas and tiger conservation landscapes

7.3 Prepare and implement management plans designed to reduce threats to tigers and prey in tiger conservation landscapes

Gaps: To recover and maintain viable populations of wild tigers and prey, site-specific plans are needed to i) identify and rank threats to wild tigers and prey and, ii) select realistic management activities that will reduce the greatest threats. Prime Minister' agreement No. 25/PM, dated on 3rd April, 2007 states clearly that each NPA must be assigned at least 15 government staff, provided sufficient equipment, vehicles and financial support to implement management interventions. At the present time, only two protected areas (NEPL and NK) in two Tiger Conservation Landscapes have management plans designed to reduce threats specific to the conservation of wild tigers and prey.

Recommended Actions:

7.3.1 Increase national capacity at the provincial protected area division and in protected areas to i) identify and rank threats to wild tigers and prey, ii) design management activities that will reduce the greatest threats, and iii) implement site-specific plans for conservation of wild tigers and prey in priority tiger conservation landscapes .

7.3.2. Secure financial and technical support to implement Prime Minister's agreement No. 25/PM for recruitment of staff, building of facilities, and necessary equipment for NPA management.

7.3.3. Train protected area managers in tiger conservation landscapes in the:

i) principles of tiger ecology and conservation and of wildlife management,
ii) how to integrate wildlife management with rural livelihoods and development,
iii) group leadership, communication and coordination skills,
iv) conflict resolution for resource disputes and stakeholder disagreements,
v) tools for financial and administrative management of tiger conservation landscapes,
vi) project design, budgeting, fundraising, and reporting.

7.4 Increase enforcement of national regulations and international conventions to reduce illegal harvest and trade of tigers and their prey

Gaps: Illegal hunting and trade of wild tigers and prey is the greatest threat to the conservation of wild tigers in Laos. As a result, strong enforcement of national regulations and international conventions against illegal hunting and trade is one of the most important management activities to recover and protect wild tigers and their prey. Government policy on the environment, particularly the 2007 Wildlife Law, provides good guidelines for the management of wildlife resources, including the control of wildlife crime. However, weak law enforcement and poor management of protected areas results in tiger poaching and illegal hunting of prey for the domestic and international wildlife trade. Building capacity within and between enforcement agencies, and providing support for "on the ground" action is necessary to tackle these illegal activities. At the present time, only three protected areas (NNT, NK and NEPL) have developed specific wildlife protection strategies in place to reduce the illegal harvest and trade of wildlife, including tigers and their prey[38,39,40].

A high demand for tiger parts in the international market for traditional Chinese medicine results is driving poaching of tigers for trade. It has been acknowledged that tiger farms are established and managed primarily for commercial trade (i.e. the sale of tiger parts) to conserve wild tigers. At the present time, one tiger farm is present at Ban Nongbua Noi, Khammouan province and is advertising the sale of tigers for zoos. Unfortunately, all commercial trade in tigers parts and their derivatives (either farmed or wild tigers) is prohibited internationally (CITES Decision 14.65-72) and banned domestically in all of its range countries including China – historically the largest market for tiger products at[43]. Tiger bone was officially removed from the traditional Chinese medicine pharmacopeia by the Chinese government in 1993 and viewed the use of tiger bone as a dying practice[30]. Reasons for the ban are due to the fact that if legal tiger products from farms are widely available in the market, it makes law enforcement difficult because of problems distinguishing wild from farmed products.

Recommended Actions:

7.4.1. Strengthen the institutional capacity of enforcement agencies, Department of Forest Investigation (DOFI), CITES Management and Scientific Authorities and other concerned agencies such as police and custom offices, to enforce the existing laws and regulations on illegal trafficking of tigers, prey and other wildlife.

7.4.2 Following the 2007 Wildlife Law, manage for the sustainable harvest of Category 2 tiger prey (muntjacs and pigs) in areas outside of protected area TPZs and corridors in Tiger Conservation Landscapes.

7.4.3. Increase national capacity to develop protection strategies that detail the threats to wild tigers and prey at sites and identify enforcement activities (e.g., regulations, zoning, foot patrol sectors, mobile patrol routes, enforcement and prosecution procedures, etc.) that will reduce each threat.

7.4.4. Train, supervise and coordinate multi-sectoral law enforcement teams: for example, foot patrol teams to guard and enforce wildlife laws within TPZs; mobile patrol teams to guard and enforce wildlife trade laws outside of TPZs; coordination with other enforcement agencies (police, military, customs and justice) to implement law enforcement interventions.

7.4.5. Install law enforcement monitoring systems (e.g. MIST) to systematically monitor, evaluate and adapt law enforcement activities.

7.4.6. In order for enforcement authorities to monitor and control trade in tiger parts, register all existing tiger farms and close farms if objectives are do not comply with the international CITES ban on trade in tiger parts and derivatives, to which Lao PDR is a signatory.

7.5 Increase public awareness and support for the recovery and conservation of wild tigers and their habitats

Gaps: While law enforcement is an essential component of any plan to conserve wild tigers and prey, it alone is not sufficient. It is also critical to have public compliance with and support for the increased law enforcement as well as public understanding of how improved wildlife management will benefit citizens and the consequences of engaging in wildlife crime. At the present time, national capacity to design and deliver public outreach programs specific to the conservation of wild tigers and prey is limited. Only three protected areas (NNT, NK and NEPL) have outreach units that are actively engaged in design and delivery of programs to increase public awareness and support for the conservation of wildlife; only the NEPL outreach unit is focused on land use planning and management issues specifically related to wild tigers and their prey.

In the last decade, methods for implementing outreach and education activities to increase public knowledge about and support for the

conservation of wild tigers and prey has advanced considerably. Methods now available to reliably increase public knowledge and support include: formal education, social marketing campaigns, conflict mitigation, and natural resource planning. In order to implement effective conservation education and outreach, it critical to build national practitioners with capacity to[52]:

i) Understand communication – Why do we need communication? What is communication? The elements of communication theory.
ii) Identify the conservation targets and associated direct and indirect threats to these targets.
iii) Plan an education or outreach program or activity that includes:
    a. Identifying what conservation threat the program will address.
    b. Determining who the stakeholders are the influence the conservation threat.
    c. Assess where and when the target audiences can be reached.
    d. Design a monitoring plan for the education and outreach, including measurable objectives.
    e. Create a program or materials that effectively deliver the messages to result in action reducing the conservation threat.
iv) Negotiate and mitigate conflicts that arise between different stakeholders.
v) Understand the linkages between conservation of biodiversity, natural resource management, and classic rural development at the macro and micro levels.

Recommended Actions:

7.5.1. Train and support outreach units in protected areas in priority tiger landscapes to design, deliver and evaluate outreach activities using formal education, social marketing campaigns, conflict mitigation, and natural resource planning to increase public knowledge and support for the conservation of wild tigers and their habitats.

7.6 Monitor and reduce human-tiger conflict in tiger conservation landscapes

Gaps: Human-tiger conflict in Laos is mainly a result of livestock depredation by tigers rather than man-eating by tigers. Half of Laos' 5.2 million residents are subsistence farmers whose principle source of income is livestock[53]. Livestock frequently graze freely away from villages, providing conditions where conflict is likely. When an incidence occurs, tigers are often being killed in revenge in many parts of country.

An evaluation of these husbandry practices on human-tiger conflict in the NEPL NPA found that depredation affected only a small percentage of villages and a small fraction of the total livestock herd. But given the opportunity to report attacks in return for possible compensation, farmers lagged in both reporting and removing livestock to villages given the lack

of forage to keep livestock near the village as required by the program, and the lucrative market for tiger bone trade. Farmers typically delayed reporting of kills while trying to opportunistically use the freshly killed livestock carcasses as bait to poach tigers.

These results indicate that conservation of tigers in Laos will be dependent on spatially separating large carnivores and prey from humans by modifying livestock husbandry practices and enforcing protected area zoning. In order to reduce the conflict, it is important to build capacity for protected area and district livestock extension staff to;
i) immediately respond to farmer reports of the depredation,
ii) collect data to accurately verify the identity of the predator
iii) explain explicitly to villagers about the cause of human-tiger conflict and provide recommendations to villagers on livestock management
iv) provide guidance how to avoid encounter with tigers in the forest

Recommended Actions:

7.6.1. Train and equip all field personnel in protected areas in priority tiger landscapes to respond to and investigate carnivore-human conflict reports and to maintain a carnivore-human conflict database.

7.6.2. Develop regulations regarding livestock management in management zone around protected areas with source populations in tiger landscapes (e.g. livestock should be attended by an adult herder during the day and corralled at night, preferably in guarded predator-proof enclosures.)

7.6.3. Engage agricultural extension agencies to provide technical assistance and support to villages on "tiger-friendly" livestock management practices, such as predator-proof livestock enclosures that minimize depredation in tiger conservation landscapes.

7.6.4. Include depredation and livestock management issues in education and outreach programs in tiger conservation landscapes.

7.7 Strengthen linkages from ecotourism benefits in tiger conservation landscapes to the conservation and recovery of tigers and their habitats.

Gaps: The Nature Conservancy defines ecotourism as "environmentally responsible travel to natural areas in order to enjoy and appreciate nature (and accompanying cultural features) that promote conservation, have a low visitor impact, and provide for beneficially active socio-economic involvement of local people". Although tourism is currently significant to national economic growth, it is important to note that "tourism is sustainable when its development and operation includes the participation of local population, protection of the total environment, fair economic return for the industry and its host community, as well as a mutual respect for and gratification of all involved parties"[41].

Therefore, PA managers should think carefully about the design of ecotourism in tiger conservation landscapes. In general, ecotourism in a tiger conservation landscape should generate public support as well as revenue for tiger and prey conservation. For example, in the NEPL NPA the business plan for ecotourism in the PA was designed to bring benefits to villages near ecotourism activities based on the level of compliance of the entire village with government regulations for tiger and prey conservation[42].

Recommended Actions:

7.7.1. Provide protected areas with technical assistance to draw up a business plan to determine if ecotourism in the landscape has the potential to generate economic benefits for PA management and the local communities and, if so, how benefit-sharing from the enterprise will be structured to provide direct incentives for the conservation of wild tigers and their habitats in the landscape.

7.8 Increase cross-sectoral cooperation for the recovery and conservation of wild tigers and their habitats in Lao PDR

Gaps: Within and beyond tiger conservation landscapes, natural resource managers - largely from the forestry sector, need to be able to effectively communicate, coordinate and gather support for tiger and prey conservation interventions from other sectors of government and the NGO community. Within tiger conservation landscapes, leadership is needed for coordination of multi-disciplinary teams from the natural resource and rural development sectors across large and often remote landscapes. At the present time, there is a general lack of clarity and capacity to integrate biodiversity conservation, including recovery and conservation of tigers and their habitats, with rural, economic, and infrastructure development in tiger conservation landscapes.

Recommended Actions:

7.8.1 Create forums for dialog within/among all government ministries to integrate conservation of tigers and their habitats into the national planning and investment sectors.

7.8.2 Brief high level authorities on the ecology and management of wild tigers and prey and the role of tigers in national/local economic development and environmental protection.

7.8.3 Assess and minimize the impact of development projects on tigers and their habitats in tiger conservation landscapes.

7.8.4. Increase national, provincial and district capacity to coordinate cross-sectoral management for conservation and recovery of wild tigers and their habitats.

7.9 Increase international cooperation to reduce the illegal trade of tiger and prey

Gaps: Although wild tigers are a legally protected species in Laos, at the present time they are illegally hunted and traded in response to the increasing demand of international markets for tiger parts for traditional medicine. Likewise, body parts of some species of large prey (e.g. gaur, sambar) are killed and traded across international borders for medicinal use.

Inadequate funding of protection authorities and a related absence of sufficient human resource capacity are two primary reasons why governments have been unable to halt the trade along these borders crossings. However, a recent boost in cooperation amongst Association of Southeast Asian Nations (ASEAN) members through the ASEAN Wildlife Enforcement Network, which has been in operation since 2005, is enabling greater communication between authorities in source, transit and destination countries. There is a need to incorporate this movement for improved international cooperation to strengthen communication and collaboration procedures to build enforcement capacity for controlling the trade.

Recommended Actions:

7.9.1. Collaborate with ASEAN Wildlife Enforcement Network, TRAFFIC and CITES to strengthen the enforcement capacity of customs authorities and other relevant border enforcement agencies by building awareness of the CITES convention; related national legislation and regulations; general information about the nature of the trade regionally, and how to identify, confiscate and handle illegally traded tigers and prey.

7.9.2. Convene relevant border enforcement agencies to begin developing a framework for collaboration to control the illegal trade of tigers and prey between Lao and neighboring countries.

7.10 Monitor the status and distribution of tigers and prey at priority sites to measure progress towards the goals for tiger and prey recovery and conservation

Gaps: To measure progress towards achieving the goals for the recovery and conservation of tiger populations in Laos, it is critical to regularly monitor the status and distribution of tigers and prey in response to management. At the present time, regular systematic monitoring of the status and distribution of tigers and prey is in place in only three NPAs (NEPL, NNT and NK) in two of the priority landscapes.

To conserve tigers in representative biomes across their range, it is critical to manage for the recovery and conservation of breeding tiger populations

in the global priority (Class 1) and regional priority (Class 2) tiger conservation landscapes[6].

In the last decade, methods for survey and monitoring of tiger and prey populations have advanced considerably. Methods now available to reliably estimate tiger abundance include, i) camera-trap surveys to identify minimum number of individual tigers or tiger population density using capture-recapture models[36], ii) fecal DNA analysis to identify and determine minimum number of individual tigers, iii) systematic surveys for tiger or prey reports or sign to estimate an abundance index using occupancy models, which is useful for measure change over time[37].

In order for national biologists to use these methods, it is critical for Lao national universities and international conservation NGOs to train national biologists to, i) develop appropriate designs for survey and monitoring with sufficient effort to generate a reliable result, ii) accurately collect field data and to enter, analyze and interpret results, iii) present results on the status and trends in tiger and prey populations and, iv) use the results to make management recommendations to government authorities and managers about how to recover or maintain tiger and prey populations.

Recommended Actions:

7.10.1. Increase national capacity to systematically monitor tiger and prey populations and to interpret and apply the results to the design and evaluation of management interventions.

7.10.2. Generate rigorous tiger and prey baseline estimates for source populations in protected areas in the Class 1 and 2 landscapes in Laos and apply this data to the design and evaluation of aggressive management interventions to recover tiger populations (see maps of tiger conservation landscapes and NPAs in Appendix 4). This includes:

TCL#35 (Nam Et-Phou Louey)
Tiger and prey population monitoring is ongoing in the NEPL NPA core zone. Existing gaps are to, i) conduct camera trap surveys in the NPA core zone to update the 2004 tiger population estimate, ii) continue updating prey occupancy estimates annually to assess and adapt management interventions and, ii) to conduct a landscape level occupancy survey over 30,000 km^2 to generate a tiger and prey baseline for TCL#35.

TCL#27 (Southern Laos)
There are no rigorous population estimates for tiger and prey any part of TCL#27 in Laos. Current data on tiger and prey derived from villager's reports and general wildlife field surveys. Existing gaps are to conduct camera trap and/or occupancy sign surveys for areas within and adjoining Dong Hua Sao, Xe Pian, Don Amphan and Xe Sap and Dong Phou Vieng NPAs and the Xe Khampho, Bolvan Southwest and Phou Khathong PPAs to generate tiger and prey baseline estimates for TCL#27.

TCL#34 (Central Laos)

Tiger and prey monitoring is ongoing only in NKD and NNT NPAs in TCL#34 in Central Laos. Existing gaps are to, i) continue tiger and prey occupancy monitoring in the NKD and NNT NPAs and to, ii) conduct camera trap survey and/or occupancy sign surveys for other areas in the Nam Theun basin including the corridors adjoining NNT and NKD NPAs, NNT and HNN, within PKK NPA, Phou Chom Voy PPA and the Nam Chouan and Nam Ngeum Watershed Management Areas to generate tiger and prey baseline estimates for TCL#34.

TCL#26 (Dong Khanthung)
There are no rigorous population estimates for tiger and prey any part of TCL#26 in Laos. Existing gaps are to conduct camera trap and/or occupancy sign surveys in the area.

7.10.3 Conduct questionnaire surveys associated with GIS analysis to determine current occurrence of tiger and prey source populations in Class 3 and potential landscapes.

This includes TCL#33 (areas within and adjoining Hin Namno NPA, areas within & adjoining Phou Xang He NPA), TCL#36 (areas within and adjoining the NHA and NKN NPAs), and Xe Bang Nouan NPA, and potential tiger conservation landscapes that are "large areas of potential habitat under low human impact where tiger status is unknown (or that have not been surveyed since 1995)[6]. This includes, i) areas adjoining Nam Phoun and Phou Phanang PPAs, and ii) areas within Phou Den Din NPA, and iii) areas within and adjoining Phou Xang He (north and west).

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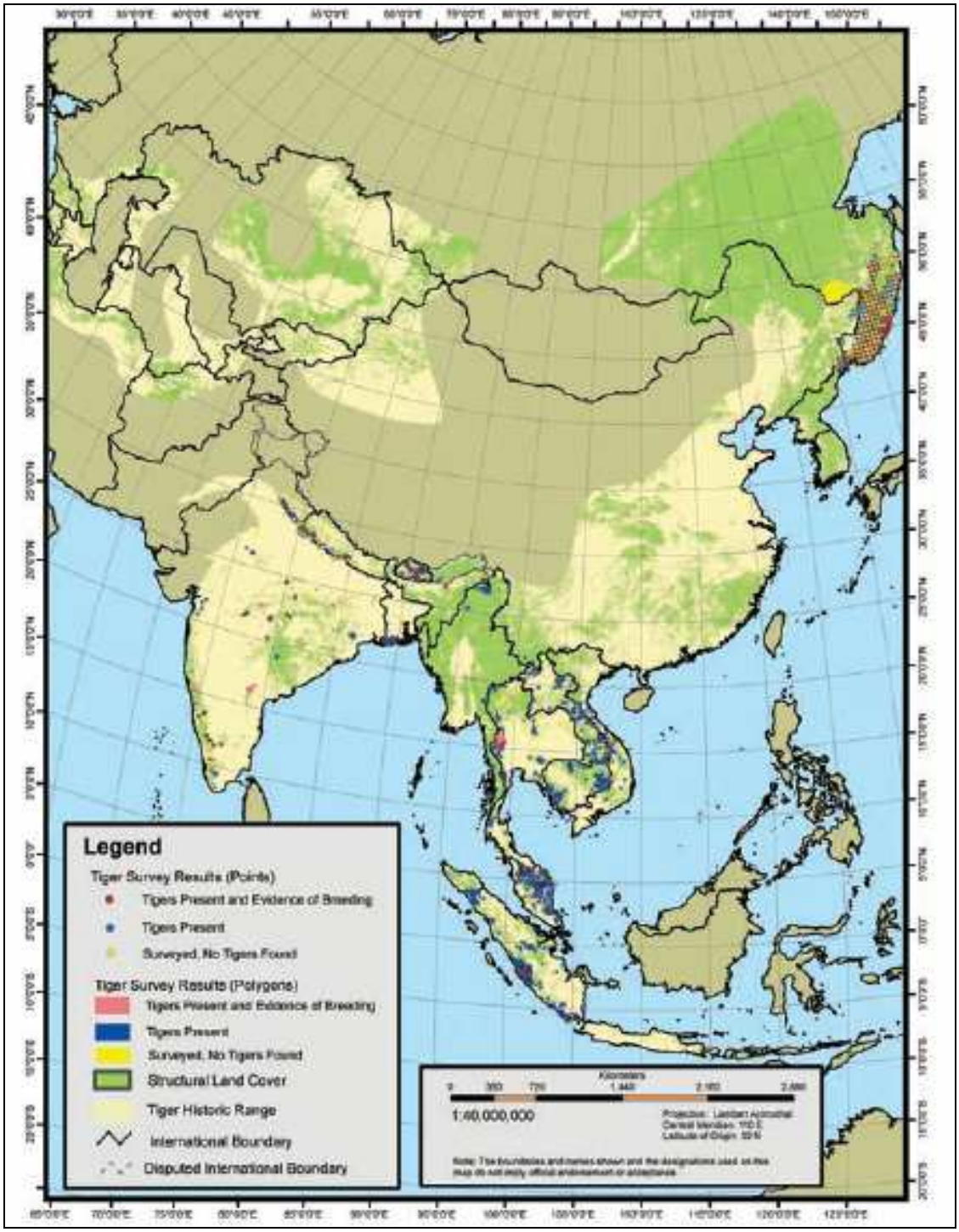
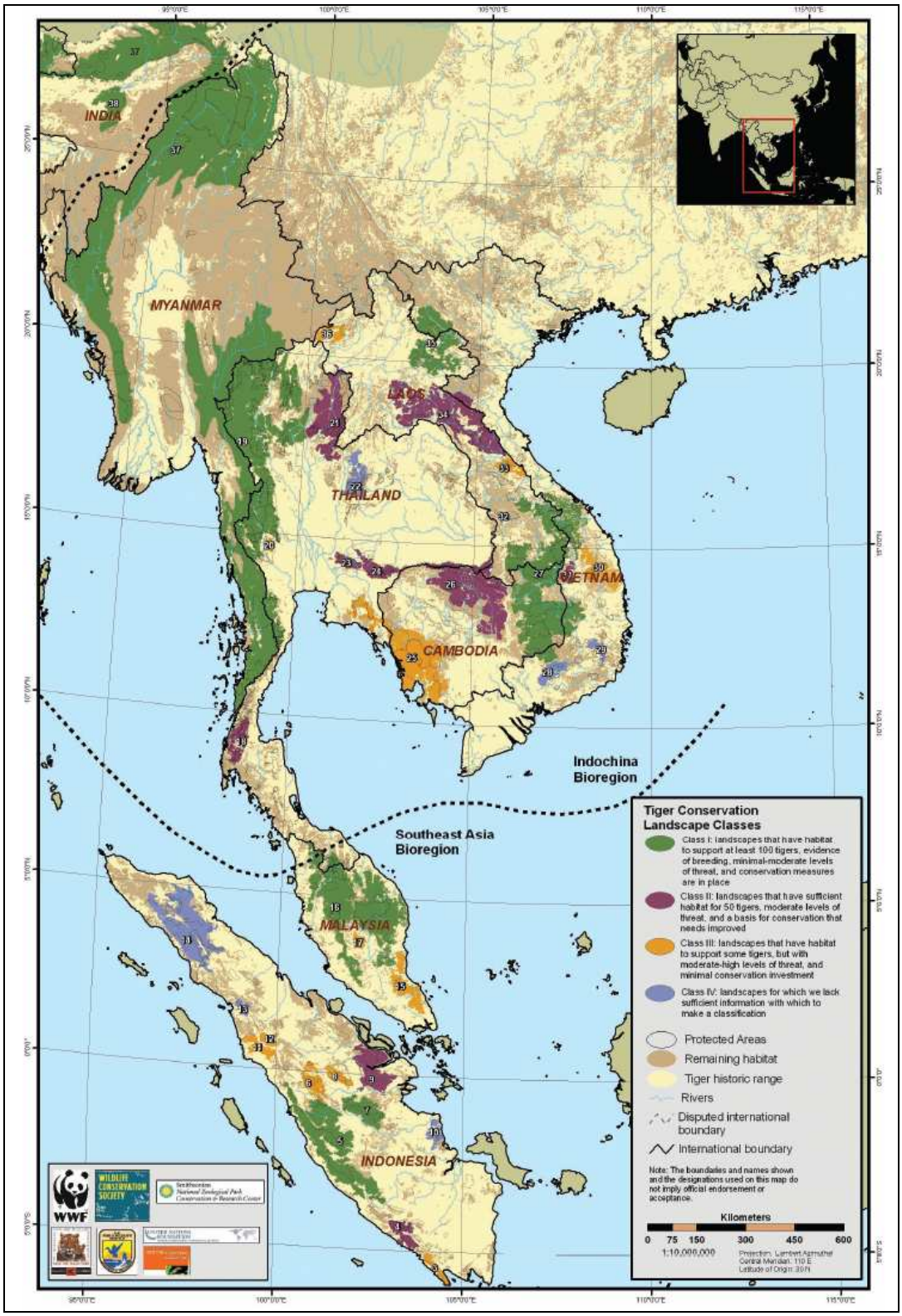
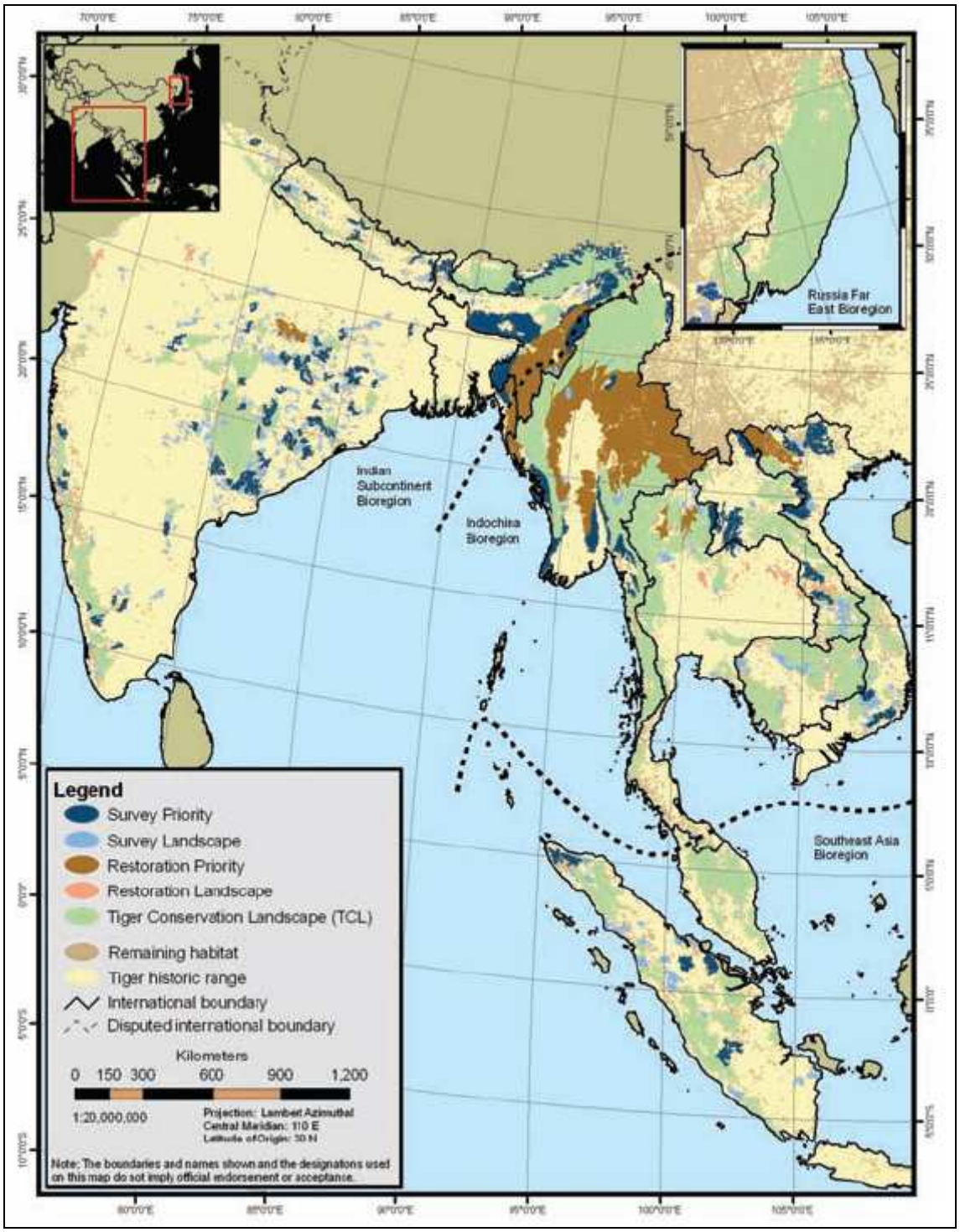


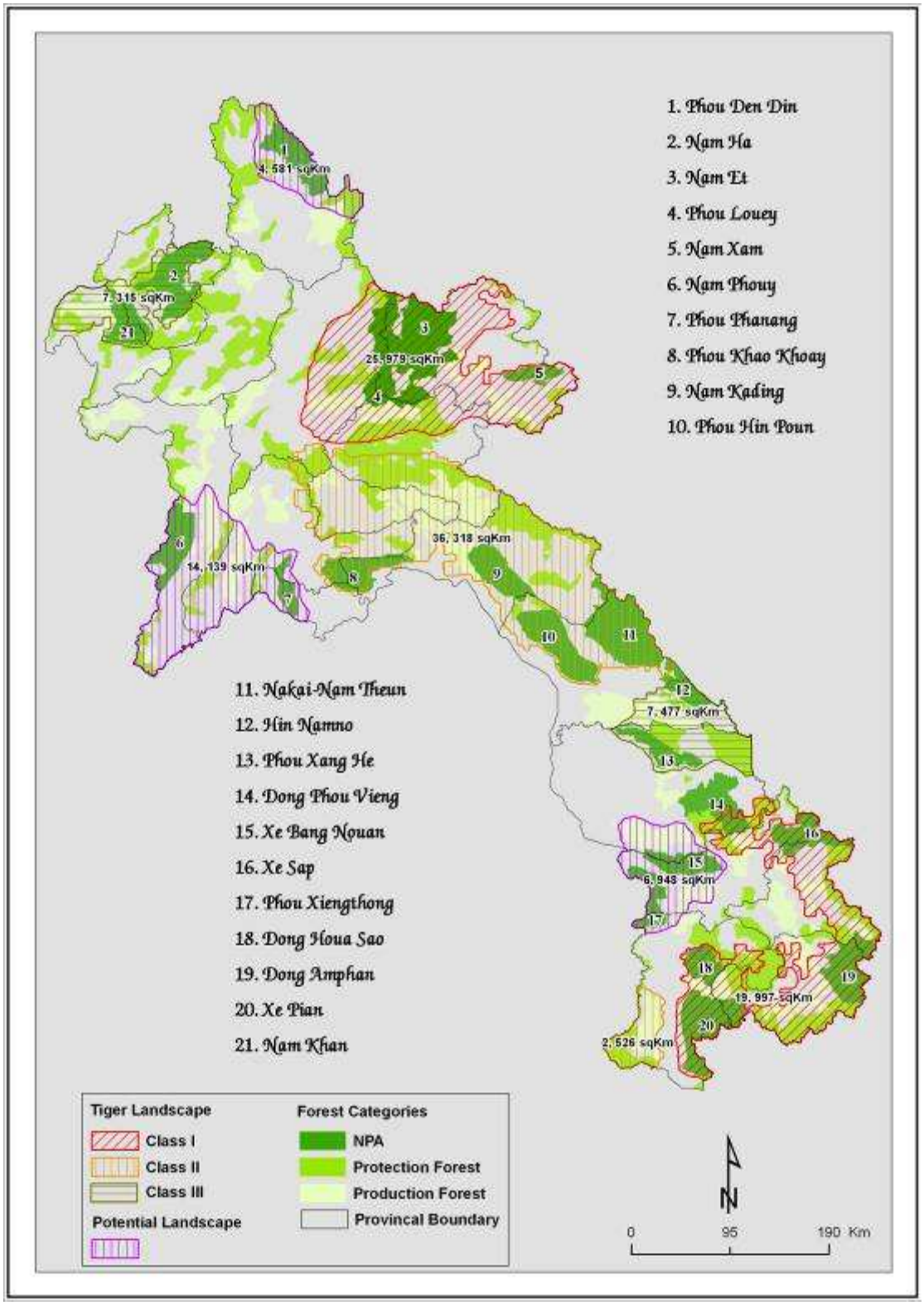
Appendix 1. Tiger survey reports (1995-2005) *(Source: Sanderson et al. 2006)*



Appendix 2. Tiger Conservation Landscape Prioritization based on tiger records from 1995-2005. *(Source: Sanderson et al. 2006).*



Appendix 3. Survey and restoration priorities based on tiger records from 1995-2005. *(Source: Sanderson et al. 2006)*



Appendix 4. National protected areas and tiger conservation landscapes in Lao PDR.