Nam Ngiep 1 Hydropower Project

Baseline Biodiversity Assessment Report

Nam Ngiep One Power Company

January 2014

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January 2014

Approved by:	David Nicholson
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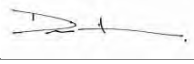
Signed:	
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Date:	17 January 2014

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FINAL REPORT

Nam Ngiep 1 Power Company

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

January 2014

Reference: 0200749

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Acronyms and Abbreviations

ADB	Asian Development Bank
CR	Critically endangered (IUCN Red List)
DBH	Diameter at breast height
DD	Data deficient (IUCN Red List)
DFRM	Department of Forest and Resource Management
DoF	Department of Forestry
EDL	Electric du Laos
EGAT	Electricity Generating Authority of Thailand
EIA	Environmental Impact Assessment
EN	Endangered (IUCN Red List)
ERI	Environmental Research Institute
ERM	Environmental Resources Management ERM-Siam Co. Ltd.
ha	hectares
IAP	(Project's) Independent Advisory Panel
IFC	International Finance Corporation
IHA	International Hydropower Association
IP	Indigenous People
IR	Involuntary Settlement
IUCN	International Union for Conservation of Nature
Kansai	Kansai Electric Power Company Inc.
km	kilometre
kV	kilovolts
LC	Least concern (IUCN Red List)
LHSE	Lao Holding State Enterprise
LMD	Lower mixed deciduous
m	metre
MSL	Mean Sea Level
MW	Megawatt
NDVI	Normalised difference vegetation index
NE	Not evaluated (IUCN Red List)
NNP1 Project	Nam Ngiep 1 Hydropower Project
NNP1PC	Nam Ngiep 1 Power Company
NPA	National Protected Area
NT	Near threatened (IUCN Red List)
NUL	National University of Lao
PAFO	Provincial Agriculture and Forestry Office of Bolikhamxay
PDR	People's Democratic Republic
PKK	Phou Khao Kouay
PPA	Provincial Preserved Area
PS6	Performance Standard 6 (IFC)
SPS	Safeguard Policy Statement
TISTR	Thailand Institute of Scientific and Technological Research
ToR	Terms of Reference
UMD	Upper mixed deciduous
VU	Vulnerable (IUCN Red List)
WWF	Worldwide Fund for Nature

EXECUTIVE SUMMARY

The Nam Ngiep 1 Hydropower Project (NNP1 Project) involves construction and operation of a 290 megawatt (MW) hydroelectric power generation facility on a build-operate-transfer basis at the Nam Ngiep River, Lao PDR. The Project will generate 262 MW of its capacity for export to Thailand and 20MW for domestic supply.

The purpose of this report is to provide an updated baseline assessment (following submission of the Project environmental impact assessment) of the biodiversity values relevant to the Project in response to the Terms of Reference (ToR) provided by ADB.

The Project area

The Project area is defined as the area potentially directly and indirectly affected by the Project components. The componens include two reservoirs each impounded by a separate dam serving two separate power stations, transmission line and resettlement area. The main power station is designed to re-regulate and stabilise the Nam Ngiep River discharge from the main power station for the safety to the downstream area of the re-regulation dam. The main dam inundation area is 70 km in length, and includes a total surface area of 66.9 km^2. The transmission line will span between the main powerhouse and the Ban Nabong substation near Vientiane.

The proposed Project lies on the Nam Ngiep River which flows in a south-southeast direction through a mountainous region to the gorge at Hat Gniun village where the topography changes to a hilly landscape before entering the Mekong River at Pakxan. The gorge is the location for the construction of the proposed dam.

Terrestrial ecoregions are natural ecological communities with shared species, dynamics and environmental conditions and offer a useful way of understanding the biodiversity within an area (ADB & UNEP, 2004). The ecoregion associated with the Project area is characterised by a variety of forest associations including montane hardwoods, mixed conifer-hardwood forests, open montane forests, and open conifer forests (Wikramanayake *et al.*, 2002). These forests have been subject to heavy logging pressure and much of the forest cover of central Lao PDR is subject to existing forestry operations, or occurs within approved forest leases. Slash and burn agriculture is a land use that is still practiced widely in central Lao PDR, including the Project area (ERM 2013b).

This report uses available information (from desktop and preliminary field surveys) to describe the biodiversity values in accordance with the requirements of IFC Performance Standard 6 and ADB Environmental Safeguard Policy. A combination of field survey, desktop review, village interview, consultation with species specialists and geospatial analysis was undertaken to describe the existing characteristics of the Project area. Field

sampling was undertaken in 2007 and in the wet and dry seasons of 2013. Additional aquatic surveys are scheduled to assist in further understanding of the significance of the fish biodiversity and values of the area for migratory species.

The vegetation within the Project area is dominated by forest (natural habitat) and fallow land vegetation (modified habitat). The deciduous forest land cover dominates the Project area, representing approximately 36 per cent of the footprint. Young and old fallow land is also highly represented with 16 and 21 per cent respectively. Condition assessment of the Project area indicated that over 80 per cent of the Project area is classified as moderate or high NDVI (or photosynthetic capacity).

Flora and fauna species diversity was recorded to be high in comparison to other areas in the region. A total of thirteen flora and thirty-five fauna species listed as critically endangered, endangered or vulnerable on the IUCN Red List of Threatened Species were reported (by interview, secondary data or direct observation) as known or may occur within the Project area. This includes the critically endangered flora species *Dipterocarpus turbinatus* and the Northern white-cheeked gibbon (*Nomascus leucogenys*).

Aquatic ecology surveys were also undertaken in 2007 and 2013. In general, river habitats were fast flowing with greater water depth and flows during the wet season. Dry season river habitats exhibited riffle zones which were flooded during the wet season. The river bed was generally dominated by sand and gravel. Villagers use the river environment for fishing and other activities and cattle were observed in the waterbody.

The fish community of the Mekong River is one of the largest in the world with most of the production based on migratory river species (Poulsen *et al.*, 2004). Fish migration is an important component for many fish species life cycle. The EIA (ERI, 2009) noted that the fish community detected in 2007 contains species common to the Mekong tributaries and was dominated by Cyprinid species. Cyprinid family species were reported to adapt to different environments in various sections of the river, and this family was also the dominant group detected during 2013 survey. The EIA assessment noted that of the larger species detected, many are migratory species of the lower Mekong basin that move upstream during the wet season spawning activities (EIA citing Poulsen *et al.,* 2004). These larger species, such as mud carp (*Cirrhinus molitorella*) and Asian red tailed catfish *(Hemibagrus wyckioides*) were detected in 2007 and 2013 surveys. The surveys noted a number of juvenile individuals of the migratory species suggesting that the Nam Ngiep River plays a role in providing habitat for these species' reproductive cycle (EIA citing Lowe-McConnell, 1995).

It is evident that villagers in the Project area regularly use local terrestrial and aquatic biodiversity – e.g. as a food source. However, the dependence on natural resources varies by village and is largely associated with accessibility. For example, remote villages tend to rely more heavily on medicinal plants as access to pharmaceuticals is limited. The biodiversity values of the area provide ecosystem services such as hunting and gathering, medicinal plants and materials, timber products, fishing and cultural services.

IFC Habitat Categories

Land cover mapping for the Project area identified a number of vegetated cover classes. The grassland, old fallow land, young fallow land, rice paddy, slash and burn land, and urban classes are considered to be modified habitats while bamboo, deciduous forest and evergreen forest areas are considered to be natural habitats in accordance with the IFC habitat categories assessment.

Assessment for critical habitat within the Project area was undertaken for species considered to be candidates based on desktop and field survey review. Using baseline data and consultation with species experts the species were screened against the determination criteria and quantitative thresholds. No flora species or terrestrial fauna species were determine likely to have critical habitat within the Project area. Additional assessment is being undertaken to further understand the significance of the aquatic environment for candidate fish species.

Candidate Offset Sites

Four candidate offset sites have been identified in the Biodiversity Offset Design Report for the Project. This report investigated the biodiversity values of each of the candidate offset sites such that their ecological suitability to provide a biodiversity offset can be assessed. The sites described include parts of the Nam Ngiep catchment (Upper Nam Ngiep), stretches of the Nam Xan River between Nam Lao and Bolikhan, the Huay Ngua PPA and Phou Khao Kouay Protected Area. The candidate sites have been identified as part of the offset design process and details are provided in the related report.

The candidate offset sites vary in site and character. Each site has been described in terms of land cover, vegetation condition, flora species, fauna species and threatened species. In general, a number of the sites display characteristics similar to the Project area biodiversity.

1 INTRODUCTION

1.1 BACKGROUND

The Nam Ngiep 1 Hydropower Project (NNP1 Project) involves construction and operation of a 290 megawatt (MW) hydroelectric power generation facility on a build-operate-transfer basis at the Nam Ngiep River, Lao PDR. The NNP1 Project site is located on the Nam Ngiep River, in the provinces of Vientiane, Xieng Khouang and Bolikhamxay, approximately 145 kilometres (km) northeast from the city of Vientiane or 50 km north from Pakxan District, as shown in *Figure 1.1*.

The Project will generate 262 MW of its capacity for export to Thailand and 20MW for domestic supply. The Project will be funded predominantly by private sector funds. The Nam Ngiep 1 Power Company (NNP1PC) is the proponent of the proposal.

An Environment Impact Assessment (EIA) was compiled for the Project in 2012 to identify and quantify the potential impacts of the Project, assess their significance and consider mitigation measures. Following reviews, the Kansai Electric Power Company Inc. (Kansai) was requested by the Asian Development Bank (ADB) and the Project's Independent Advisory Panel (IAP) to investigate the biodiversity offset requirements for the NNP1 Project and has contracted Environmental Resources Management ERM-Siam Co. Ltd (ERM) to undertake these studies.

The investigation for biodiversity offsets has been triggered by the Policy Principles of *ADB Safeguard Policy Statement, Environmental Safeguards* (ADB, 2009). The ADB requirements include the design of appropriate biodiversity offset measures to achieve at least a "no net loss" of biodiversity values.

The ADB provided a Terms of Reference (ToR) specific to the preparation of a *Baseline Biodiversity Assessment Report* and *Biodiversity Offset Design Report* for the Project. This report is the *Baseline Biodiversity Assessment Report*.

250000 300000 350000 400000

2200000 2150000 2100000 2050000 2000000 1950000

Legend

- Nam Ngiep Catchment Boundary
- Lao Province Boundary
- Lao PDR Boundary

Nam Ngiep 1 Hydropower Project:

- Nam Ngiep Inundation Area
- Re-regulation Dam
- Proposed Access Road

N

0 10 20 30Km

1:750,000

Basemap: ESRI Street
Datum: WGS84

Houamuang
Muang Yong
Muang Peun
Muang Ven
Ban Houali
Muang O
Ban Ko Kieng
Houaphan
Ban Houay Tieng
Nam Neun
Xiangkhoang [Xieng Khouang]
Louangphabang [Louang Prabang]
Houaphan
Muang Xamtong
Ban Pak Mene
Ban Songhak
Ban Naxa
Ban Ban
Ban Niang
Ban Chuong La
Ban Sen Done Mong
Muang Souy
Ban Sen Kom
Ban Len
Phonsavan
Xiangkhouang
Nong Het
Nam Ngum
Ban Nampit
Ban Nammadao
Muang Pan
Xiangkhoang
Ban Palan Noy
Ban San Teng
Muang Phoun
Vientiane
Nam Ngum
Nam Ngiep
Ban Phatang
Ban Muangngat
Ban Dong
Muang Thathom
Songkeo
Ban Vang-An
Vientiane
Ban Houaykap-Lang
Muang Mok
Ban Thasi
Nam Xan
Ban Houay Pamon
Xaisomboun
Ban Keo Song Lay
Muang Huang
Ban Hatkham
Bolikhamsai
Ban Nong Khay
Nam Ngum Reservoir
Borikhan
Ban Hatkonong
Tourakom
Ban Saka
Ban Keun
Ban Thabök
Bung Kan
Ban Pakxa
Ban Thana
Mekong River
Thailand
Ban Na Inh Noi
Vientiane
Ban Non
Ban Hatkiang
Ban Woen
Vientiane Capital
Ban Thong-Noy
Phon Phisai
2095
2267
Vientiane
Wattay Int'l Airport
Thailand
Ban Sieo
Nong Khai
Ban Lao
Ban Kong Khan
2239
2096
Sakon Nakhon
Nong Khai
2026
222
Khammouane
212
Ban Wan
2020
211
Ban Phu Din
2092

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Date:	06/09/2013	Drawing Size: A3	
Drawn By:	TC	Reviewed By: DN	

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Figure 1.1 - The Project Location

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

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Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

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1.2 PROJECT DESCRIPTION

NNP1 consists of two reservoirs each impounded by a separate dam serving two separate power stations. The Project components are shown in *Figure 1.2*.

The Project will operate a main power station and a re-regulation power station. The main power station is designed to re-regulate and stabilise the Nam Ngiep River discharge from the main power station for the safety to the downstream area of the re-regulation dam. The re-regulation power station is designed generate 19.6 MW per annum.

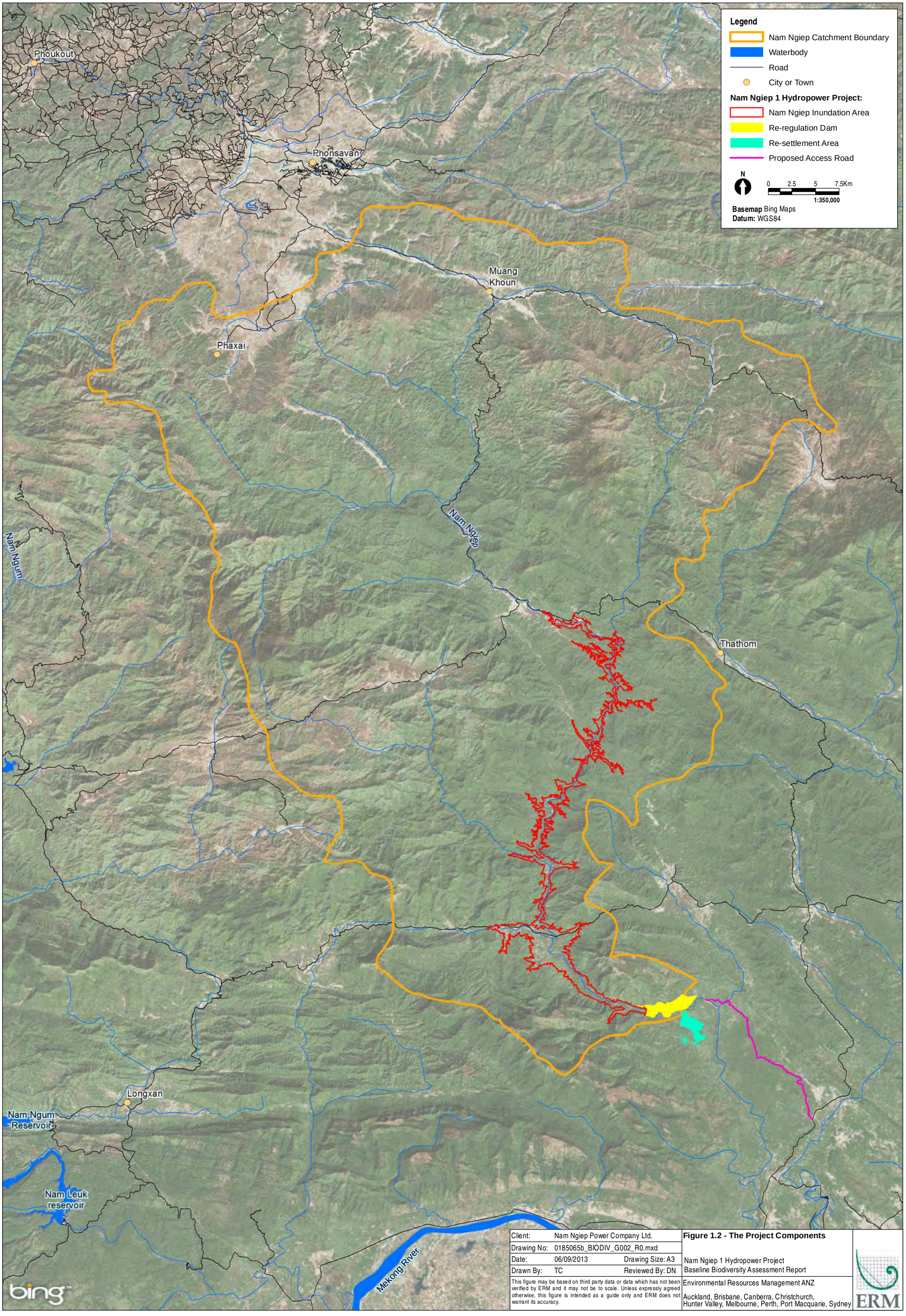
The main dam creates a reservoir with the normal water level at 320 m and minimum operating level at EL 296.0 m. The effective storage capacity is 1192 Mm^3 at normal water level 320 m. The dam inundation area is 70 km length, and includes a total surface area of 66.9 km^2.

The main components of the project include:

- Main dam site
  - Main Power Station and Powerhouse;
  - Spillway with gates;
  - Inundation area.
- Re-regulation dam;
  - Re-regulation Power Station and Powerhouse;
  - Spillway without gates;
  - Saddle dams;
  - Intake;
  - Penstock;
  - Tailrace;
  - Dam control centre;
  - Switchyard.
- 230 kV Transmission Line and 115 kV Transmission Line (between main powerhouse and Ban Nabong Substation) (between the re-regulation powerhouse and Pakxan Substation) 115 kV Pakxan Substation (Extension)
- Resettlement area; and

- Access road network from Ban Nomsomboun to the main dam wall. This network has been subject to a separate impact assessment however baseline biodiversity value information is included in this report for completeness. The access road network includes:
    - upgrade of existing road from Ban Nomsomboun to Ban Hat Gniun through the Huay Ngua Provincial Preserved Area (21.2 km)
    - upgrade of the existing JICA Road from Ban Hat Gnium to dam site (9.25 km)
    - construction of two permanent roads including road from Ban Hat Gniun to the dam site (11.16 km)
    - construction of a network of temporary roads from Ban Hat Gniun to the dam site (16.81 km)
    - bridges and culverts at four locations
    - associated infrastructure including workers camp, batching plants and quarries to facilitate road construction.

The NNP1 project has been developed on a 'Built Operate and Transfer' basis with the Government of Lao PDR. The project will generate and sell electricity to EGAT and EDL for 27 years under a concession provided by Government of Lao PDR and the Power Purchase Agreements with EGAT and EDL respectively.



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Drawn By:	TC	Reviewed By: DN

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Figure 1.2 - The Project Components

Nam Ngiep 1 Hydropower Project
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1.3 ADB TERMS OF REFERENCE

The ADB provided ToR identified four key objectives:

1. *Provide updated baseline biodiversity data in NNP1 project affected* areas covering the: inundation area, downstream of the reservoir, downstream of the regulating and construction quarry site.

2. *Provide comprehensive baseline biodiversity data* covering Nam Xan River (140 km-stretch) and a nearby National Protected Area (NPA) as the potential biodiversity offset area;

3. *Assess the suitability of a biodiversity offset to address any residual impacts on biodiversity* and associated natural habitats from the NNP1 projects in order to achieve "no net loss or a net gain of the affected biodiversity". This will take into consideration the ecological, social, legal, institutional and financial viability and value of establishing a biodiversity offset at the target sites.

4. *Recommend and design biodiversity offset measures.* This will include identifying suitable sites/areas, designing biodiversity offsetting activities, quantifying conservation benefits and gains, developing operational management plans and associated legal, institutional arrangements, roles and requisite capacities, calculating budgets and designing suitable financial arrangements, developing stakeholder participation programs, benefit mechanisms and compensation requirements, and establishing appropriate monitoring and evaluation arrangements.

1.4 PURPOSE OF THIS REPORT

The purpose of this report is to provide an updated baseline assessment of the biodiversity values relevant to the Project in response to the Terms of Reference (ToR) provided by ADB. This report is intended to meet the first two objectives of the ToR, by describing the biodiversity of NNP1 affected areas as well as the biodiversity of candidate offset sites (including Nam Xan River as described in objective two).

This report will document updated baseline biodiversity assessment required to revise the Project EIA and finalise the Biodiversity Offset Design Report. The Biodiversity Offset Design Report will be compiled to satisfy the final two objectives of the ADB ToR.

2 BIODIVERSITY VALUES ASSESSMENT METHODS

2.1 RELEVANT ASSESSMENT STANDARDS

2.1.1 International Finance Corporation Performance Standard 6

The International Finance Corporation (IFC) Performance Standards establish a range of social and environmental obligations to be met by recipients of IFC financing. Governance of the Performance Standards is the responsibility of the IFC. There are eight IFC Performance Standards of which Performance Standard 6 (PS6) is relevant to this biodiversity assessment.

IFC PS6 defines the parameters of biodiversity and ecosystem services which will be considered when assessing the Project against the IFC Performance Standards. This includes the identification and consideration of biodiversity values that include habitat values, threatened species, ecosystem services, protected areas and invasive species. PS6 outlines the objective of no net loss of biodiversity in natural and modified habitats and a net gain of biodiversity in Critical Habitats, where feasible. The PS6 also identifies the need to consider use of offsets to compensate for residual impacts to biodiversity as a result of the Project, but only after the mitigation hierarchy has been applied to the fullest extent practicable.

Threatened Species

Threatened species are identified in PS6 as those listed on the IUCN Red List of Threatened Species. The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants and animals that have been evaluated using the IUCN Red List categories and criteria. The criteria identify three categories of threatened species:

- Critically Endangered (CR);
- Endangered (EN); and
- Vulnerable (VU).

Five additional categories of plants and animals are included in the IUCN Red List including;

- Extinct;
- Extinct in the Wild;
- Near Threatened (NT);
- Least Concern (LC);
- Those for which data is insufficient Data Deficient (DD); and
- Those which have not been evaluated (NE).

Species categorised as CR, EN and VU are considered to be at a heightened risk of extinction and are awarded an elevated level of consideration under the IFC Performance Standards.

Critical Habitat

One of the key provisions of IFC PS 6 is the identification of 'Critical Habitat'. IFC PS6 defines Critical Habitats as areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes. Critical Habitat may not be limited to pristine or highly biodiverse areas but rather may include modified and natural habitats across the broader landscape that supports the biodiversity values that trigger the Critical Habitat designation.

2.1.2 Asian Development Bank

The Safeguard Policy Statement (June 2009) outlines the requirements that the borrower/clients are required to meet when delivering environmental safeguards for project supported by the ADB.

Environmental assessment requirements are identified, including the basis for the assessment process. Specific to biodiversity conservation and sustainable natural resource management the borrower/client:

'will assess the significance of Project impacts and risks on biodiversity and natural resources as an integral part of the environmental assessment process…. The assessment will focus on the major threats to biodiversity, which include destruction of habitat and introduction of invasive alien species, and on the use of natural resources in an unsustainable manner. The borrower/client will need to identify measures to avoid, minimise, or mitigate potentially adverse impacts and risks and, as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity.'

Primarily the revised EIA documents the significance of Project impacts and management of potentially adverse impacts, with this report providing the baseline data to facilitate the impact assessment.

The policy statement describes habitat area categories to be considered including modified habitat, natural habitat and critical habitat.

2.2 REGIONAL BIODIVERSITY CONTEXT

The proposed Project is located in central Lao PDR within the Mekong River basin in the Luang Prabang Montane Rainforest Ecoregion (IM0121), as defined by the Worldwide Fund for Nature (WWF) (WWF, 2003a).

Terrestrial ecoregions are natural ecological communities with shared species, dynamics and environmental conditions and offer a useful way of understanding the biodiversity within an area (ADB & UNEP, 2004). The Luang Prabang Montane Rainforests ecoregion comprises areas largely above 800 m in north-central Lao PDR and is globally recognised for its diversity in bird species (some 540 different species of birds have been recorded) despite more than 70 per cent of the original forest cover being lost as a result of shifting cultivation. The remaining forests contain a rich mix of tree and non-timber species including hardwoods, conifers, rhododendron, ferns, orchids and lichens (WWF, 2003b). No endemic species have been recorded in this ecoregion but this is thought to be due to the lack of biological surveys rather than a true lack of endemics.

The ecoregion is characterised by a variety of forest associations including montane hardwoods, mixed conifer-hardwood forests, open montane forests, and open conifer forests (Wikramanayake *et al.,* 2002). These forests have been subject to heavy logging pressure and much of the forest cover of central Lao PDR is subject to existing forestry operations, or occurs within approved forest leases. Humid evergreen forest occurs at lower elevations around 800 m with *Dipterocarpus turbinatus* and *Toxicodendron succedanea* as the dominant over storey species. The low stature of trees in this community and open understory with an abundance of broad-leaved monocots and grasses suggest severe past impacts from burning and clearance (Wikramanayake *et al.,* 2002). Slash and burn agriculture is a land use that is still practiced widely in central Lao PDR, including the Project area (ERM, 2013b).

Large tracts of remnant and intact forest are reported to occur in less accessible parts of the ecoregion housing several large mammals such as Northern White-cheeked Gibbon (*Nomascus leucogenys*), Tiger (*Panthera tigris corbetti*), Asian Elephant (*Elephas maximus*) and Asiatic Black Bears (*Ursus thibetanus*); all of which are considered to be under continued threat due to habitat loss and hunting/ poaching (WWF, 2003b).

The ecoregion, and the biodiversity housed within it, continues to be threatened by intensive land use pressures, such as cultivation, agriculture, mining and hydropower. As of 2004, the remaining forest cover in Lao PDR was considered to be approximately 41.5 per cent, which is a significantly less than the 1940 estimation of approximately 70 per cent (World Bank, 2005).

These pressures are coupled with use by local communities pose additional threats to the biodiversity values of the area. This includes hunting of small mammals and firewood collection in nearby forests and fishing in local waterways. Much of what is caught and/ or collected is consumed locally (i.e. within household) rather than sold at market.

2.3 *INVESTIGATION AREAS*

A number of locations, summarised below, were assessed as part of this baseline biodiversity assessment. Within this report the following terminology applies:

- Study area – the area encompassing all areas assessed for biodiversity values. This includes the Project area and candidate offset sites (*Figure 2.1*).
- Project area – the area potentially directly and indirectly affected by the Project (*Section 3*). This includes the footprint of disturbance of the various project components.
- Candidate offset sites – the areas investigated to provide potential offset sites. This included consideration of the biodiversity values at four locations: the Upper Nam Ngiep River, Nam Xan River, Huay Ngua Provincial Preserved Area (PPA) and the Phou Khao Kouay (PKK) National Protected Area (NPA). The extent and characteristics of these areas is further described in *Section 4*.

The location of the investigation areas is shown in *Figure 2.1* and summarised in *Table 2.1*. Note the transmission line assessment is included as separate documentation and not included in this report.

Table 2.1 Summary of Study Area

Study Area		**Area (ha)**
Project area	Main Dam site and reservoir area	6,798
	Resettlement Site	467
	Re-regulation Dam	699
	Access Road network	49 (Length 58 km)
	Lower Nam Ngiep (downstream of the dams)	-
Candidate Offset Sites	Upper Nam Ngiep River (outside inundation area)	127,176
	Nam Xan River	Length – 85 km
	Huay Ngua PPA	5,860
	Phou Khao Kouay NPA	181,306

250000 300000 350000 400000

2150000 2100000 2050000

Legend

- Catchment Boundary
- Waterbody
- Road
- City or Town
- Lao PDR Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Candidate Offset Sites:

- Nam Ngiep Offset Area
- Huay Ngua Provincial Protected Area
- Phou Khao Khouay National Protected Area
- Nam Xan Offset - River Centreline

N

0 10 20 30Km

1:600,000

Basemap: Bing Maps

Phoukout
Phonsavan
Nonghet
Muang Khoun
Phaxai
Nam Ngum
Nam Ngiep
Nam Ngiep Catchment
Thathom
Nam Xan Catchment
Vang Vieng
Nam Ngum 2 Reservoir
Nam Song Diversion
Nam Xan
Hinheup
Nam Ngum Reservoir
Ba. Donkha
Nam Ngum Reservoir
Longxan
Thinkeo
Phonhong
Nam Ngum Reservoir
Nam Leuk reservoir
Ban Keun
Nam Mang 3 Reservoir
Pakxan
Mekong River
Hai
Tha Ngon

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Client:	Kansai Electric Power Company Inc.		**Figure 2.1 - Study Area**
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2.4 *BASELINE BIODIVERSITY SURVEY*

The baseline biodiversity values of the Study area have been determined using a number of information sources including:

- Flora and fauna survey across the Study area;
- Desktop sources (published and grey literature, available reports, geospatial datasets and species profiles);
- Geospatial datasets; and
- Detailed flora survey of the access road corridor.

These sources provide description of vegetation communities and habitats, and species that may occur in the Project area. The data collated for the purposes of this report can be categorised into two types:

Direct: Species recorded during biodiversity field surveys undertaken during 2007 and 2013 are considered direct counts. In general the location and details of this data has been recorded and a higher level or certainty can be inferred.

Indirect: Species reported from village surveys or within reports (secondary data) using a more regional study area are considered indirect records. These data sources provide a valuable understanding of the biodiversity of the locality and region however should be afforded further analysis or applicability considered. Data obtained from village surveys can contain errors in some instances, especially when considering identification of species with more challenging diagnostic features.

The reliability of the records has been considered throughout the report and the data category of species records is denoted.

2.4.1 *Direct Biodiversity Data Sources*

NNP1 Environmental Impact Assessment 2012

The NNP1 Project Environmental Impact Assessment (EIA) document was completed in 2012, which included an ecological investigation undertaken by the Environmental Research Institute (ERI). The investigation included studies on the biological environment of the Project area covering terrestrial ecology and wildlife, forest and vegetation cover, aquatic biota and wetlands.

ERI surveyed the Project area in March and October 2007 in order to identify threatened species occurring in or near the Project area, and whether the project has potential to impact their habitats.

The assessments were carried out through visual inspection (direct data), interviews with villagers (indirect data) and utilisation of secondary data sources. Detailed survey methodology for this component is provided in *Annex A*. Results of the surveys reported that current clearing and general habitat disturbance has resulted in many species not occurring in the Project area.

The forest types within the project sub-catchment were classified according to the classifications and definitions from Forest Inventory and Planning Division, Department of Forestry (DoF). The forest and land use data used for the study was based upon imagery (the Assessment of Forest Cover and Land Use during 1992-2002 (Department of Forestry, 2005)) that has now been superseded by land cover mapping data prepared by the Department of Forest and Resource Management (DFRM) in 2010 (DRFM, 2010).

Thailand Institute of Scientific and Technological Research Biodiversity Survey

Field investigations were undertaken in March and July 2013 by the Thailand Institute of Scientific and Technological Research (TISTR) to collect data representative of wet and dry season biodiversity conditions. The TISTR team as a subcontractor to ERM were engaged to undertake survey design, field survey and deliver a field survey biodiversity report. The TISTR report has been used in the development of this biodiversity baseline assessment report.

Surveys were undertaken by teams targeting separate taxa: vegetation (team of 7 people), terrestrial wildlife (team of 6 people) and aquatic biota (team of 5 people). The surveys incorporated detailed assessments that included forest and vegetation cover survey and assessment, wildlife survey and assessment, and aquatic ecology survey and assessment.

Surveys were undertaken at four of the investigation areas that include:

- The Project area (main dam site and reservoir, re-regulation dam site, resettlement site/lower Nam Ngiep);
- Upper Nam Ngiep River;
- Upper and lower Nam Xan River; and
- Huay Ngua Provincial Preserved Area.

Sampling locations are shown in *Figure 2.2*. Detailed survey methodology for this component is provided in *Annex B*.

Forest and Vegetation Survey

The forest survey team surveyed for species diversity along trails and in sampling plots. Unknown plants were collected and three duplicates of leave with flowers or fruits for further analysis in the laboratory. Botanists recorded necessary information i.e. morphology, habit, colour of flowers and ecology, georeferenced location, and compiled photographic records.

Across the survey the sampling plots consisted of 3 types of temporary plots:

- A circular sample plot with a radius of 17.85 meters (or 0.1 ha);
- Square plots of 5x5 meters (25 square meters or 0.0025 ha); and
- Square plots of 2x2 meters (4 square meters or 0.0004 ha).

Analyses of the data collected included specialised laboratory investigations to establish identification of voucher specimens.

Terrestrial Fauna Survey

The terrestrial fauna survey aimed to describe the baseline wildlife diversity of the NNP1 Project area impact zones for the purposes of assessing the potential Project impacts to terrestrial wildlife. Survey and sampling work involved developing an inventory of wildlife species (amphibians, reptiles, birds, and mammals).

The inventory of each fauna group was collected through direct and indirect counts.

Direct counts were carried out to determine numbers of amphibians, reptiles, birds, and mammals by sightings during the field surveys at the survey station. Observations and records of animal signs such as tracks, nets, burrows, droppings, hair and feathers, were also recorded. Details of the techniques used for each group include:

- Amphibians and reptiles: species searches were undertaken in habitats such as under logs, rocks, bark as well as digging in the buttress of trees. At night, spotlighting was used to detect nocturnal species along rivers, around poundages, and within tree canopies.
- Birds: were directly observed using binoculars during day time. Some species of birds were identified using call identification during the morning or evening, when they are the most active. Birds were also caught using mist-nets under tree canopies or cross the creeks these were identified, photographed, and released.

- Mammals: were observed from their signs such as tracks, scats, scratches on trees, burrows, etc. small mammals, were captured using live-traps or Sherman's traps. Bats were surveyed at night using mist-net and harp traps placed under tree canopies or cross creeks. Some species of mammals were identified from local hunters.

For all wildlife species the habitats were recorded. In the case of unidentified individuals these were collected and preserved and later analysed at the laboratory in the Natural History Museum-Nation Science Museum, Prathum Thani, Thailand.

Indirect counts were used to obtain supplementary information on fauna by interviewing local residents who lived in or near by the area. Some local villagers may hunt animals for food or for sale. Local households as well as local markets were also sampled.

Relative abundance of wildlife was calculated from numbers obtained in the direct and indirect counts, species were assigned as abundant, common, and less common using a calculation formulated by Pettingil (1969).

Aquatic Biota Survey

Aquatic biota sampling was conducted at different locations in Nam Ngiep, Nam Xan, Huay Ngua PPA and the resettlement area. Survey techniques included:

- collection of phytoplankton and zooplankton species using multiple plankton net surveys at each location, followed by preservation, identification and laboratory analysis at TISTR;

- collection of benthos at multiple replicate sites using an Ekmann dredge, followed by identification and abundance counts at the TISTR laboratories; and,

- capture and identification of fish species within the main rivers and their tributaries using the help of local fishermen using multi-mesh gillnets, electrofishing, cast nets, gun and hook, as well as discussions with fishermen and other information sources.

National University of Laos Ground-truth of Natural Habitat Survey (Access Road Corridor)

Specific to the proposed disturbance area for the access road network Nam Ngiep 1 Power Company engaged Pheng Phengsintham, a local botanist and lecturer of the National University of Laos (NUL) to undertake survey to ground-truth flora species and delineate natural/modified habitat.

The November 2013 assessment aimed to identify areas of natural and modified habitat within the Proposed Road. Some stretches of temporary and permanent roads in the vicinity of the re-regulation dam were not able to be assessed. The assessment involved survey at 53 temporary sampling plots where the vegetation type and tree species were recorded each side of the proposed access road. The temporary sample plots were set within the proposed access road area with the ten closest trees recorded and measured. The outcomes of NUL assessment have been incorporated in baseline data.

2.4.2 Indirect Biodiversity Data Sources

Desktop Review

Desktop review was undertaken to collate and assess other data sources. The desktop review included an assessment of:

- Online reports relating to the Project area and biodiversity of Lao PDR;
- Threatened species profiles and online species distribution information; and
- Published literature relating to threatened species and Lao PDR biodiversity.

Information collated through desktop review was used to provide additional background information relating to the biodiversity values associated with the Study area. Key desktop documents included:

- Houy Ngua Provincial Preserved Area Management Plan (MP) 2011-2015 by the Provincial Agriculture and Forestry Office of Bolikhamxay (PAFO) (December 2010) – species identified have been considered to have potential to occur in habitat associated with the Access road (indirect data). The management plan reports species based on some field survey and village interview results;
- Nam Ngum 3 Hydropower Project: Final Environmental Impact Assessment, October 2011 prepared by NN3 Power Company;
- The Status and Distribution of Freshwater Biodiversity in Indo-Burma compiled by D.J. Allen, K.G. Smith and W.R.T. Darwall for the International Union for Conservation of Nature (IUCN);
- Wildlife in Lao PDR, 1999 Status Report compiled by J.W. Duckworth, R.E. Salter and K. Khounboline for the IUCN, Wildlife Conservation Society and Centre for Protected Areas and Watershed Management;
- Significant Wildlife and Wildlife Habitats of Bolikhamxay Province April 2011, Integrated Ecosystem and Wildlife Management Project: Bolikhamxay Province Provincial Agriculture and Forestry Office and the Wildlife Conservation Society

Geospatial Analysis

Geospatial analysis was undertaken to assist in understanding the biodiversity values in the Project area and candidate offset sites. Primarily this was based on interpretation of a variety of spatial layers provided by DFRM and Rapideye Imagery. The analysis included land cover mapping, production forest and vegetation community mapping that delineates land cover types.

In order to further understand the biodiversity values represented within the Project area and candidate offset sites, remote sensing analysis was undertaken to map the variation in vegetation condition. Rapideye Imagery was used to identify the normalised difference vegetation index (NDVI) across the area. NDVI is a remote sensing indicator that provides a measure of vegetation density and condition by indicating the photosynthetic capacity of the land surface cover.

The imagery outputs provide a NDVI in grid formation (5m x 5m) across the Project area and candidate offset sites. For the Project condition classes (for a range of NDVI) were defined and applied to each forest type. The condition classes are shown in *Table 2.2*. These condition classes were used to refine land cover calculations. Area within the Impacted NDVI range was removed from the habitat area calculations.

Table 2.2 Condition Class NDVI Range

Condition	NDVI Range
Benchmark	0.8 to 1.0
High	0.6 to 0.8
Moderate	0.4 to 0.6
Low	0 to 0.4
Impacted	-ve to 0

Limitations

For this Project NDVI has been used as a remote sensing tool to indicate vegetation condition. As with all remote sensing techniques there are limitations associated and all information has not been ground-truthed. The outcomes of this assessment should be interpreted on a regional scale and note that the data is based on image capture at one specific time. Similarly, as discussed NDVI is an indicator of photosynthetic capacity of the surface and does not distinguish between vegetation communities.

The inherent benefit of utilising NDVI relates to the remote sensing accessibility of information from areas that may be difficult to access on the ground or when considering larger areas for a local and regional context. The index allows for comparison of vegetation photosynthetic capacity along the length of the corridor in the context of the surrounding landscape.

The NDVI and land cover calculations are based on 5 metre square pixels. The RapidEye satellite imagery provided was at 5 metre square pixels and this same level of accuracy was used in generating the NDVI and land cover calculations presented in this report.

Species Specialist Consultation

In addition to desktop sources, a number of species specialists were consulted to assist in developing an understanding of the importance of the Project area for the critical habitat candidate species. Each specialist contacted provided advice via email response to queries clearly identified as related to this Project. The specialists that provided advice are listed in *Annex C* and advice is referenced as appropriate.

Key input was provided by Dr J.W Duckworth and Dr M Kottelat. Comments was provided on some species texts however it is acknowledged that the final content remains the responsibility of the report compilers.

A number of primate species were determined candidates for critical habitat and Dr Phaivanh Phiapalath of the IUCN SSC Primate Specialist Group was engaged to undertake further site survey and advice relating to critical habitat for primate species. The method of assessment and discussion relating to habitat value is provided in *Annex D* and the advice has been incorporated into the critical habitat assessment.

Social and Cultural Surveys

An assessment of the ecosystem services was undertaken to supplement the biodiversity assessment completed for the NNPI project. The aim was to provide a social context to the establishment of biodiversity offsets.

The assessment included two field visits. The first visit was conducted in February and March 2013. It involved engagement with key government and non-government officials to understand current land use and tenure as well as use and threats to biodiversity in the Nam Ngiep River catchment and potential offset site. In addition, village and market surveys were undertaken. These were used to gather data on the utilisation of ecosystem services by project affected people (PAP), including the use of threatened flora and fauna. The village surveys included focus group discussions and in-depth interviews with relevant community representatives (e.g. hunters, gatherers); while the market surveys involved visual surveys and informal discussions with stall operators.

The second field visit was conducted in July 2013. The focus was on understanding and assessing the ecosystem services in the potential offset site as well as community acceptance of the proposed offset measures. The survey approach was similar to that conducted in the first field visit – e.g. focus group discussions, in-depth interviews and visual surveys.

In total, 18 villages and four markets were surveyed. The outcome was an understanding of stakeholder opinions and concerns as they relate to the potential offset site and proposed offset measures and an understanding of ecosystem services utilised by local community members.

Other sources reviewed included:

- NNP1 Social Impact Assessment Draft Report, which provided initial baseline information for the Project area (2012);

- Physical Cultural Resources: Preliminary Archaeological Survey in the proposed Nam Ngiep 1 Hydropower Project (NNHP-1), an archaeological survey report written in October 2007 provided by Mr Viengkeo Souksavatdy, Deputy Head of the Archaeology Department, MICT;

- Village surveys to determine the socio-economic context for the biodiversity offsets. This included focus groups and in-depth interviews with relevant representatives from communities in the Project area and proposed offset catchment;

- Market surveys in the Project area and proposed offset catchment to further understand and quantify the threat to flora and fauna; and

- Engagement with relevant stakeholders (e.g. representatives from government and non-governmental organisations) to confirm local land use activities, including the presence and use of biodiversity.

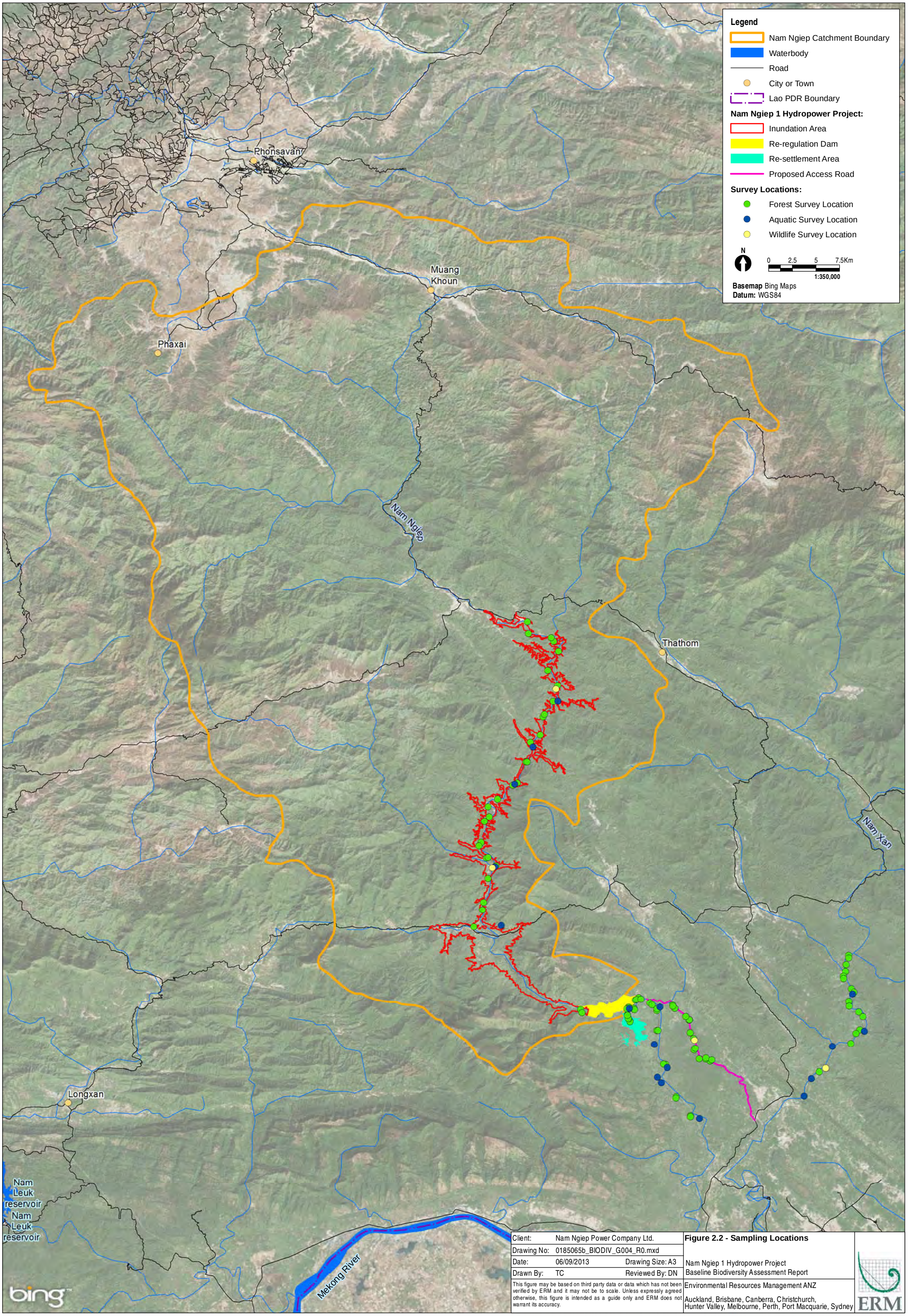

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Figure 2.2 - Sampling Locations

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3 PROJECT AREA BIODIVERSITY VALUES

3.1 OVERVIEW

The following section summarises the key biodiversity values identified during in the baseline assessment of the Project area. It provides an overview of the biodiversity values associated with the Project area to enable determination of impact assessment associated with the project activities and for the determination of biodiversity offsets. Specifically, a description of habitats within the Project area in accordance with the terminology defined by IFC PS6 and the ADB Safeguard Policy Statement is provided. The Project area is made up of the components described in *Section 1.2* and shown in *Figure 1.2*.

Lao PDR is approximately 41 per cent covered by forest and is considered one of the most biodiversity rich countries in Southeast Asia (World Bank, 2005). In general, the main dam inundation area (inundation area approximately 6798 ha) is located in mountainous terrain with some intermittent narrow plains. There are high mountains on both sides of the river. Downstream of the main dam is a valley with slopes less steep than the upstream reaches as the river widens and the relief flattens downstream of the re-regulation dam (approximately 700 ha). Forest vegetation dominates the Lao PDR and the Project area.

3.2 TERRESTRIAL BIODIVERSITY VALUES

3.2.1 Vegetation

Land Cover

Using land cover mapping (DFRM, 2010), natural and modified habitats, in accordance with IFC definition, can be identified within the Project area. *Table 3.1* summarises the land cover shown in *Figure 3.1* and identifies the habitat category of each land cover type.

Natural habitat is an environment where the biological communities are largely formed by native plant and animal species and where human activity has not modified the areas primary ecological functions (ADB, 2012). The natural habitats within the Project area include deciduous forest, evergreen forest and bamboo vegetation.

Modified habitat is altered natural habitat, often formed by the removal of native species for harvesting, land conversion and/or introduction of alien flora and fauna species (ADB, 2012). The modified habitats within the Project area include young and old fallow land, slash and burn, rice paddy, grassland and urban areas. The Project EIA (ERI, 2009) identified during field reconnaissance and village interviews that a large portion of the main dam and re-regulation dam site has already been disturbed by conversion of forest land to other land use types (predominantly agriculture) as well as burning for hunting and illegal logging.

Overall, the vegetation within the Project area is dominated by forest (natural habitat) and fallow land vegetation (modified habitat). The deciduous forest land cover dominates the Project area, representing approximately 36 per cent of the footprint. Young and old fallow land is also highly represented with 16 and 21 per cent respectively.

Within the main dam, approximately 50 per cent of the area is mapped as natural habitat with deciduous forest the dominant land cover type. Patches of natural habitat are dispersed throughout the main dam inundation area though it is the narrower stretches of the inundation area where the majority of the deciduous forest and evergreen forest is mapped. The fallow lands and rice paddy areas dominate the lower third of the inundation area, in particular in large patches where the dam inundation will be its widest at Vang Naxay and Na Nhao.

Within the re-regulation dam area, approximately 40 per cent is mapped as natural habitat with high proportions of deciduous forest and bamboo, mainly located on the southern bank of the Nam Ngiep River. These land cover types are located in the upper re-regulation dam area as the lower reach is dominated by fallows lands.

The resettlement site is mapped with approximately 40 per cent natural habitat which is primarily bamboo and a small area of deciduous forest. The bamboo is distributed throughout the fallow lands, though the deciduous forest is generally restricted to the edges of the proposed resettlement area.

Table 3.1 Landcover within the Project areas

Land Cover	IFC Habitat Class		Area (ha)				Total (ha)	% of Total
			Main dam	Re-regulation dam	Resettle-ment	Access Road*		
Deciduous Forest	N	Deciduous forest occurs when deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen type. Deciduous Forest includes both upper and lower deciduous forest types and this definition is based on relative altitude, forest occurring above 200 m is classified as Upper Mixed deciduous Forest and deciduous forest occurring at an altitude 200 m and below is classified as Lower Deciduous Forest.	2690	131	56	19	**2896**	**36%**
Evergreen Forest	N	Area dominated by trees where 75% or more of the tree species maintain their leaves all year. Canopy is never without green foliage.	488	24	0	2	**514**	**6%**
Bamboo	N	Bamboo area where the over storey has a crown cover less than 5%.	236	127	132	7	**502**	**6%**
Old Fallow Land	M	Land that has been ploughed and tilled and left un-seeded during a growing season.	1321	194	163	12	**1678**	**21%**
Young Fallow Land	M	Land that has been recently ploughed and tilled and left un-seeded during a growing season.	1036	143	82	5	**1261**	**16%**
Slash and Burn	M	Slash-and-burn is a description of land that has been subjected to an agricultural technique which involves cutting and burning of forests or woodlands to create fields.	328	27	19	1	**374**	**5%**
Rice Paddy	M	Areas permanently being used for rice cultivation.	107	5	15	1	**127**	**2%**
Grassland	M	Unfertile or degraded land on which no trees or shrubs grow. It might be an area that is too dry for tree growth that has been covered by grasses. It could also be an area that has originally been covered by trees, but has been heavily disturbed by cutting and fire and gradually depleted.	108	0	0	0	**108**	**1%**

Land Cover	IFC Habitat Class		Area (ha)				Total (ha)	% of Total
			Main dam	Re-regulation dam	Resettle-ment	Access Road*		
Urban Area	M	Urban Areas include all areas being used for permanent settlements such as villages, towns, public gardens etc. It also includes roads having a width of more than 5 m and areas under electric high power lines.	38	3	0	<1	**41**	**1%**
Water	-	The land cover class Water includes rivers, water reservoirs (i.e. ponds and dams for irrigation and hydro power) and lakes. Water reservoirs and lakes with an area of 0.5 ha and rivers should be at least 10m wide to be classified as Water.	368	42	0	<1	**410**	**5%**
Rock	-	Unfertile or seriously degraded land on shallow soil and rocky areas on which neither trees nor grasses can grow.	1	0	0	0	**1**	**<1%**
Cloud	-	Cloud indicates limitations in the dataset from shadows and cloud contained in the aerial imagery.	4	0	0	<1	**4**	**<1%**
Shadow	-	Shadow indicates limitations in the dataset from shadows and cloud contained in the aerial imagery.	16	0	0	1	**16**	**<1%**
Impacted Natural Habitat (NDVI)			*57*	*3*	*0*	***1***	***60***	***1%***
Total			**6798**	**699**	**467**	**49**		

*Access Road calculations based on 9.5 m wide road corridor.

Forestry Classification Mapping

Forestry classification mapping identifies both protection forest and production forest across the Project area. *Figure 3.2* depicts the extent of protected and production forest within the Project area and shows that greater than half of the Project area is mapped as National Protected Forest. Protection forest is described as:

'forest and forest land classified for the protection of watershed areas and the prevention of soil erosion. It also includes areas of forest land significant for national security, areas for protection against natural disaster and protection of the environment and other areas.'

The protection forest extends from the resettlement site upstream in the catchment of the Nam Ngiep River. The upper area of the main dam inundation area is mapped as production forest. Production Forests are natural forests and planted forests classified for the utilization purposes of areas for production, and wood and forest product businesses to satisfy the requirements of national socio-economic development and people's living. Production forests are primarily managed for the production of timber resources. The Forestry Law provides the basis for the management of production and conservation forests in Lao PDR outside of the protected area system. It enables the possible reclassification of production forests to protection forests to enable long-term conservation of potential biodiversity offset areas.

Vegetation Condition

The NDVI features recorded in Rapideye Imagery provides an index of vegetation density and condition at the time of image capture. It indicates the photosynthetic capacity of the land surface cover and has been used to refine the vegetation type extents into an additional level of detail. The NDVI across the Project area is shown in *Figure 3.3* and the area of each classification is summarised in *Table 3.2, Table 3.3, Table 3.4* and *Table 3.5*.

Over 80 per cent of the Project area is classified as moderate or high NDVI. Up to 5 per cent of the Project area is classified as impacted NDVI. The following tables summarise the vegetation condition for each Project area component.

Table 3.2 Vegetation Condition within the Main Dam (inundation area)(ha)

Forest type	Impacted (- to 0)	Low (0 - 0.4)	Moderate (0.4 - 0.6)	High (0.6 - 0.8)
Deciduous Forest	31	154	1091	1445
Evergreen Forest	20	38	266	184
Old Fallow Land	10	93	573	644
Young Fallow Land	19	217	549	250
Bamboo	5	21	67	147
Slash and Burn	10	171	96	51

Forest type	Impacted (- to 0)	Low (0 - 0.4)	Moderate (0.4 - 0.6)	High (0.6 - 0.8)
Rice Paddy	5	72	27	2
Water	237	80	39	12
Grassland	8	34	51	16
Urban Area	1	31	6	0
Rock	1	0	0	0
Cloud	2	1	0	1
Shadow	8	5	2	0
Total (ha)	**357**	**917**	**2767**	**2752**
% of Total	**5%**	**13%**	**41%**	**41%**

Table 3.3 Vegetation Condition within the Re-regulation Dam (ha)

Forest type	Impacted (- to 0)	Low (0 - 0.4)	Moderate (0.4 - 0.6)	High (0.6 - 0.8)
Deciduous Forest	1	10	75	47
Evergreen Forest	2	5	16	4
Old Fallow Land	2	30	139	24
Young Fallow Land	1	14	101	27
Bamboo	0	11	59	57
Slash and Burn	0	7	15	4
Rice Paddy	0	4	1	0
Water	32	7	2	0
Urban Area	0	3	0	0
Total (ha)	**38**	**91**	**408**	**163**
% of Total	**5%**	**13%**	**58%**	**23%**

Table 3.4 Vegetation Condition within the Resettlement Site (ha)

Forest type	Impacted (- to 0)	Low (0 - 0.4)	Moderate (0.4 - 0.6)	High (0.6 - 0.8)
Deciduous Forest	0	8	39	10
Old Fallow Land	0	37	106	20
Young Fallow Land	0	25	48	10
Bamboo	0	19	77	36
Slash and Burn	0	5	12	2
Rice Paddy	0	7	7	1
Total (ha)	**0**	**101**	**289**	**79**
% of Total	**0%**	**22%**	**62%**	**17%**

Table 3.5 Vegetation Condition within Access Road Network (ha)

	Impacted (- to 0)	Low (0 - 0.4)	Moderate (0.4 - 0.6)	High (0.6 - 0.8)
Ban Nomsomboun – Ban Hat Gniun	<1	11	6	<1
JICA Road	<1	2	4	<1
Permanent Roads Ban Hat Gniun	<1	1	6	3
Temp Roads Ban Hat Gniun	<1	2	8	5

300000 310000 320000 330000 340000 350000 360000

2120000 2110000 2100000 2090000 2080000 2070000 2060000 2050000 2040000 2030000

Legend

- Evergreen Forest (Current Forest)
- Deciduous Forest (Current Forest)
- Deciduous Forest Plantation (Current Forest)
- Bamboo (Potential Forest)
- Old Fallow Land (Potential Forest)
- Young Fallow Land (Potential Forest)
- Slash and Burn Land (Potential Forest)
- Rice Paddy
- Grassland
- Swamp
- Rock
- Barren Land
- Urban Area
- Water
- Other Land
- Cloud
- Shadow
- Nam Ngiep Sub-catchment Boundary
- Watercourse
- City, Town or Village

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Thathom

Xiengmi

Mekong River

N

0 2.5 5 7.5Km

1:250,000

Land Cover: DFRM
Datum: WGS84

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Figure 3.1 - Land Cover within the Project Area

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280000 290000 300000 310000 320000 330000 340000 350000 360000 370000

2160000 2150000 2140000 2130000 2120000 2110000 2100000 2090000 2080000 2070000 2060000 2050000 2040000

Phoukout
Phonsavan
Nam Ngum
Muang Khoun
Phaxai
Nam Xan
Thathom
Nam Ngiap
Mekong River

Legend

- Nam Ngiep Catchment Boundary
- Waterbody
- Road
- City or Town

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Forest Zone:

- National Protection Forest
- Production Forest

N

0 4 8 12Km

1:350,000

Basemap: Bing Maps
Datum: WGS84

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Figure 3.2 - Forestry Classification Mapping within the Project Area

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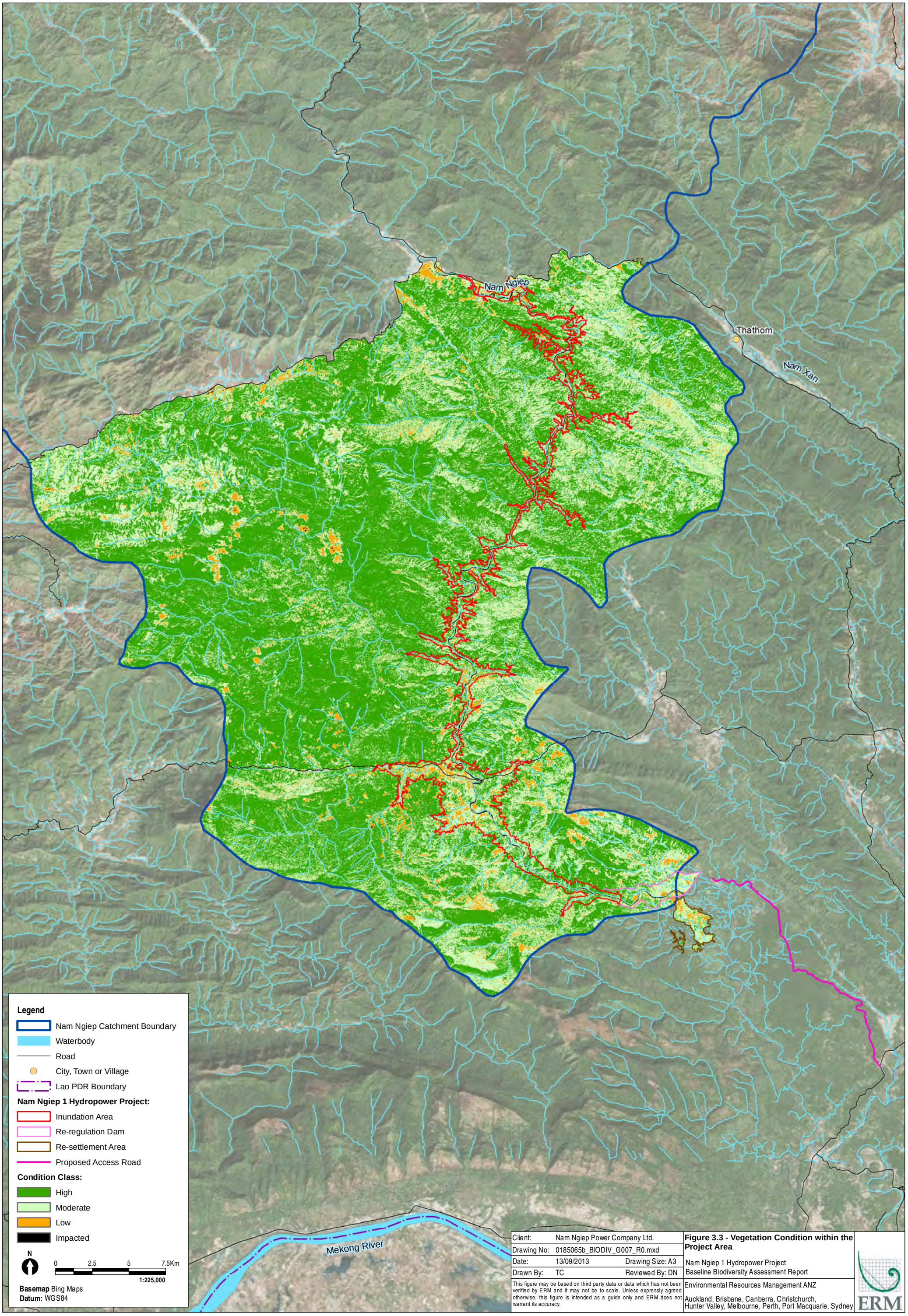

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Figure 3.3 - Vegetation Condition within the Project Area

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

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Ground-truthed Vegetation Communities/Habitat

Detailed ground-truthing was undertaken within the proposed access road corridor only in preparation for construction activities. In general detailed ground-truthing determined, with respect to the representation of natural habitat, that the landcover mapping provides an over-estimate of the extent of natural habitat.

Ground-truthing results for the access road corridor for the Ban Nomsomboun to Ban Hat Gnium section of the proposed road identified substantially less natural habitat (47% natural habitat) than detected in land cover mapping (61% natural habitat). Similarly, ground-truthing of the JICA Road results (11% natural habitat) were less than indicated on land cover mapping (22% natural habitat).

The flora survey undertaken of the access road by NUL, ground-truthed the land cover mapping to confirm the presence of natural or modified habitat in accessible areas of the access road network. *Table 3.6* summarises the habitat description for segments of the access road, as provided in the draft field report from the corridor flora survey (Phengsintham 2013).

Table 3.6 Vegetation descriptions from road corridor flora survey (Phengsintham 2013)

Road Segment	Vegetation Description
Ban Nomsomboun to Huay Ngua PPA	Primarily modified habitat on left and right sides, except TSP no5 on the left hand side, where regeneration forest occurs across for approximately 500 m of the access road.
Inside Huay Ngua PPA	Huay Ngua PPA primarily consisted of lower mixed deciduous forest (LMD). Within the corridor, the average DBH in LMD is 38 cm and average distance 9.3 m. In comparison, outside the corridor, the average DBH was 34.5 cm and the average distance 7.8m. A total of 114 Mai Yang Khao have previously been recorded. 21 items were cleared by the EDL (pole installation), 29 exist within the road corridor; and the remaining will be preserved by NNP1PC and PAFO. Removal of Mai Yang Khao could be replaced by replanting the species inside the PPA, supporting the provincial office to improve Huay Ngua PPA through reforestation and providing a check point during road construction.
JICA road	JICA road passes through Ban Hat Gnuin and Hatsaykham villages. The sections is primarily modified forest, except two points (TSP no35 and no40), which are small patches of UMD. The Average DBH 43 cm and average distance 7.08 m for TSP no35. This vegetation type represented the dense vegetation (UMD) at the site, but the forest was disturbed by historical logging activities, shifting cultivation (ray) and other agricultural activities.
P2 and T12	Three TSPs were established. The area between ICA road and TSP no43 was primarily Fallow Forest. Between TSP no43 and TSP no45 vegetation was primarily disturbed UMD to the right of the road, and Fallow Forest to the left of the road. This vegetation represented the highest quality dense vegetation, however the forest was disturbed by historical logging activities, shifting cultivation (ray) and fired in May 2013.

Road Segment	Vegetation Description
T7, T8 and T9 Access Road	Eight TSPs were surveyed in these access roads. The area included young fallow forest, plantation area and mixed deciduous forest. The average DBH in UMD was 44.8 cm and the average distance 9.48m. In comparison, outside the corridor the average DBH was 28 cm and distance about 6.36m.

Source: direct summary of Draft Land Use Study prepared by Pheng Phengsintham (Local botanist and Lecturer of the National University of Laos) (November 2013).

3.2.2 Flora Species

Thirty-five sample plots were assessed in the main dam area during the 2007 survey by ERI with an additional 113 survey plots assessed across the main dam, re-regulation dam, resettlement area and candidate offset sites during the 2013 TISTR survey.

Sampling undertaken during the 2013 survey by TISTR recorded the diversity of vascular plants in the main dam inundation area (upper Nam Ngiep) was greater in comparison to all other areas sampled for the Project, with at least 509 species recorded. The primary vegetation types at each of the components of the Project is summarised in *Table 3.7* based on the 2013 TISTR survey results. A full species list is provided in *Annex E.*

Table 3.7 Primary Forest Type at Project area

Survey Location	Forest Type Description
Main Dam Site	**Mixed deciduous forest** located in the steep valley. Nearby the forest is mixed with some species of dry evergreen forest. Canopy cover is approximately 60-70%. Top canopy height is 20-40 m.
Resettlement Site	**Secondary growth of mixed deciduous forest**. Canopy cover is approximately 40%. The average height of the upper canopy is approximately 15 m.
Re-regulation Dam Site	**Lower mixed deciduous forest** and **mixed deciduous forest** on one river bank. Canopy cover is approximately 50-60%. Top canopy height is 10 m. On other river bank is Eucalyptus plantation. Canopy height is 15 m under which is densely covered by seedlings of the original mixed deciduous forest type.
Lower Nam Ngiep	Dominated by **disturbed mixed deciduous forest**. Canopy cover is approximately 60-70%. Top canopy height is 20-30 m.
Access Road (Huay Ngua PPA)	Dominated by **mixed deciduous forest** with some areas of **mixed evergreen forest and secondary growth of mixed deciduous forest**. Canopy cover is approximately 60-70%.
Transmission Line	**Secondary growth of mixed deciduous forest** with canopy cover of 40%. Forest condition and species diversity is similar to the Resettlement site. The average height of the upper canopy is approximately 15 m.

For the forest types the forest canopies are divided in 3 classes. The dominant species for each survey locations are summarised in *Table 3.8*.

Table 3.8 Dominant Flora Species in Project area

Canopy class	Dominant species
Main Dam Site Mixed Deciduous Forest	
Top canopy (20-35m)	*Pometia pinnata, Duabanga grandiflora, Lagerstroemia calyculata, Toona ciliata, Pterospermum diversifolium.*
Middle canopy (10-15m)	*Nephelium hypoleucum, Mitrephora tomentosa, Baccaurea ramiflora, Saracia indica, Arenga weaterhoutii.*
Lower canopy (<10m)	saplings and seedling of the higher canopies
Resettlement Site Secondary Growth of Mixed Deciduous Forest	
Top canopy (~15m)	*Taliparitimacrophyllum, Peltophorum dasyrachis, Macaanga denticulata, Lepisanthes rubiginosa, Cratoxylum formosum, Aporosa villosa, Chaetocarpus castanocarpus, Maesa ramentacea, Irvingia malayana, Lagerstoemia calyculata.*
Lower canopy (<10m)	Densely covered by seedlings of original forest type, shrubs, climbers and herbs such as *Cleistanthus papyraceus, Ardisia helferiana, Chionanthus velutinus, Connarus semidecandrus, and Amomum biflorum*. The typical species of bamboo found in the area is *Gigantochloa albociliata.*
Re-regulation Dam Lower Mixed Deciduous Forest	
Top canopy (~10m)	*Macaanga denticulata, Maesa ramentacea, Milletia acutiflora, Lagerstoemia calyculata.* The common species of bamboo found in the area, which are *Gigantochloa albociliata, Pseudostachyum polymorphum, Bambusa bambos.*
Lower Nam Ngiep Disturbed Mixed Deciduous Forest	
Top canopy (20-30m)	*Gironniera nervosa, Ficus racemosa, Xanthophyllum lanceatum*. In a particular area, a cemetery forest, contains a very large tree, and dominated with *Lagerstroemia calyculata.* The forest is highly respected by local people, and very well preserved.
Middle canopy (10-18m)	*Callicarpa arborea, Litsea glutinosa, Crudia chrysantha, Cratoxylum formosum.*
Lower canopy (<10m)	Saplings and seedling of the trees in the higher such as *Trewia nudiflora, Baccaurea ramiflora, Pseuduvaria rugosa, Mallotus philippinensis.*
Access Road (Huay Ngua PPA) Mixed Deciduous Forest	
Top canopy (20-35m)	*Anisoptera costata, Lagerstroemia calyculata, Shorea roxburghii, Irvingia malayana, Alstonia glaucescens, Schima wallichii, Vitex pinnata, Stereospermum fimbriatum*
Middle canopy (10-20m)	*Acronychia pedunculata, Peltophorum dasyrachis, Nauclea orientalis, Microcos tomentosa, Mallotus paniculatus, Gonocaryum lobbianum, Cratoxylum formosum*
Lower canopy (<10m)	*Croton cascarillicdes, Breynia glauca, Ardisia helferiana, Glycosmis pentaphylla, Melicope pteleifolia, Allophylus cobbe, Salacia chinensis*
Transmission Line Secondary Growth of Mixed Deciduous Forest	
Top canopy (~15m)	*Taliparitimacrophyllum, Peltophorum dasyrachis, Macaanga denticulata, Lepisanthes rubiginosa, Cratoxylum formosum, Aporosa villosa, Chaetocarpus castanocarpus, Maesa ramentacea, Irvingia malayana, Lagerstoemia calyculata.*
Lower canopy	Densely covered by seedlings of original forest type, shrubs, climber and herbs such as *Cleistanthus papyraceus, Ardisia helferiana, Chionanthus velutinus, Connarus semidecandrus, and Amomum biflorum*. The typical species of bamboo found in the area is *Gigantochloa albociliata.*

IUCN Listed Species

A total of thirteen species of plants listed as critically endangered, endangered or vulnerable under the IUCN Red List were recorded within the Project area during 2007 ERI and/or 2013 TISTR surveys. These include one species listed as critically endangered, seven as endangered and five as vulnerable (*Table 3.9*).

Table 3.9 IUCN Listed Flora Species recorded in the Project area

Scientific Names	Main Dam	Resettle-ment Site	Re-regula-tion Dam	Lower Nam Ngiep	Access Road	IUCN Status
Dipterocarpus turbinatus	✓		✓		✓	CR
*Aquilaria crassna**						CR
Afzelia xylocarpa	✓	✓	✓	✓	✓	EN
Anisoptera costata					✓	EN
Dalbergia oliveri	✓	✓	✓		✓	EN
Dipterocarpus alatus	✓			✓	✓	EN
Hopea ferrea	✓					EN
Shorea roxburghii	✓	✓		✓	✓	EN
Vatica cinerea					✓	EN
Cycas pectinata					✓	VU
Dalbergia cochinchinensis	✓				✓	VU
Hopea odorata	✓	✓	✓	✓	✓	VU
Syzygium vestitum				✓	✓	VU
Ternstroemia wallichiana	✓				✓	VU

IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable
✓ = Direct record; x = Indirect record
*Species included at request

3.2.3 Fauna Species

The main dam area was surveyed for fauna during the 2007 survey by ERI with additional data collected in 2013 by TISTR at eight key survey locations (including the candidate offsets sites).

The diversity of fauna in the main dam inundation area (upper Nam Ngiep) was high in comparison to other areas sampled in 2013 by TISTR. Habitats varied in condition with human disturbance evident in areas downstream of the main dam. The habitat and species detected at each of the main surveyed areas are summarised in *Table 3.10*. A full species list is provided in *Annex D*. Threatened species are discussed separately below.

Table 3.10 Fauna Habitat in the Surveyed Areas

Survey Location	Forest Type Description
Main Dam Site	The upper area of the Nam Ngiep River is dominated by primary forest. Site surveys detected (through interviews with villagers or direct observation) at least 46 mammals species, 50 bird species, 28 reptiles species and 10 amphibian species.
Resettlement Site	The resettlement area is mostly and heavily disturbed as a result of slash and burn activities. There is evidence of some regeneration and secondary growth. Site surveys detected (through interviews with villagers or direct observation) at least 9 mammals species, 24 birds species, 19 reptiles species and 8 amphibian species.

Survey Location	Forest Type Description
Lower Nam Ngiep	This area is mostly disturbed and dominated by agricultural landuse. There is high human activity in this area. Site surveys detected (through interviews with villagers or direct observation) at least 12 mammals species, 27 birds species, 21 reptiles species and 7 amphibian species.

Restricted Species

Species listed as Restricted under the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF includes wild animals and fish which are rare, endangered, high conservation value, and special significance to the economy and national environment.

The Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF identifies wildlife into two categories, restricted species (List I), and protected species (List II). Restricted species are wild species which are rare, endangered, high conservation value and species significance to the economy/society and national environment in Lao. Activities relating to this group require permission from the Lao Ministry of Agriculture and Forestry.

A number of these species were recorded during field surveys in the Project area undertaken by ERI (2007) and TISTR (2013). Species listed as Restricted are considered candidates for critical habitat (Section *3.5*).

The recent surveys (TISTR 2013) in main dam site (upper Nam Ngiep), lower Nam Ngiep, resettlement site and access road detected the following terrestrial species listed as restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF:

- fifteen mammal species;
- six bird species;
- three reptiles; and
- no amphibians.

Annex F shows the results.

Table 3.11 No. 0360/MAF Restricted Fauna Species Reported

Common Name	Scientific Name	No. 060/MAF Status	IUCN Status	Main Dam	Re-settlement Site	Re-regulation Dam	Lower Nam Ngiep	Access Road
Mammals								
Asian small-clawed otter	*Aonyx cinera*	R	VU	x				
Golden jackal	*Canis aureus*	R	LC	x				
Southwest China serow	*Capricornis milneedwardsii*	R	NT	✓				
Dhole	*Cuon alpinus*	R	EN	x				
Sun bear	*Helarctos malayanus*	R	VU	x				x
Smooth-coasted otter	*Lutrogale perspicillata*	R	VU	x				
Northern white-cheeked gibbon	*Nomascus leucogenys*	R	CR	✓				
Bengal slow loris	*Nycticebus bengalensis*	R	VU	x				
Pygmy slow loris	*Nycticebus pygmaeus*	R	VU	x				
Leopard	*Panthera pardus*	R	NT	x				x
Tiger	*Panthera tigris*	R	EN	x				
Asiatic golden cat	*Pardofelis temminckii*	R	NT	x				x
Leopard cat	*Prionailurus bengalensis*	R	LC	x				
Sambar deer	*Rusa unicolor*	R	VU	✓				x
Himalayan black bear	*Ursus thibetanus*	R	VU	x				
Birds								
Greater hornbill	*Buceros bicornis*	R	NT					x
Greater coucal	*Centropus sinensis*	R	LC	✓	✓	✓	✓	✓
Siamese fireback	*Lophura diardi*	R	LC					x
Silver pheasant	*Lophura nycthemera*	R	LC	✓				x
Grey peacock-pheasant	*Polyplectron bicalcaratum*	R	LC					x
Red-breasted parakeet	*Psittacula alexandri*	R	LC					✓

Common Name	Scientific Name	No. 060/MAF Status	IUCN Status	Main Dam	Re-settlement Site	Re-regulation Dam	Lower Nam Ngiep	Access Road
Reptiles								
Reticulated python	*Broghammerus reticulatus*	R		✓	x		x	x
King cobra	*Ophiophagus hannah*	R	VU	x			x	
Big-headed turtle	*Platysternon megacephalum*	R	EN	x				x

IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable; NT – Near Threatened; LC – Least Concern

✓ = Direct record; x = Indirect record

IUCN Listed Species

The fauna species have been categorised by the IUCN (2012) and a number listed on the IUCN Red List have been recorded within the Project area. The 2013 (TISTR) surveys recorded one species, the Northern white-cheeked gibbon listed as critically endangered within the Project area at the main dam area. A number of other species were reported through indirect records. Species listed as critically endangered or endangered are considered candidates for critical habitat and these species records have been investigated further in *Section 3.5*.

Overall, the direct and indirect records identified:

- Twenty-one mammal species (1 critically endangered, 7 endangered, 13 vulnerable);
- Five bird species (1 critically endangered, 2 endangered, 2 vulnerable);
- Nine reptile species (2 endangered, 7 vulnerable);
- No amphibian species.

Table 3.12 summarises the species recorded.

Table 3.12 IUCN Fauna Species reported within the Project area

Family/Common Name	Scientific Name	2012 EIS		TISTR Survey				IUCN Status
		Inside Project area	Outside Project area	Upper Nam Ngiep	Lower Nam Ngiep	Huay Ngua	Resettlement Site	
MAMMALS								
Northern white-cheeked gibbon	*Nomascus leucogenys*			✓				CR
Dhole	*Cuon alpinus*	x	x	x				EN
Asian elephant	*Elephas maximus*	x	x			x		EN
Sunda pangolin	*Manis javanica*	✓	x	x			x	EN
Tiger	*Panthera tigris*	x	x	x				EN
Fishing cat	*Prionailurus viverrinus*	x	x			x		EN
Red-shanked douc langur	*Pygathrix nemaeus*		x					EN
Phayre's leaf monkey	*Trachypithecus phayrei*	x	x	x				EN
Asian small-clawed otter	*Aonyx cinerea*			x				VU
Binturong	*Arctictis binturong*	x	x	x				VU
Gaur	*Bos gaurus*	x	x			x		VU
Sun bear	*Helarctos malayanus*		x	x		x		VU

Family/Common Name	Scientific Name	2012 EIS		TISTR Survey				IUCN Status
		Inside Project area	Outside Project area	Upper Nam Ngiep	Lower Nam Ngiep	Huay Ngua	Resettlement Site	
Smooth-coated otter	*Lutrogale perspicillata*			x				VU
Stump-tailed macaque	*Macaca arctoides*	x	x	x				VU
Northern pig-tailed macaque	*Macaca leonina*			x				VU
Clouded leopard	*Neofelis nebulosa*					x		VU
Bengal slow loris	*Nycticebus bengalensis*	x	x	x				VU
Pygmy slow loris	*Nycticebus pygmaeus*	x	x	x				VU
Sambar	*Rusa unicolor*	✓	x	x		x		VU
Himalayan black bear	*Ursus thibetanus*	✓	x	x		x		VU
Large spotted civet	*Viverra megaspila*					x		VU
BIRDS								
White backed vulture	*Gyps bengalensis*		x					CR
White winged duck	*Cairina scutulata*		x			x		EN
Green peafowl	*Pavo muticus*					x		EN
Rufous-necked hornbill	*Aceros nipalensis*		x					VU
Imperial eagle	*Aquila heliaca*	✓	x			x		VU
REPTILES								
Elongated tortoise	*Indotestudo elongata*							EN
Big-headed turtle	*Platysternon megacephalum*			x		x		EN
Southeast Asian softshell turtle	*Amyda cartilaginea*			x	x		x	VU
Southeast Asian box turtle	*Cuora amboinensis*							VU
Snail-eating turtle	*Malayemys subtrijuga*			x			x	VU
Impressed tortoise	*Manouria impressa*					x		VU
Indo-Chinese spitting cobra	*Naja siamensis*			x	x		x	VU
King cobra	*Ophiophagus hannah*	x	x	x	x			VU
Siamese temple turtle	*Siebenrockiella crassicollis*			x				VU

IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable; NT – Near Threatened; LC – Least Concern

✓ = Direct record; x = Indirect record; blue x = noted within Huay Ngua PPA Area Management Plan

3.4 AQUATIC BIODIVERSITY VALUES

3.4.1 Hydrological Features

The proposed Project lies on the Nam Ngiep River which flows in a south-southeast direction through a mountainous region to the gorge at Hat Gniun village where the topography changes to a hilly landscape before entering the Mekong River at Pakxan. The gorge is the location for the proposed dam construction.

The flow regime of an aquatic ecosystem plays a role in the health and productivity of the system and for some species, flows can trigger movement during some periods. The Nam Ngiep River has a catchment area of 3700 km^2 with the river approximately 160 km in length (Kansai, 2012). Flows of the river are influenced by the monsoon dominated weather which divides the year into clearly defined wet and dry periods. Peak discharges (200-325 m^3/s) occur between June and September with lowest discharge volumes (50-75 m^3/s) in February to April.

Upstream of the main dam site is mountainous terrain with intermittent narrow plains which are inhabited. High mountains are found on both sides of the Nam Ngiep River and tributaries, providing continuous supply of large amounts of water throughout the year.

Between the main dam and the re-regulation dam, the terrain on both sides of the river widens and consequently forms flatter plains. Downstream of the re-regulation dam, the terrain is predominately flat and slopes gradually towards the Mekong River. In this area, the Nam Ngiep River runs parallel to the Nam Xan before it merges with the Mekong River at Pakxan.

3.4.2 Aquatic Habitats

Aquatic riverine and tributary habitats were assessed during TISTR 2012 site surveys. Seasonal variation was observed in terms of water depth, clarity, flow and wetted width. Habitat characteristics recorded are summarised in *Table 3.13*.

In general, river habitats were fast flowing with greater water depth and flows during the wet season. Dry season river habitats exhibited riffle zones which were flooded during the wet season. The river bed was generally dominated by sand and gravel. Villagers use the river environment for fishing and other activities and cattle were observed in the waterbody.

Tributary habitats were surveyed in the Upper Nam Ngiep River and Resettlement Area (as well as Huay Ngua PPA). These habitats were generally shallower and slower flowing than riverine habitats with some areas drying to isolated pools in the dry season.

Aquatic plants were not recorded at all sites and when recorded were noted to be sparse.

Table 3.13 Aquatic Ecology Sampling Area Habitat Characteristics

Sampling Area	Aquatic habitat features
Main Dam Site (Upper Nam Ngiep) Dry Season  Wet Season  **Lower Nam Ngiep** Dry Season  Wet Season 	• main river and tributary habitats • in tributary areas, the watercourse is dried to small pools in the dry season • the main river current flows rapidly in the wet and dry season • river depth in dry season 1-3m (shallower in riffle zone where water flows fastest), wet season 3-5m • river bed is sand and gravel with some boulders • aquatic plants present sparsely • water level is high during the wet season flooding all banks and vegetation • riparian zone is mainly original forest with agriculture close to communities • water is clear with greenish brown colour in the dry season, turbid and reddish brown in the wet season • surrounding landuse is agriculture and communities • Villagers use waterbody for fishing, cattle swim • main river habitat • river depth in dry season 2-3 m (shallower in riffle zone where water flows fastest), wet season 4-5m depth • width of the river is approximately 50-100 m in dry season, 100-150 during wet season • river bed is sand and small gravel • aquatic plants present sparsely on the river bank in the dry season • water is turbid and reddish brown in wet season • riparian zone is mainly covered by big trees and bamboos • upper zone has communities where people and cattle share the river in terms of swimming and washing. People always fishing

Sampling Area		Aquatic habitat features
Resettlement Area Dry Season 	Wet Season 	• tributary habitat • water is approximately 1m depth in the dry season and 5m wetted width • bed is clay • no aquatic plants • riparian zone is covered by big trees left after shifting and burning • landuses around the creek are agricultural areas, and secondary growth

3.4.3 Aquatic Biota

Fish

The fish community of the Mekong River is one of the largest in the world with most of the production based on migratory river species (Poulsen *et al*., 2004). Fish migration is an important component for many fish species life cycle. In the Mekong catchment, fish migration can be generally described in terms of (Poulsen *et al*., 2004):

- Annual movement between inundated floodplains (where most fish production originates) and dry season refuges;
- Movement into spawning areas within the river system (usually upstream) from dry season refuges, generally upon start of flooding; and
- Passive migration of fish fry downstream from spawning areas.

During the 2007 ERI survey of the main dam site, 42 species were detected. The community detected included relatively similar proportion of surface feeder, column feeder and bottom feeder species. Survey within the main dam area during the 2013 TISTR survey detected 75 species.

The EIA noted that the fish community detected by ERI in 2007 contains species common to the Mekong tributaries and was dominated by Cyprinid species. Cyprinid family species were reported to adapt to different environmental in various sections of the river, and this family was also the dominant group detected during the 2013 TISTR survey. The ERI 2007 assessment also noted that of the larger species detected many are migratory species of the lower Mekong basin that move upstream during the wet season spawning activities (EIA citing Poulsen *et al.,* 2004). These larger species, such as mud carp (*Cirrhinus molitorella*) and Asian red tailed catfish *(Hemibagrus wyckioides*) were detected in 2007 and 2013 surveys. The surveys noted a number of juvenile individuals of the migratory species suggesting that the Nam Ngiep River plays a role in providing habitat for the reproductive cycle (EIA citing Lowe-McConnell, 1995). Species detected in 2007 in juvenile phase included Mackerel barb (*Opsarius pulchellus*), Swamp barb (*Puntius brevis*), *Rasbora borapetersis*, Slender rasbora (*Rasbora danioconius*), Salmon carp (*Raimas guttatus*) and *Poropuntius spp*.

A full species list is provided in *Annex E.*

An additional field survey is planned to support the data collected and assist in the determination of critical habitat for fish species. The results of this study will be used to update this report and the impact assessment.

IUCN Listed Species

Aquatic surveys across the Project area detected nine species listed as critically endangered, endangered or vulnerable on the IUCN Red List (summarised in *Table 3.14*). Species listed as critically endangered or endangered are considered candidates for critical habitat and these species records have been queried further in *Section 3.5*. Species listed a Restricted under the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF are also considered candidates for critical habitat and as such *Wallago leeri* has also been included as a candidate species.

Table 3.14 IUCN Listed Fish Species reported within the Project area

Family/Common Name	Scientific Name	2012 EIS		TISTR Survey				IUCN Status
		Inside Project area	Outside Project area	Upper Nam Ngiep	Lower Nam Ngiep	Huay Ngua	Resettlement Site	
Giant barb	*Catlocarpio siamensis*					x		CR
Leaping barb	*Laubuca caeruleostigmata*			13				EN
Striped catfish	*Pangasianodon hypothalamus*					x		EN
Yellow tail brook barb	*Poropuntius deauratus*			139	22	13	21	EN
Thicklipped barb	*Probarbus labeamajor*					x		EN
Mrigal carp	*Cirrhinus cirrhosus*				2			VU
Common carp	*Cyprinus carpio*							VU
Bandan sharp-mouth barb	*Scaphognathops bandanensis*					3		VU
Jaguar loach	*Yasuhikotakia splendida*				1	4		VU

IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable; NT – Near Threatened; LC – Least Concern
counts = Direct record; x = Indirect record; blue x = noted within Huay Ngua PPA Area Management Plan

3.5 IFC PS6 HABITAT CATEGORIES

Modified Habitat

Modified habitat is altered natural habitat, often formed by the removal of native species for harvesting, land conversion and/or introduction of alien flora and fauna species (ADB, 2012).

Land cover mapping for the Project area identified a number of vegetated cover classes. The grassland, old fallow land, young fallow land, rice paddy, slash and burn land, and urban classes are considered to be modified habitats. *Figure 3.1* shows the distribution of these modified landuses within the Project area.

Natural Habitat

Natural habitat is an environment where the biological communities are largely formed by native plant and animal species and where human activity has not modified the areas primary ecological functions (ADB, 2012).

Land cover mapping for the Project area identified a number of vegetation cover classes. The bamboo, deciduous forest and evergreen forest areas are considered to be natural habitats for the purposes of this assessment. *Figure 3.1* shows the distribution of these natural habitat landuses within the Project area. Bamboo is a native species in Lao however it is noted that it can be invasive and used for commercial purposes. For the purposes of this assessment, the precautionary approach has been applied and bamboo areas have been considered as natural habitat.

Critical Habitat

One of the key provisions of IFC PS 6 is the identification of 'Critical Habitat'. IFC PS6 defines critical habitats as areas with high biodiversity value, including (but not limited to) habitat of significant importance to critically endangered and/or endangered species. For this Project, threatened species with potential to occur have been considered as candidates for determination of critical habitat.

Specifically, critical habitat criteria form the basis of the determination (IFC PS6 Guidance Note). The criteria include:

- Criterion 1: Critically endangered and or endangered species (Tier 1 and Tier 2 sub-criteria for habitat for these species). Tier 1 sub-criteria relate to a proportion of the population and known and regular occurrences. Tier 2 sub-criteria relate to nationally/regionally important concentrations;

- Criterion 2: Endemic and/or restricted-range species (Tier 1 and Tier 2 sub-criteria for habitat for these species). Tier 1 and 2 sub-criteria relate to the proportion of the global population;

- Criterion 3: Migratory and/or congregatory species (Tier 1 and Tier 2 sub-criteria for habitat for these species). Tier 1 and 2 sub-criteria relate to the proportion of the global population;

- Criterion 4: Highly threatened and/or unique ecosystems;

- Criterion 5: Key evolutionary processes.

Assessment of the Project area has not identified any highly threatened and/or unique ecosystems, or key evolutionary processes. As such the assessment focusses on the relevance of Criterion 1-3. Each of the candidate species has been assessed for the critical habitat determination criteria 1-3 using the literature and field survey data collected in the Project area.

The species information was collated and analysed against the relevant critical habitat criteria (*Annex G*). A summary of the analysis is provided below. The species screened against the determination criteria and quantitative thresholds include IUCN listed species, species listed as Restricted in the Regulation of the Ministry of agriculture and Forestry No. 0360/MAF and species considered to be migratory.

Table.3.15 Candidate Species Critical Habitat Assessment Summary

Species	Criteria	Record		Likely Critical Habitat	Comment
		Direct	In-direct		
Afzelia xylocarpa	1	✓		No	Project area not of significant importance for the species.
Anisoptera costata	1	✓		NA	Not native to Lao PDR.
Dalbergia oliveri	1	✓		NA	Not native to Lao PDR.
Dipterocarpus alatus	1	✓		NA	Not native to Lao PDR.
Dipterocarpus turbinatus	1	✓		No	Project area not of significant importance for the species.
Hopea ferrea	1	✓		NA	Not native to Lao PDR.
Shorea roxburghii White meranti	1	✓		No	Project area not of significant importance for the species.
Vatica cinerea	1	✓		NA	Not native to Lao PDR.
Aonyx cinerea Asian small-clawed otter	1		✓	No	Key threats will require management.
Canis aureus Golden jackal	1		✓	No	Project area not of significant importance for the species.
Capricornis milneedwardsii Southwest China serow	1		✓	No	Project area not of significant importance for the species.
Cuon alpinus Dhole	1		✓	No	Project area not of significant importance for the species.
Elephus maximus Asian elephant	1		✓	No	Project area not of significant importance for the species.
Helarctos malayanus Sun bear	1		✓	No	Project area not of significant importance for the species.
Lutrogale perspicillata Smooth-coated otter	1		✓	No	Key threats will require management.
Manis javanica Sunda pangolin	1		✓	No	Key threat will require management.
Nomascus leucogenys Northern white-cheeked gibbon	1	✓		No	Project area not of significant importance for the species.
Nycticebus bengalensis Bengal slow loris	1		✓	No	Project area not of significant importance for the species.
Nyctocebus pygmeaeus Pygmy slow loris	1		✓	No	Project area not of significant importance for the species.
Panthera pardus Leopard	1		✓	No	Key threat will require management.
Panthera tigris Tiger	1		✓	No	Key threat will require management.
Pardofelis temminckii Asiatic golden cat	1		✓	No	Project area not of significant importance for the species.

Species	Criteria	Record		Likely Critical Habitat	Comment
		Direct	In-direct		
Prionailurus bengalensis Leopard cat	1		✓	No	Project area not of significant importance for the species.
Prionailurus viverrinus Fishing cat	1		✓	No	Project area not of significant importance for the species.
Pygathrix nemaeus Red shanked douc langur	1		✓	No	Project area not of significant importance for the species.
Rusa unicolor Sambar	1		✓	No	Project area not of significant importance for the species.
Trachypithecus phayrei Phayre's leaf monkey	1		✓	No	Project area not of significant importance for the species.
Ursus thibetanus Himalayan black bear	1		✓	No	Project area not of significant importance for the species.
Aceros undulates Wreathed hornbill	1		r	No	Project area not of significant importance for the species.
Buceros bircornis Great hornbill	1		✓	No	Project area not of significant importance for the species.
Cairina scutulata White winged duck	1		✓	No	Project area not of significant importance for the species.
Centropus sinensis Greater coucal	1	✓		No	Project area not of significant importance for the species.
Gyps bengalensis White backed vulture	1		✓	NA	Unreliable record.
Lophura diardi Siamese fireback	1		✓	No	Project area not of significant importance for the species.
Lophura nycthemera Silver pheasant	1		✓	No	Project area not of significant importance for the species.
Pavo muticus Green peafowl	1		✓	No	Project area not of significant importance for the species.
Polyplectron bicalcaratum Grey peacock pheasant	1		✓	No	Project area not of significant importance for the species.
Psittacula alexandri Red-breasted parakeet	1		✓	No	Project area not of significant importance for the species.
Anhinga melanogaster Darter	1		✓	No	Project area not of significant importance for the species.
Ichthyophaga humilis Lesser fish eagle	1		✓	No	Project area not of significant importance for the species.
Broghammerus reticulatus Reticulated python	1		✓	No	Project area not of significant importance for the species.
Indotestudo elongate Elongated tortoise	1		r	No	Project area not of significant importance for the species.
Ophiophagus hannah King cobra			✓	No	Project area not of significant importance for the species.
Platysternon megacephalum Big-headed turtle	1		✓	No	Project area not of significant importance for the species.
Catlocarpio siamensis Giant barb	1,3		✓	Pending	Further village survey being undertaken
Laubuca caeruleostigmata Leaping barb	1,3	✓		Pending	Verification survey being undertaken

Species	Criteria	Record		Likely Critical Habitat	Comment
		Direct	In-direct		
Pangasianodon hypophthalmus Striped catfish	1,3		✓	Pending	Further village study being undertaken
Poropuntius deauratius Yellow tail brook barb	1	✓		No	Species misidentification. Verification survey being undertaken
Probarbus labeamajor Thicklipped barb	1,2,3		✓	No	Project area not of significant importance for the species.
Yasuhikotakia splendida Jaguar loach	2	✓		Pending	Verification survey being undertaken
Wallago leeri	2		✓	Pending	Verification survey being undertaken
Migratory fish species	3	✓		Pending	Indirect impacts require management to downstream habitats
r = species included at request					

3.6 SOCIO-ECONOMIC AND CULTURAL VALUES

It is evident that villagers in the Project area regularly use local terrestrial and aquatic biodiversity – e.g. as a food source. However, the dependence on natural resources varies by village and is largely associated with accessibility. For example, remote villages tend to rely more heavily on medicinal plants as access to pharmaceuticals is limited.

The following section describes the uses and cultural values placed on (and/ or associated with) biodiversity by local villagers in the Project area. Much of the data is from village and market surveys undertaken by ERM in February and March 2013. *Annex F* contains the results of the socio-economic survey.

3.6.1 *Hunting and Gathering*

Villagers, both Loa and Hmong people, hunt and gather. This is done primarily for household consumption. However, when surplus exists, it is sold within the village or neighbouring villages.

Although the norm is to consume the materials locally, there are a small number of species that are collected for sale. Access to markets from villages is limited due poor road access, so external sales are to intermediaries who travel to the villages.

Hunting for small animals is common across all villages. Villagers rarely admitted to hunting larger animals as all were aware this is illegal. Bamboo traps are predominantly used for capturing squirrels and rats, though hunting dogs, firearms and knives are also reportedly used.

Hmong families tend to hunt together while lowland Lao hunt individually or in small groups of either men or women. Hunting activity is no longer a daily activity, and is only triggered when a change from chicken or fish is desired or a ceremony requires it (i.e. a wedding or Hmong New Year). Villagers will generally travel as far as the need to hunt and gather though based on survey data this is unlikely to be further than 3-5 kilometres from the village (i.e. walking distance).

Villagers have noted that availability of naturally occurring resources, especially forest animals and fish, has been declining in recent years.

3.6.2 Medicinal Plants and Materials

Usage, and therefore dependence, appears to be predicated on access to health services - the easier the access to pharmaceuticals, the lower the usage of natural medicines. In the Project area, villages have indicated a preference for pharmaceuticals but said natural medicines were generally used in the first instance.

3.6.3 Timber Products

Timber products are actively sourced from the forests by villagers and commercial operators. For instance the local villagers were observed sourcing and processing hardwood into planks near the proposed dam site.

3.6.4 Fishing

When compared to hunting, fishing occurs on a more regular basis. This is largely because of the close proximity of villages to waterways.

Fishing may have been more important for income generation in earlier times though with greater availability of alternative protein sources and reported reduction in stock availability and size, villages have adapted.

Fish is generally caught only for household consumption, but it is also a common item used in inter-household exchange and transactions. Surplus fish tends to be sold at below market rates suggesting such transactions may more likely be part of a local gift economy rather than a commercial transaction. This being said, it was common to hear that small fish are eaten at home while big fish, when found, are sold.

The most common fishing method is with a cast weighted net, an item commonly seen in most houses. Larger nets are used during the rainy season to catch larger fish that swim up river from the Mekong River. At Hatsaykham, the survey team observed other methods such as scaring fish into a net hung across a short section of the river and gathering by hand. Other equipment observed in villages included lines, hooks and spear guns. Fishing takes place at established riverside sites at which small shelters are built.

3.6.5 Cultural Services

Most of the villages surveyed in the Project area have been settled only relatively recently signalling a lesser dependence on cultural services provided within proximate ecosystems. While length of residence is not an exclusive factor in determining usage and dependence, the less time people have to form attachments to aspects of an ecosystem, the less significant these features are likely to be. Indeed the relatively new nature of the villages acts to sever any bonds that people may have with prehistoric features within the environment such as tangible objects (i.e. stone tools, brass or ceramic objects) and intangible knowledge (i.e. creation myths or site specific rituals). This is not to say that the cultural values villagers derive from the ecosystem are insignificant, it is to signal that what values they do use are likely severable and reproducible elsewhere.

Numerous locally collected polished stone tools have been found in the Project area indicating human occupation in the area occurred between 4,000 and 12,000 years ago. However, most of the existing villages were settled in the early-1980s and 1990s.

The most significant social, religious and cultural sites people were able to identify (during the surveys) in villages in the Project area were grave sites. Reflecting the severable nature of connections people have with grave sites, villagers indicated that the ancestor spirits associated with such grave sites are transferrable to a new location through the performance of a complex ceremony conducted by the village shaman (called a Yao in the surveyed villages).

Each of the Hmong villages visited in the lower reservoir zone had a shaman residing there. Each house has a small shrine that is used by the shaman for ceremonies. The shaman is essentially a conduit between the human and spirit worlds. Sickness among Hmong is believed to be the result of contact with evil spirits. At risk of overgeneralising, the shaman's role is to free a person's spirit (or soul) from the malevolence brought through this contact with spirit world. The shaman was identified in these villages as the person most dependent on the naturally occurring forest though little detail was able to be collected about the extent of this dependence.

Naturally occurring bamboo is used by both Lao and Hmong to make an animist symbol that is hung above doorways to ward off evil spirits.

4 CANDIDATE BIODIVERSITY OFFSET SITES

4.1 OVERVIEW

This section discusses the biodiversity values of each of four candidate offset sites which have been proposed for this Project including parts of the Nam Ngiep catchment (Upper Nam Ngiep), stretches of the Nam Xan River between Nam Lao and Bolikhan, the Hauy Ngua PPA and Phou Khao Kouay Protected Area (PKK) (*Figure 4.1*). The candidate offset sites have been described such that their ecological suitability to provide a biodiversity offset can be assessed. The suitability assessment is documented in the Biodiversity Offset Design Report for the Project.

250000
300000
350000
400000
2150000
2100000
2050000

Legend

- Catchment Boundary
- Waterbody
- Road
- City or Town
- Lao PDR Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Candidate Offset Sites:

- Nam Ngiep Offset Area
- Huay Ngua Provincial Protected Area
- Phou Khao Khouay National Protected Area
- Nam Xan Offset - River Centreline

N

0 10 20 30Km

1:600,000

Basemap: ESRI World Imagery
Datum: WGS84

Phoukout
Nonghet
Phonsavan
Muang Khoun
Phaxai
Nam Ngum
Nam Ngiep
Nam Ngiep Catchment
Thathom
Nam Xan Catchment
Vang Vieng
Nam Song Diversion
Nam Ngum 2 Reservoir
Nam Xan
Hinheup
Ba. Donkha
Nam Ngum Reservoir
Longxan
Thinkeo
Phonhong
Nam Leuk reservoir
Nam Mang 3 Reservoir
Pakxan
Ban Keun
Mekong River
Hai
Tha Ngon

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_BIODIV_G007a_R0.mxd	
Date:	17/01/2014	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 4.1 - Map of Offset Sites

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

4.2 UPPER NAM NGIEP

4.2.1 Overview

The biodiversity values of the Upper Nam Ngiep investigation area are similar to those described in the Project area (*Section 3*). Sampling locations for the baseline field surveys in 2007 and 2013 were restricted to adjacent to the waterway and, as such, it is considered that many terrestrial species detected during these surveys may utilise the habitats outside the inundation area and in the wider Nam Ngiep catchment area. Many of the fauna species identified during survey are highly mobile and habitat preferences are not restricted to riparian areas. These species have potential to move to forested and other natural habitats locally.

4.2.2 Vegetation

Land Cover

Using land cover mapping (DFRM, 2010), natural and modified habitats, in accordance with IFC definition, can be identified within the Upper Nam Ngiep candidate offset site. The Upper Nam Ngiep is dominated by natural habitat (76 per cent) with almost half of the area deciduous forest land cover. There is limited urban area. *Table 4.1* summarises the land cover shown in *Figure 4.2* and identifies the habitat category of each land cover type.

Table 4.1 Land Cover within the Upper Nam Ngiep Candidate Offset Site

Land Cover	IFC Habitat Class	Total Area (ha)	% of Total
Deciduous Forest	Natural	59,078	46%
Evergreen Forest	Natural	37,666	30%
Bamboo	Natural	5,735	5%
Old Fallow Land	Modified	15,165	12%
Young Fallow Land	Modified	3,496	3%
Slash and Burn	Modified	1,500	1%
Rice Paddy	Modified	169	<1%
Water	-	122	<1%
Grassland	Modified	3,900	3%
Urban Area	Modified	7	<1%
Rock	Natural	161	<1%
Cloud	-	30	<1%
Shadow	-	149	<1%
	Total	**127,178**	

Forestry Classification Mapping

Forestry classification mapping identifies both protection forest and production forest in the Upper Nam Ngiep. *Figure 4.3* depicts the extent of protected and production forest and shows that greater than half of the offset site is mapped as National Protected Forest.

Vegetation Condition

The NDVI across the Upper Nam Ngiep is shown in *Figure 4.4* and the area of each classification is summarised in *Table 4.2*.

Over 96 per cent of the Project area is classified as moderate or high NDVI. Almost 65 per cent of the area is mapped as high NDVI. Less than 1 per cent of the area is classified as impacted NDVI.

Table 4.2 Vegetation Condition within the Upper Nam Ngiep Candidate Offset Site

Forest type	Impacted (- to 0)	Low (0 - 0.4)	Moderate (0.4 - 0.6)	High (0.6 - 0.8)
Deciduous Forest	16	1209	19,614	38,240
Evergreen Forest	11	1008	13,447	23,200
Old Fallow Land	2	370	3148	11,643
Young Fallow Land	2	265	1493	1735
Bamboo	5	181	1526	4021
Slash and Burn	4	556	551	389
Rice Paddy	2	106	53	9
Water	52	39	21	9
Grassland	6	412	1913	1569
Urban Area	0	6	1	0
Rock	0	65	87	9
Cloud	0	4	17	10
Shadow	4	57	72	16
Total (ha)	**104**	**4278**	**41943**	**80850**
% of Total	**<1%**	**3%**	**33%**	**64%**

Thathom

Legend

- Nam Ngiep Sub-catchment Boundary
- Watercourse
- City, Town or Village

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Land Cover:

- Evergreen Forest (Current Forest)
- Deciduous Forest (Current Forest)
- Bamboo (Potential Forest)
- Old Fallow Land (Potential Forest)
- Young Fallow Land (Potential Forest)
- Slash and Burn Land (Potential Forest)
- Rice Paddy
- Grassland
- Rock
- Urban Area
- Water
- Cloud
- Shadow

N

0 2.5 5 7.5Km

1:200,000

Basemap Bing Maps
Datum: WGS84

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_BIODIV_G008_R0.mxd	
Date:	11/09/2013	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

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Figure 4.2 - Land Cover within the Upper Nam Ngiep Candidate Offset Site

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch,
Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

310000 320000 330000 340000 350000

2120000 2110000 2100000 2090000 2080000 2070000 2060000 2050000

Nam Ngiep

Thathom

Nam Xan

Legend

- Nam Ngiep Catchment Boundary
- Road
- Watercourse
- City, Town or Village
- Proposed Access Road

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area

Forest Zone:

- National Protection Forest
- Production Forest

N

0 2.5 5 7.5Km

1:200,000

Basemap: Bing Maps

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_BIODIV_G009_R0.mxd	
Date:	10/09/2013	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 4.3 - Forestry Classification Mapping within the Upper Nam Ngiep

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

310000 320000 330000 340000 350000

2120000 2110000 2100000 2090000 2080000 2070000 2060000 2050000

Nam Ngiep

Thathom

Nam Xan

Legend

- Nam Ngiep Catchment Boundary
- Waterbody
- Road
- City, Town or Village
- Lao PDR Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Condition Class:

- High
- Moderate
- Low
- Impacted

N

0 2.5 5 7.5Km

1:200,000

Basemap Bing Maps
Datum: WGS84

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_BIODIV_G010_R0.mxd	
Date:	10/09/2013	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

Figure 4.4 - Vegetation Condition within the Upper Nam Ngiep Candidate Offset Site

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch,
Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

4.2.3 *Flora Species*

As described, the Upper Nam Ngiep is the area adjacent to the main dam site and re-regulation dam site areas which have been surveyed (see Section *3.2.2*). The land cover mapping shows similar vegetation covers across the catchment area and, as such, it is likely that many flora species recorded during surveys (2013) within the Project area will also occur within the wider Upper Nam Ngiep area.

Deciduous forest types were recorded during Project area surveys and this vegetation is likely to be similar to the Upper Nam Ngiep. The deciduous forest types were present in terms of mixed deciduous forest and lower mixed deciduous forest at the main dam site and re-regulation dam site. The dominant species recorded within these forest types during the 2013 survey by TISTR within the Project area are summarised in *Table 4.3* and are considered likely to occur within the Upper Nam Ngiep.

Table 4.3 Dominant Flora Species in vegetation communities similar to the Upper nam Ngiep Candidate Offset Site

Canopy class	Dominant species
Mixed Deciduous Forest	
Top canopy (20-35m)	*Pometia pinnata, Duabanga grandiflora, Lagerstroemia calyculata, Toona ciliata, Pterospermum diversifolium.*
Middle canopy (10-15m)	*Nephelium hypoleucum, Mitrephora tomentosa, Baccaurea ramiflora, Saracia indica, Arenga weaterhoutii.*
Lower canopy (<10m)	saplings and seedling of the higher canopies
Lower Mixed Deciduous Forest	
Top canopy (~10m)	*Macaanga denticulata, Maesa ramentacea, Milletia acutiflora, Lagerstoemia calyculata.* The common species of bamboo found in the area, which are *Gigantochloa albociliata, Pseudostachyum polymorphum, Bambusa bambos.*

IUCN Listed Species

A total of nine species of plants listed as critically endangered, endangered or vulnerable under the IUCN Red List were identified within the upper Nam Ngiep area during 2007 and/or 2013 surveys. These include one species listed as critically endangered, five as endangered and three as vulnerable (*Table 4.4*).

Table 4.4 IUCN Listed Flora Species recorded in the Upper Nam Ngiep Candidate Offset Site

Scientific Names	IUCN Status
Dipterocarpus turbinatus	CR
Afzelia xylocarpa	EN
Dalbergia oliveri	EN

Scientific Names	IUCN Status
Dipterocarpus alatus	EN
Hopea ferrea	EN
Shorea roxburghii	EN
Dalbergia cochinchinensis	VU
Hopea odorata	VU
Ternstroemia wallichiana	VU
IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable	

4.2.4 Fauna Species

As identified for the flora species, many of the fauna species detected during TISTR surveys of the main dam site have potential to utilise the habitat of the Upper Nam Ngiep. The diversity of fauna is expected to be high given the large intact area of habitat and the results obtained from surveys of the Project area. The Upper Nam Ngiep River is dominated by primary forest. The fauna habitat in this area is in good condition in comparison to other areas surveyed. Site surveys during 2013 (TISTR) detected (through interviews with villagers or direct observation) at least 46 mammals species, 50 bird species, 28 reptiles species and 10 amphibian species.

IUCN Listed Species

The fauna species have been categorised by the IUCN (2012) and a number have been recorded within the Project area. The 2013 TISTR surveys recorded one species, the Northern white-cheeked gibbon (*Nomascus leucogenys*) listed as critically endangered within the Project area and as such it is considered possible these species may also inhabit the Upper Nam Ngiep.

Overall, the direct and indirect records identified:

- Twenty-one mammal species (1 critically endangered, 7 endangered and 13 vulnerable);
- Five bird species (1 critically endangered, 2 endangered and 2 vulnerable);
- Nine reptile species (2 endangered and 7 vulnerable); and
- No amphibian species.

Table 4.5 summarises the species recorded.

Table 4.5 ***IUCN Fauna Species reported within the Upper Nam Ngiep Candidate Offset Site***

Family/Common Name	Scientific Name	Direct Record	Indirect Record	IUCN Status
MAMMALS				
Northern white-cheeked gibbon	*Nomascus leucogenys*	✓		CR
Dhole	*Cuon alpinus*		✓	EN
Asian elephant	*Elephas maximus*		✓	EN
Sunda pangolin	*Manis javanica*		✓	EN
Tiger	*Panthera tigris*		✓	EN
Fishing cat	*Prionailurus viverrinus*		✓	EN
Red-shanked douc langur	*Pygathrix nemaeus*		✓	EN
Phayre's leaf monkey	*Trachypithecus phayrei*		✓	EN
Asian small-clawed otter	*Aonyx cinerea*		✓	VU
Binturong	*Arctictis binturong*		✓	VU
Gaur	*Bos gaurus*		✓	VU
Sun bear	*Helarctos malayanus*		✓	VU
Smooth-coated otter	*Lutrogale perspicillata*		✓	VU
Stump-tailed macaque	*Macaca arctoides*		✓	VU
Northern pig-tailed macaque	*Macaca leonina*		✓	VU
Bengal slow loris	*Nycticebus bengalensis*		✓	VU
Pygmy slow loris	*Nycticebus pygmaeus*		✓	VU
Sambar	*Rusa unicolor*		✓	VU
Himalayan black bear	*Ursus thibetanus*		✓	VU
BIRDS				
White backed vulture	*Gyps bengalensis*		✓	CR
White winged duck	*Cairina scutulata*		✓	EN
Rufous-necked hornbill	*Aceros nipalensis*		✓	VU
Imperial eagle	*Aquila heliaca*		✓	VU
REPTILES				
Big-headed turtle	*Platysternon megacephalum*		✓	EN
Southeast Asian softshell turtle	*Amyda cartilaginea*		✓	VU
Snail-eating turtle	*Malayemys subtrijuga*		✓	VU
Indo-Chinese spitting cobra	*Naja siamensis*		✓	VU
King cobra	*Ophiophagus hannah*		✓	VU
Siamese temple turtle	*Siebenrockiella crassicollis*		✓	VU

IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable.

4.3 NAM XAN

4.3.1 Overview

The Upper Nam Xan River, on the west bank of the river, is covered by primary forest, deciduous forest. On the east bank of the river is the production forest, where the larger trees have been previously harvested and there is evidence of re-succession recovery. There are stretches of the river that are currently mostly vegetated with a relatively low population density, poor vehicular access, and steep riparian terrain.

The Nam Xan candidate offset site has been the subject of consultation with Lao PDR representatives and following consultation the option of this area as use for offsetting has been discounted. The area is predominantly mapped as production forest which is an important resource for Lao PDR and unlikely to be suitable for conversion to reserve status.

Field surveys collected some species information summarised below however it is unlikely this site will be investigated further.

4.3.2 Flora

The Nam Xan River area consists of upper mixed deciduous forest, mixed with dry evergreen forest species in the upper area. Canopy cover in the upper Nam Xan area recorded 80-90 per cent while the lower Nam Xan area recorded 50-60per cent canopy cover. Surveys undertaken by TISTR in the area in 2013 identified at least 468 species.

For the forest types the forest canopies are divided in 3 classes. The dominant species for each survey (2013) locations are summarised in *Table 4.6*.

Table 4.6 Dominant Flora Species in Nam Xan Candidate Offset Site

Canopy class	Dominant species
Upper Nam Xan River Upper Mixed Deciduous Forest	
Top canopy (22-30m)	Consists of large trees such as *Palaquium poilanei*, *Duabanga grandiflora*, *Pterospermum litorale*, *Lagerstroemia calyculata*,
Middle canopy (8-15m)	Contains saplings of the higher canopy or small trees such as *Crateva magna*, *Alanqium chinense*, *Shorea roxburghii*, *Vatica ordorata*,
Lower canopy (<15m)	Saplings and seedling of the trees in the higher canopies, for example, *Elaeocarpus sphaericus*, *Litsea glutinosa*, *Baccaurea ramiflora*, *Sterospermum fimbriatum*
Lower Nam Xan River Disturbed Mixed Deciduous Forest	
Top canopy (20-30m)	*Lagerstroemia calyculata, Tetrameles nudiflora*, *Hopea ferrea*, *Castanopsis argyrophylla*, *Garuga pinnata*, *Parkia sumatrana*, *Crudia chrysantha*, *Calleya atropurpurea, Toona ciliata*
Middle canopy (10-20m)	*Crateva magna*, *Trewia nudiflora*, *Carallia brachiata*, *Albizia lucida*, *Dalbergia cultrata*
Lower canopy (~10m)	Consist of saplings and seedling of the higher canopies. Some species belong to dry evergreen forest, such *as Murraya paniculata*, *Streblus ilicifolius*, *Leea rubra*, *Caryota mitis*

IUCN Listed Species

A total of ten plant species listed under the IUCN Red List were recorded during vegetation surveys in Nam Xan in 2013. These are shown in *Table 4.7.* This includes:

- Two species listed as critically endangered;
- Five species listed as endangered; and
- Three species listed as vulnerable.

Table4.7 IUCN Listed Flora Species Recorded within Nam Xan Candidate Offset Site

Scientific Names	Status
Aquilaria crassna	CR
Dipterocarpus turbinatus	CR
Afzelia xylocarpa	EN
Anisoptera costata	EN
Dalbergia oliveri	EN
Dipterocarpus alatus	EN
Shorea roxburghii	EN
Hopea odorata	VU
Morinopsis capillaris	VU
Ternstroemia wallichian	VU

4.3.3 Fauna

The upper Nam Xam area contains the second highest species diversity in comparison to the other surveyed areas during 2013 surveys (TISTR). A total of 123 species of wildlife including 39 species of mammals, 43 species of birds, 28 species of reptiles, and 13 species of amphibians. In this area the river bank is dominated by deciduous forest while the east bank is production forest where trees are being harvested.

The lower Nam Xan area recorded at least 110 species including 35 mammal species, 40 bird species, 24 reptile species and 11 species of amphibian.

Common fish species detected in the Nam Xan River during surveys in 2013 (TISTR) included Yellow tail brook barb (*Poropuntius deauratus*), Dwarf snakehead (*Channa gachua*), Swamp barb (*Puntius brevis*), Sikuk barb (*Sikukia gudgeri*) and Sidestripe rasbora (*Rasbora paviana*). Of these species the Dwarf snakehead, Swamp barb and Sikuk barb are known full migrant species.

A full species list is provided in *Annex D.*

Restricted Species

The recent surveys (TISTR 2013) in Nam Xan detected the following species listed in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF:

- Twenty-seven mammal species (12 restricted (List I), 15 protected (List II));
- Nine bird species (6 restricted (List I), 3 protected (List II));
- Nine reptiles (3 restricted (List I), 6 protected (List II));
- No amphibians.

Annex D provides a description of the results.

IUCN Listed Species

The recent surveys (TISTR 2013) in Nam Xan detected the following species listed as critically endangered, endangered or vulnerable on the IUCN Red List:

- Thirteen mammal species (1 critically endangered, 3 endangered and 9 vulnerable);
- Five reptiles (1 endangered and 4 vulnerable); and
- Four fish species (2 endangered and 2 vulnerable).

Table4.8 IUCN Listed Fauna Species Recorded within Nam Xan area

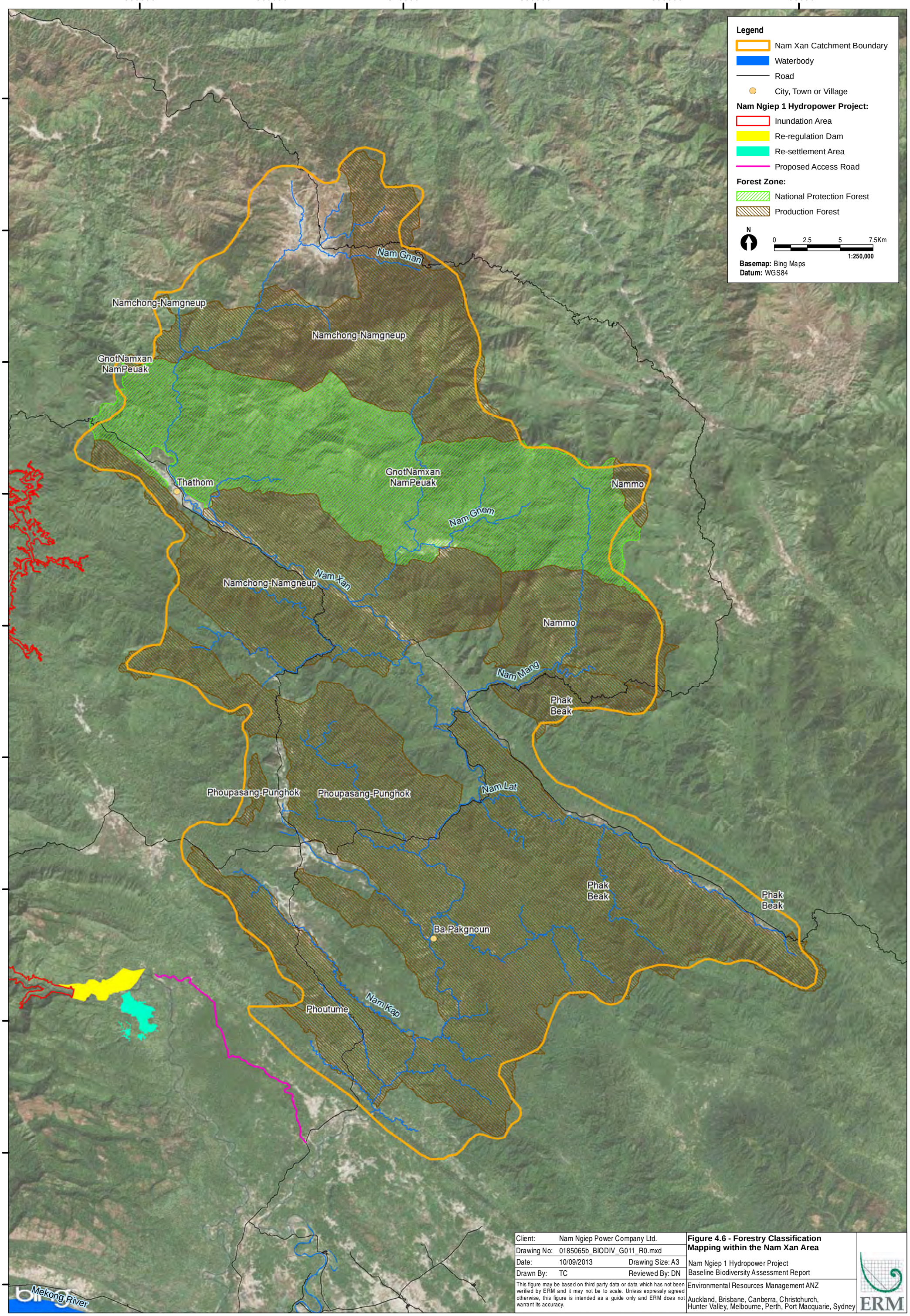
Common Name	Scientific Name	Direct Record	Indirect Record	IUCN Status
Mammals				
Northern white-cheeked gibbon	*Nomascus leucogenys*		✓	CR
Asian wild dog, dhole	*Cuon alpinus*	✓		EN
Sunda pangolin	*Manis javanica*		✓	EN
Phayre's leaf monkey	*Trachypithecus phayrei*		✓	EN
Asian small-clawed otter	*Aonyx cinerea*		✓	VU
Binturong	*Arctictis binturong*	✓		VU
Sun bear	*Helarctos malayanus*	✓		VU
Smooth-coated otter	*Lutrogale perspicillata*		✓	VU
Stump-tailed Macaque	*Macaca arctoides*		✓	VU
Northern pig-tailed macaque	*Macaca leonina*		✓	VU
Bengal slow loris	*Nycticebus bengalensis*		✓	VU
Pygmy slow loris	*Nycticebus pygmaeus*		✓	VU
Sambar deer	*Rusa unicolor*	✓		VU
Reptiles				
Elongated tortoise	*Indotestudo elongata*		✓	EN
Southeast Asian softshell turtle	*Amyda cartilaginea*		✓	VU
Southeast Asian box turtle	*Cuora amboinensis*		✓	VU
King cobra	*Ophiophagus hanah*	✓		VU
Siamese temple turtle	*Siebenrockiella crassicollis*		✓	VU

Common Name	Scientific Name	Direct Record	Indirect Record	IUCN Status
Fish				
Flying minnow	*Laubuca caeruleostigmata*	✓		EN
Wild common carp	*Cyprinus carpio*	✓		VU
Yellow tail brook barb	*Poropuntius deauratus*	✓		EN
Bandan sharp-mouth barb	*Scaphognathops bandanensis*	✓		VU
IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable.				

4.3.4 Aquatic

The Nam Xan River surveyed in 2013 habitats exhibited a gravel substrate with variety in depth and flow seasonally. During the wet season water was approximately 1-3m depth and up to 150 m wide in area where the wetted width is 100m during the dry season. Reaches recorded areas with larger rock and riffle zones as well as beach and island areas where aquatic plants grow sparsely. In general the substrate is dominated by gravel. In the upper area there are settlements with fish cultivation in the lower area. Sand and gravel is harvested in some reaches. *Figure 4.5* shows the habitat within the Nam Xan River.

Figure 4.5 Top: Lower Nam Xan River (dry season), Upper Nam Xan Tributary (wet season); Bottom: Upper and Lower Nam Xan River (wet season) (TISTR 2013)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360000
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2040000
Legend
Nam Xan Catchment Boundary
Waterbody
Road
City, Town or Village
Nam Ngiep 1 Hydropower Project:
Inundation Area
Re-regulation Dam
Re-settlement Area
Proposed Access Road
Forest Zone:
National Protection Forest
Production Forest
N
0 2.5 5 7.5Km
1:250,000
Basemap: Bing Maps
Datum: WGS84
Nam Gnan
Namchong-Namgneup
Namchong-Namgneup
GnotNamxan
NamPeuak
Namchong-Namgneup
Thathom
GnotNamxan
NamPeuak
Nammo
Nam Gnem
Nam Xan
Nammo
Nam Mang
Phak
Beak
Phoupasang-Punghok
Phoupasang-Punghok
Nam Lat
Phak
Beak
Phak
Beak
Ba.Pakgnoun
Phoutume
Nam Kap
Mekong River
Client: Nam Ngiep Power Company Ltd.
Drawing No: 0185065b_BIODIV_G011_R0.mxd
Date: 10/09/2013 Drawing Size: A3
Drawn By: TC Reviewed By: DN
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.
Figure 4.6 - Forestry Classification Mapping within the Nam Xan Area
Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report
Environmental Resources Management ANZ
Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney
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4.4 HUAY NGUA PPA

4.4.1 Overview

The Huay Ngua PPA (the PPA) was established in 2010 and is located to the east of the Nam Ngiep River between Borikham and Hat Kham. The preserved area is approximately 5,430 ha. There are five villages with a total population of 4,302 made up of Laoloum, Laosoung and Keummou ethnic groups. The groups are located in scattered settlements living near highland rice fields and rivers. The villagers use local terrestrial and aquatic biodiversity however dependence varies (Provincial Conservation Division, 2010).

The PPA is an important part of a wildlife corridor between PKK and along the Nam Ngiep River. The area is considered significant for aquatic and wildlife habitat (Provincial Conservation Division, 2010) as well as providing a research site of Province Agriculture and Forestry School. The PPA currently does not have any formal management arrangements in place to facilitate its management. A management committee under Central, Provisional or District levels of government has not been established. A Management Plan for the PPA has been prepared but it has not been implemented as no funding currently exists to pay for the management actions it contains. The priority actions to manage the PPA included in the plan are related to:

- raising community awareness to increase participation in sustainable uses;
- improving community livelihoods in and around the PPA to assist in management of natural resources;
- law enforcement and patrolling;
- biodiversity research and monitoring; and
- development of ecotourism opportunities.

The forest and wildlife is considered a high value resource with increasing demand in Lao PDR and neighbouring countries. The PPA is abundant in these resources. Some fauna species have been impacted by hunting and trapping for local and regional market and there is harvesting for rosewood and agar wood (*Aguilaria cassna*) (Provincial Conservation Division, 2010).

Forest resources have played an important role in the economics of the surrounding province contributing to almost 30% of the total province economy in 2000. Although production of forest products is important for the province, environmental values remain important and the forest is considered a place for production and collection of food for the rural population as well as a source of traditional medicine (Provincial Conservation Division, 2010).

4.4.2 *Vegetation*

Land Cover

Using land cover mapping (DFRM, 2010), natural and modified habitats, in accordance with the IFC definition, can be identified within the Huay Ngua candidate offset site. The Huay Ngua is dominated by natural habitat (83 per cent) which is mapped as deciduous forest. *Table 4.9* summarises the land cover shown in *Figure 4.7* and identifies the habitat category of each land cover type.

Table 4.9 Land Cover within the Huay Ngua Candidate Offset Site

	IFC Habitat Class	Total Area (ha)	% of Total
Deciduous Forest	Natural	4,853	83%
Old Fallow Land	Modified	833	14%
Slash and Burn	Modified	31	1%
Rice Paddy	Modified	11	<1%
Cloud	-	80	1%
Shadow	-	52	1%
	Total	**5,860**	

Vegetation Condition

The NDVI across the Huay Ngua PPA is shown in *Figure 4.8* and the area of each classification is summarised in *Table 4.10*.

Over 94 per cent of the Huay Ngua is classified as moderate or high NDVI. The majority of the area is classified as moderate (71 per cent). Less than 0.1 per cent of the area is classified as impacted NDVI.

Table 4.10 Vegetation Condition within the Huay Ngua Candidate Offset Site

Forest type	Impacted (- to 0)	Low (0 - 0.4)	Moderate (0.4 - 0.6)	High (0.6 - 0.8)
Deciduous Forest	4	131	3558	1161
Old Fallow Land	22	120	518	173
Slash and Burn	5	14	12	0
Rice Paddy	0	7	4	0
Cloud	11	22	36	10
Shadow	0	1	40	12
Total (ha)	**42**	**295**	**4168**	**1356**
%of Total	**1%**	**5%**	**71%**	**23%**

Aquatic Habitats

The Huay Ngua aquatic habitats can be described as tributary habitat. The aquatic habitats sampled were very shallow during the dry season. No aquatic plants were observed. The substrate is dominated by sand and small gravel. The riparian zone in this area is original forest dominated by bamboo. No disturbance was observed.

350000 352500 355000 357500 360000 362500

2067500 2065000 2062500 2060000 2057500 2055000 2052500 2050000

Nam Xao
Nam Tak
H. Miang
Nam Ngiep
Nam Louan
H.Soup
H. Khinguak
H. Khi-Nguak
H. Khinguak-Noy
H. Khinguak-Gnai
H. Kokkhen
H. Poungxang

Legend

- Watercourse
- Road

Nam Ngiep 1 Hydropower Project:

- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Land Cover:

- Deciduous Forest (Current Forest)
- Old Fallow Land (Potential Forest)
- Slash and Burn Land (Potential Forest)
- Rice Paddy
- Cloud
- Shadow

N

0 0.45 0.9 1.35 Km

1:50,000

Land Cover: DFRM
Basemap: ESRI Imagery
Datum: WGS84

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_BIODIV_G012_R0.mxd	
Date:	13/09/2013	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

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Figure 4.7 - Land Cover within the Huay Ngua Candidate Offset Site

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

Environmental Resources Management ANZ

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ERM

350000 352500 355000 357500 360000 362500

2067500 2065000 2062500 2060000 2057500 2055000 2052500 2050000

Nam Xao
Nam Tak
H. Miang
Nam Ngiep
Nam Louan
H.Soup
H. Khinguak
H. Khi-Nguak
H. Khinguak-Noy
H. Khinguak-Gnai
H. Kokkhen
H. Poungkang

Legend

- Huay Ngua Provincial Protected Area
- Watercourse
- Road

Nam Ngiep 1 Hydropower Project:

- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Condition Class:

- High
- Moderate
- Low
- Impacted

N

0 0.5 1 1.5Km

1:50,000

Land Cover: DFRM
Basemap: ESRI Imagery
Datum: WGS84

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_BIODIV_G013_R0.mxd	
Date:	13/09/2013	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 4.8 - Vegetation Condition within the Huay Ngua Candidate Offset Site

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch,
Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

4.4.3 *Flora Species*

The climatic conditions (low temperature, high humidity and high winds) have led to dense growth of several plant species such as rosewood, mai kebe, mai ngang (*Dipterocarpus alatus*), maid tae (*Sindora cochinchinensis*), mai peuy (*Lagerstroemia calyculata, Lagerstroemia floribunda*) and mai bark (*Anisoptera costata*) (Provincial Conservation Division, 2010).

Sampling undertaken during 2013 surveys by TISTR recorded 451 species of vascular plants in the Huay Ngua PPA sampling locations. Vegetation is dominated by mixed deciduous forest with some areas of mixed evergreen forest and secondary growth of mixed deciduous forest. Canopy cover is approximately 60-70 per cent. The forest canopies are divided in 3 classes. The dominant species are summarised in *Table 4.11*.

Table 4.11 Dominant Flora Species in Huay Ngua Candidate Offset Site

Canopy class	Dominant species
Top canopy (20-35m)	*Anisoptera costata, Lagerstroemia calyculata, Shorea roxburghii, Irvingia malayana, Alstonia glaucescens, Schima wallichii, Vitex pinnata, Stereospermum fimbriatum*
Middle canopy (10-20m)	*Acronychia pedunculata, Peltophorum dasyrachis, Nauclea orientalis, Microcos tomentosa, Mallotus paniculatus, Gonocaryum lobbianum, Cratoxylum formosum*
Lower canopy (<10m)	*Croton cascarillicdes, Breynia glauca, Ardisia helferiana, Glycosmis pentaphylla, Melicope pteleifolia, Allophylus cobbe, Salacia chinensis*

IUCN Listed Species

A total of 11 plant species listed under the IUCN Red List were recorded during vegetation surveys in Huay Ngua in 2013. These are shown in *Table 4.12*. This includes:

- One species listed as critically endangered;
- Six species listed as endangered; and
- Five species listed as vulnerable.

Table 4.12 IUCN Listed Fauna Species Recorded within Huay Ngua Candidate Offset Site

Scientific Names	Status
Dipterocarpus turbinatus	CR
Afzelia xylocarpa	EN
Anisoptera costata	EN
Dalbergia oliveri	EN
Dipterocarpus alatus	EN
Shorea roxburghii	EN
Vatica cinerea	EN
Cycas pectinata	VU
Dalbergia cochinchinensis	VU
Hopea odorata	VU
Syzygium vestitum	VU

Scientific Names	Status
Ternstroemia wallichian	VU
IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable	

4.4.4 Fauna Species

A total of 38 terrestrial species of fauna from 19 families, and 31 genera were recorded from the field surveys in 2013 surveys in Huay Ngua PPA by TISTR. This includes one species of mammal, 29 species of birds, three species of reptiles, and six species of amphibians. Species diversity of animals in this area is lowest among the total study areas due to the lack of secondary data, all records were obtained by direct observation during the field surveys.

Common fish species detected in the Nam Xan River during surveys in 2013 included Spiny barb (*Mystacoleucus marginatus*), Sikuk barb (*Sikukia gudgeri)*, Horseface loach (*Acantopsis choirorhynchos*), and Long fin mystus (*Mystus singaringan*). Of these species the Sikuk barb and Long fin mystus are known full migrant species.

The Houy Ngua Provincial Preserved Area Management Plan reports (indirect data) fauna species occurring within the PPA to include wild pig, munjac, clouded leopard (*Pardofelis nebulosa*), civet, flying squirrel as well as Green peafowl (*Pavo muticus*), Hill myna (*Gracula religiosa*), Red junglefowl (*Gallus gallus*) and the Siamese fireback (*Lophura diardi*).

Overall, the TISTR surveys and indirect data reported:

- Nine amphibian species;
- Fifty-nine bird species;
- Twenty-seven mammal species;
- Nine reptile species; and
- Thirty-nine fish species (including twelve species considered to be migratory).

A full species list is provided in *Annex D*.

Restricted Species

Species listed as Restricted under the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF includes wild animals and fish which are rare, endangered, high conservation value, and special significance to the economy and national environment.

The 2013 TISTR surveys (direct data) and indirect data sources identified the following species listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF:

- Two mammal species;
- Six bird species;
- One reptile;
- One fish;
- No amphibians.

Annex D provides a description of the results.

IUCN Listed Species

Three IUCN Red Listed critically endangered, endangered or vulnerable fauna species were recorded within the Huay Ngua PPA area during 2013 surveys by TISTR while PAFO surveys identified 16 species listed as critically endangered, endangered or vulnerable on the IUCN Red List that may occur within the Huay Ngua PPA.

Table 4.13 IUCN Listed Fauna Species Recorded within Huay Ngua PPA

Common Name	Scientific Name	Direct Record	Indirect Record	IUCN Status
Mammals				
Asian elephant	*Elephas maximus*		✓	EN
Fishing cat	*Prionailurus viverrinus*		✓*	EN
Gaur	*Bos gaurus*		✓	VU
Malayan sun bear	*Helarctos malayanus*		✓	VU
Clouded leopard	*Neofelis nebulosa*		✓	VU
Sambar deer	*Rusa unicolor*			VU
Himalayan black bear	*Ursus thibetanus*		✓	VU
Large spotted civet	*Viverra megaspila*		✓	VU
Birds				
White-winged duck	*Cairina scutulata*		✓*	EN
Green peafowl	*Pavo muticus*		✓	EN
Imperial eagle	*Aquila heliaca*		✓	VU
Reptiles				
Big-headed turtle	*Platysternon megacephalum*		✓	EN
Impressed tortoise	*Manouria impressa*		✓	VU
Fish				
Giant barb	*Catlocarpio siamensis*		✓	CR
Striped catfish	*Pangasianodon hypophthalmus*			EN
Yellow tail brook barb	*Poropuntius deauratus*	✓*		EN
Thicklipped barb	*Probarbus labeamajor*		✓	EN
Bandan sharp-mouth barb	*Scaphognathops bandanensis*	✓		VU
Jaguar loach	*Yasuhikotakia splendida*	✓		VU

CR = Critically endangered, EN = Endangered, VU = Vulnerable

*Specialist consultation identified potential for unreliable record

4.5 PHOU KHAO KOUAY

4.5.1 Overview

Phou Khao Kouay, or 'Buffalo Horn Mountain', is a Protected Area near Vientiane in central Laos. The area spans 2000 square kilometres over three provinces, with an elevation range of 200m - 1761m. The landscape ranges from sandstone cliffs and river gorges to rugged mountain slopes. Layered sandstones are visible as linear outcrops and large boulders along steep slopes. There are also extensive flat uplands of exposed sandstones with little or no soil development (Salter & Bouaphanh, 1990). The PKK NPA has a monsoonal climate similar to the rest of Central Laos with a mean annual temperature of 26.6 C. The wet season extends from May to October with a distinct dry season during from November to April.

4.5.2 Vegetation

Land Cover

Using land cover mapping (DFRM, 2010), natural and modified habitats, in accordance with the IFC definition, can be identified within the PKK candidate offset site. The PKK is dominated by natural habitat (73 per cent) which is a mixture of deciduous forest, evergreen forest, coniferous forest, mixed coniferous forest, scrub and bamboo. *Table 4.13* summarises the land cover shown in *Figure 4.9* and identifies the habitat category of each land cover type.

Table 4.14 Land Cover within the PKK Candidate Offset Site

Forest Type	IFC Habitat Class	Total Area (ha)	% of Total
Deciduous Forest	Natural	76,001	42%
Evergreen Forest	Natural	43,262	24%
Coniferous Forest	Natural	1,563	1%
Mixed Coniferous/Broadleaved Forest	Natural	702	<1%
Scrub, Heath	Natural	2,779	2%
Bamboo	Natural	5,832	3%
Swamp	Natural	148	<1%
Rock	Natural	1,638	1%
Old Fallow Land	Modified	22,413	12%
Agriculture Plantation	Modified	63	<1%
Young Fallow Land	Modified	11,762	6%
Slash and Burn	Modified	1,274	1%
Rice Paddy	Modified	857	<1%
Water	-	2,376	1%
Grassland	Modified	3,098	2%
Barren Land	Modified	102	<1%

Forest Type	IFC Habitat Class	Total Area (ha)	% of Total
Urban Area	Modified	157	<1%
Other Land	Modified	127	<1%
Cloud	-	6,952	4%
Shadow	-	200	<1%
	Total	**181,306**	

Vegetation Condition

The NDVI across the PKK is shown in *Figure 4.10* and the area of each classification is summarised in *Table 4.14*.

Over 87 per cent of the PKK is classified as moderate or high NDVI. Less than 2 per cent of the area is classified as impacted NDVI.

Table 4.15 Vegetation Condition within the PKK Candidate Offset Site

Forest Type	Impacted (- to 0)	Low (0 - 0.4)	Moderate (0.4 - 0.6)	High (0.6 - 0.8)
Deciduous Forest	204	4498	34272	37027
Evergreen Forest	344	4505	25445	12968
Coniferous Forest	14	782	674	93
Mixed Coniferous/Broadleaved Forest	1	332	329	39
Scrub, Heath	4	1619	1063	92
Old Fallow Land	78	1141	6647	14547
Agriculture Plantation		0	9	54
Young Fallow Land	104	2365	4618	4676
Bamboo	54	353	918	4506
Slash and Burn	22	377	468	407
Rice Paddy	15	639	158	45
Swamp	74	52	18	4
Water	1920	335	83	38
Grassland	2	881	1559	657
Barren Land	7	59	32	4
Urban Area	4	93	51	9
Other Land	12	76	30	9
Rock	55	1048	502	32
Cloud	113	1209	3692	1939
Shadow	0	27	110	63
Total (ha)	**3027**	**20391**	**80678**	**77209**
% of Total	**2**	**11**	**44**	**43**

250000 260000 270000 280000 290000 300000 310000 320000 330000 340000

2070000 2060000 2050000 2040000 2030000 2020000 2010000

Legend

Land Cover:

- Evergreen Forest (Current Forest)
- Deciduous Forest (Current Forest)
- Coniferous Forest (Current Forest)
- Mixed Coniferous/Broadleaved Forest (Current Forest)
- Bamboo (Potential Forest)
- Old Fallow Land (Potential Forest)
- Young Fallow Land (Potential Forest)
- Slash and Burn Land (Potential Forest)
- Scrub, Heath
- Rice Paddy
- Agriculture Plantation
- Grassland
- Swamp
- Rock
- Barren Land
- Urban Area
- Water
- Other Land
- Cloud
- Shadow
- Phou Khao Khouay National Protected Area
- City, Town or Village
- Lao PDR Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road
- Nam Ngiep Sub-catchment Boundary

Xiengmi
Longxan
Papek
Thabok
Na
Nakhai
Nangommay
Xienglaena
Ban Natan
Hai
Mekong River
Veunthan
Palai
Somsamay

N
0 2.5 5 7.5Km
1:250,000

Land Cover: DFRM
Basemap: Bing Maps
Datum: WGS84

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_BIODIV_G014_R0.mxd		
Date:	13/09/2013	Drawing Size: A3	
Drawn By:	TC	Reviewed By: DN	

Figure 4.9 - Land Cover within the PKK Candidate Offset Site

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

Environmental Resources Management ANZ
Auckland, Brisbane, Canberra, Christchurch,
Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

250000 260000 270000 280000 290000 300000 310000 320000 330000 340000

2070000 2060000 2050000 2040000 2030000 2020000 2010000

Legend

- Phou Khao Khouay National Protected Area
- Nam Ngiep Sub-catchment Boundary
- Waterbody
- Road
- City, Town or Village
- Lao PDR Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area

Condition Class:

- High
- Moderate
- Low
- Impacted

Xiengmi
Longxan
Nam Ngum Reservoir
Nam Leuk reservoir
Nam Mang 3 Reservoir
Papek
Nam Thon
Thabok
Na
Nakhai
Nangommay
Ban Natan
Xienglaena
Mekong River
Hai
Nam Ngum River
Veunthan
Palai
Somsamay
Pakxapmai

N
0 2.5 5 7.5Km
1:250,000

Basemap: Bing Maps
Datum: WGS84

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_BIODIV_G015_R0.mxd	
Date:	13/09/2013	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 4.10 - Vegetation Condition within the PKK Candidate Offset Site

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

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4.5.3 *Flora Species*

The central portion of the park contains the lower basins of the Nam Leuk and Nam Mang. This area is predominantly upper dry evergreen forest. This forest has plant families and genera typical for other parts of Southeast Asia, such as the genera Dipterocarpus and Shorea. Mixed deciduous forest is found on lighter, shallow soils. Large stands of coniferous forest, usually monospecific stands of *Pinus merkusii*, grow on shallow, nutrient deficient, sandy soils, particularly in the western portion of the park, where it occurs in association with extensive, fire-climax grasslands.

4.5.4 *Fauna Species*

IUCN Listed Species

Information regarding the PKK identified a number of IUCN Red List species to occur including:

- Ten mammal species (1 critically endangered, 4 endangered and 5 vulnerable).

Table 4.16 IUCN Listed Fauna Species Known within PKK Candidate Offset Site

Scientific Name	Family/Common Name	IUCN Status
Nomascus leucogenys	Northern white-cheeked gibbon	CR
Cuon alpinus	Asian wild dog, dhole	EN
Elephas maximus	Asiatic elephant	EN
Manis javanica	Sunda pangolin	EN
Trachypithecus phayrei	Phayre's leaf monkey	EN
Aonyx cinerea	Asian small-clawed otter	VU
Bos gaurus	Gaur	VU
Helarctos malayanus	Malayan sun bear	VU
Macaca leonina	Northern pig-tailed macaque	VU
Nycticebus bengalensis	Bengal slow loris	VU
Ursus thibetanus	Himalayan black bear	
IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable		

4.6 *SOCIO-ECONOMIC AND CULTURAL*

The following section provides an overview of the socio-economic activities and cultural values associated with the potential offset sites. This information is largely drawn from village and market surveys undertaken by ERM in July 2013. The location of villages surveyed is shown in *Figure 4.11*.

310000 320000 330000 340000 350000 360000 370000 380000

2130000 2120000 2110000 2100000 2090000 2080000 2070000 2060000 2050000 2040000 2030000 2020000

B. Pou
Thathom
B. Pak Yong
B. Kan Yong
B. Pak Haueng
Ba.Pakgnoun
Borikham Market
B. Don
B. Somseun
Pakxan
Thabok Market
Thabok
Mekong River
Na

Legend

- Nam Ngiep Catchment Boundary
- Nam Xan Catchment Boundary
- Waterbody
- Road
- City, Town or Village
- Lao PDR Boundary

Survey Locations:

- Village
- Market

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

N

0 2.5 5 7.5Km

1:300,000

Basemap Bing Maps
Datum: WGS84

bing

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_BIODIV_G015_R0.mxd	
Date:	12/09/2013	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

Figure 4.11 - Socio-economic and Cultural Survey Locations

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

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4.6.1 Hunting and Gathering

Hunting is generally done for household consumption; while any surplus is sold to intermediaries. However, from time to time, hunting is done to generate money, when required to cover household expenses such as clothing and education. It is typically the smaller species that are consumed within the household, while the larger animals are sold to intermediaries.

Male hunters normally go hunting individually, unless big animals such as cow or deer are needed for events (e.g. weddings) during which males will hunt in groups of four to five to hunt big animals. Females usually hunt in groups of four to five.

Hunting frequency ranges from two to three times per week to once a month in most villages. However, male hunters from Ban Don mentioned that they have not hunted for the past six years – i.e. since hunting become illegal.

Frequently caught species include small animals such as squirrels, birds, bamboo rats and the lesser mouse deer; however, once in a while larger animals such as the Rusar Unicolor, Southern Red Munjak and Pangolin are caught.

According to villagers, the most prized mammal species is the Pangolin, the price for which ranges from 100,000 KIP (13 USD) to 1 million KIP (130 USD) per kilogram. This is because of its rarity and medicinal purpose – it is believed to have sexual stimulation powers and is preferred alive.

Hunters reported that the availability of resources has been declining since around 2000. The villagers believe that the cause of the decline is the increasing number of new settlers who have migrated to the village areas and started accessing the existing natural resources.

In addition to hunting, many women collect materials from the forests (i.e. gather). A number of species are collected, including mushrooms and bamboo shoots, and are collected based on their growing season. Female gatherers reported that they visit forests more often at the start of the rainy season (i.e. May) given that the bamboo shoots and ground vegetation are abundant and ripe at this time of year.

Flora species were, again, primarily used for household consumption and only surplus is sold to intermediaries. However, from time to time, specific species will be requested by intermediaries, such as Nor boon (1,000 KIP (15 cent) per piece) and Nor Xang (50,000 KIP (7 USD) per kilogram). These are the most prized plants due to their taste.

Instead of selling materials collected, females typically engage in other activities, such as planting rice or textile production, in order to provide family income.

4.6.2 Fishing

Villagers indicated that fishing is mainly the role of females rather than males. The majority of fish caught are consumed within household. Only surplus or the prized species are sold to intermediaries. Hence, family income derived from selling fish is relatively low - ranging from 0 to 20 per cent.

In terms of species, female hunters typically catch cat fish and scale fish. The Pla Pann is reported to be the most prized species – it can attract up to 130,000 KIP (17 USD) per kilogram at market.

Females indicated that they go fishing more often during the rainy season as species that dwell in Mekong River flow downstream to the Nam Ngiep and Nam Xan rivers during this period.

Regarding availability of fish, villagers indicated that resources have been declining due to the increasing number of people fishing. Villagers noted many of these people are fishing for commercial purposes, not household consumption.

4.6.3 Cultural services

Most of the villages identified two specific cultural sites deemed important to their way of life - village temples and cremation sites. The cultural sites are typically located in close proximity to the village, but are communally owned by the village. For example, Ban Don reported to have village temple named Ban Don Chaiyaram. Religious ceremonies are held at the site from time to time. The villagers reported to do in Buddhist merits such as release fish, turtles at the temple.

When asked, the villagers indicated that the sites can be moved elsewhere or destroyed and rebuilt elsewhere. In order for this to occur, compensation in the form of land or money is required. The only exception was the Ban Hat Seung Tom, a historic cultural site where artefacts are buried, in Ban Pakheaung. The site was established prior to the founding of the village itself.

As for intangible heritage, no significant sites were identified. This is partly due to the fact that the village residences were largely lowland Laos who are Buddhist; accordingly, religious ceremonies are conducted in village temples. Another possible underlying factor is that the villagers did not settle in the area until after the Laotian Civil War (1953 – 1975).

5 CONSERVATION SIGNIFICANT VALUES SUMMARY

5.1 PROJECT AREA

The Project area is located along the Nam Ngiep River which is a major watercourse draining into the Mekong River. The Nam Ngiep River flows through a mountainous region to a gorge at Hat Gnium, which is the proposed location for the main dam wall. Surrounding the river the vegetation is dominated by deciduous forest land, representing approximately 36 per cent of the footprint. Young and old fallow land is also highly represented with 16 and 21 per cent respectively. In terms of vegetation condition the Project area is dominated by vegetation cover that shows moderate to high photosynthetic capacity.

The vegetation present provides habitat for a number of flora and fauna species, including species listed on the IUCN Red List as Critically Endangered, Endangered or Vulnerable, species listed as Restricted in the Lao PDR Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF, and species that are migratory and endemic. These species have been considered as candidates for critical habitat in accordance with International Finance Corporatation Performance Standard 6.

As part of the baseline assessment each candidate species has been assessed against the quanitative thresholds of the performance standard for the relevant criteria. Species information sourced from desktop review, field survey results, village interviews and specialist consultation was used to determine the importance of the Project area for each candidate species, and in turn the likelihood of the Project area be considered critical habitat.

The outcomes of the assessment and specialist consultation did not identify any areas of critical habitat for terrestrial flora or fauna species. Ongoing assessment is currently underway to clarify the values of the Project area and the potentially impacted downstream area for fish species, including migratory species.

5.2 CANDIDATE OFFSET SITES

Four candidate offset areas were investigated to determine the biodiversity values represented. Following impact assessment for the Project, an appropriate offset site, or combination of, will be selected. The Biodiversity Offset Design Report will document this process.

In comparison to the biodiversity values of the Project area, the candidate offset sites demonstrate biodiversity values similar to the candidate offset sites. The table below summarises some key biodiversity features for comparison. As would be expected given the proximity to the Project area the

Upper Nam Ngiep candidate offset site exhibited biodiversity values most similar to the proposed disturbance area.

Table 5.1 Project area and Candidate Site Comparison of Key Features

Feature	Project area	Upper Nam Ngiep	Nam Xan*	Huay Ngua PPA	PKK
Area of natural habitat	3,912 ha	102,479 ha	No data	4,853 ha	131,925 ha
Area of high condition vegetation	3,004 ha	80,850 ha	No data	1,356 ha	77,209 ha
Area of medium condition vegetation	3,844 ha	41,943 ha	No data	4,168 ha	80,678 ha
No. of IUCN listed flora species	13	9	10	11	No data
No. of IUCN terrestrial fauna species that may occur	35	35	18	12	10
No. of IUCN aquatic fauna species that may occur	9	9	4	7	No data
* Further analysis of the Nam Xan catchment was not completed as it was discounted as a candidate offset area					

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Annex A

Environmental Research Institute 2007 Survey Method

The following method is an excerpt from Chapter 3 of the Nam Ngiep 1 Hydropower Project Environmental Impact Assessment Draft Report prepared by: Environmental Research Institute, Chulalongkorn University, October 2009.

A.1 TERRESTRIAL ECOLOGY/WILDLIFE

Blockage in a waterway to create a large reservoir as well as other activities associated with the construction and operation of a large dam like the NNP-1 can cause abrupt changes in the environment. It may affect plants and animals in either positive or negative ways. Some animals may respond positively to the changes, hence increasing their populations. Other animals may not be able to withstand the abrupt changes and must either seek a new place to live or die out.

A.1.1 Objectives of Study

1. Investigate the diversity, abundance, and distribution of wildlife in the Project area, and any use of the wildlife by local residents.
2. Assess environmental impacts that the proposed project may have on wildlife, their food sources, and their habitat.
3. Draw up appropriate mitigating measures to protect against probable negative impacts on wildlife.

A.1.2 Method of Study

The surveyed area is broadly defined as the area north of the dam site extending to the northern margin of the reservoir, covering the proposed reservoir area. The surveys were conducted to provide baseline information on the distribution of wildlife and wildlife habitats to determine likely impacts of the project on such fauna and to assess how any such impacts might be mitigated through appropriate interventions.

After a review of available literature, a field survey was conducted in both wet (October 2007) and dry (March 2007) seasons to collect primary field data concerning all wildlife species including mammals, reptiles, amphibians and birds.

Within and around the survey areas, wildlife conditions were surveyed and assessed by visual inspection and interviews with villagers, as well as from secondary data and information gathered from available sources such as authorities concerned with wildlife. Local villagers within and around the Project area were interviewed regarding wildlife conditions within and around their villages. Additionally, wildlife within circular sample plots for forest collection were recorded, such as the sighted animals, foot-prints, nests, burrows, hair or feathers, molts, sounds and any other evidence.

Status of the wildlife species is then assessed according to the current IUCN classification (IUCN, 2009):

- CR = Critically Endangered
- EN = Endangered
- VU = Vulnerable
- NT = Near Threatened
- LC = Least Concern
- DD = Data Deficient

(IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1. <www.iucnredlist.org>. Downloaded on 09 June 2009.)

A.2 FOREST, VEGETATION COVER

The Nam Ngiep Hydropower Project will affect forest resources and ecosystems by clearing some forest to be replaced by the dam and reservoir.

A.2.1 Objectives of Study

1. Study forest characteristics particularly tree species, density, and timber volume as well as saplings and seedlings in the reservoir area and in the resettlement area.
2. Assess the economic value of timber to be cut in the reservoir and the resettlement areas.
3. Evaluate impacts on forest resources that may be caused by the project.
4. Recommend mitigating measures to minimize impacts on forest resources and ecosystems.

A.2.2 Method of Study

The surveyed area is broadly defined as the area north of the dam site extending to the northern margin of the reservoir, covering the proposed reservoir area. The surveys were conducted to provide baseline information on the distribution of forest types and vegetation to determine likely impacts of the project on such flora and to assess how any such impacts might be mitigated through appropriate interventions.

The methodology involved in assessing the forest and vegetation cover was to compile maps and available literature on the land and water resources of the region and in particular the survey area. Based on these maps and literature, the field survey was conducted in October 2007 to collect primary data concerning tree and vegetation species, density and estimated volume per hectare for big tree species with diameter at breast height (DBH) of more than 10 centimeters.

The main method used in this survey is similar to that used for the wildlife survey including interviews with villagers, especially senior persons who have experience with the types of vegetation and non-timber forest products in their vicinity. The villagers were questioned on land use as well as lists of vegetation and NTFPs.

Primary data was collected from 35 temporary sample plots that were set in the form of line plot system covering the reservoir area according to land use, geographic conditions and forest types. The sample plots were set in the dominant area or good sample areas located where the reservoir will be located. There were 3 types of temporary sample plots, and the data collected depended on their shapes and size:

1. A circular sample plots with a radius of 17.85 meters (0.1 hectare total area) from which data on trees of DBH equal to and above 10 centimeter were collected. Other significant information recorded included tree species, their diameter and height, and bamboo types, including number of clumps and stems per clump found in the plot.
2. Square plots of 5x5 meters (25 square meters) were established in the middle of the circular plots. Information on small trees and/or saplings (trees whose DBH is less than 10 centimeters and whose height exceeds 1.3 meters), tree species, number of tree and their average height as well as NTFP species was recorded from these plots.
3. Square plots of 2x2 meters were established within the larger square plots of 5x5 meters. Data concerning plants and vegetation including sapling or seedlings (all undergrowth vegetation), focusing on species of trees or seedlings of each species as well as NTFPs were recorded in these plots. The main concern was on the diversity of plants and NTFPs species, not the numbers or density of the saplings and seedling or plants, since the time available for field data collection was limited, and also since some of the data, especially that on NTFPs were being collected through interviews with villagers.

A.2.3 Forest and Vegetation Classification

Several forest classification schemes have been proposed for the Lao PDR. The classification of forest types for this study is based on the classification used by the Forest Inventory and Planning Division, Department of Forestry since 1982, and the preliminary national forest record. Box 1 shows the classification and definition of each forest or land use type.

Box 1 Definition of Land Use and Forest Types

1. <u>Current Forest</u>:

Current Forest includes natural forests and plantation forests. It is used to refer to land with a tree canopy cover of more than 20% and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m. The basis for the distinction between forest and other land use groups is the

crown density. Natural forests are classified into forest types, which are Upper and Lower Dry Evergreen Forests, Upper and Lower Mixed Deciduous Forests, Gallery Forest, Coniferous Forest, Mixed Broadleafed and Coniferous Forest, and Dry Dipterocarp Forest.

- ***Dry Evergreen Forest (DE):*** The Dry Evergreen Forest type has a lower proportion of evergreen trees than the Evergreen type, 50% -80%. Except in disturbed stands there is very little bamboo. Soil is usually deep. The forest consists of a considerable number of species, of which 2 to 3 species tend to be predominant.

- ***Mixed Deciduous Forest (MD):*** In the Mixed Deciduous Forest, deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen types and most of the seedlings and saplings are deciduous trees. Bamboo often occurs in this type of forest.

    - ***Upper Mixed Deciduous Forest (UMD):*** This type of forest is located at an altitude above 200 m. In moist areas there might be many climbers, and it could be difficult to distinguish this forest from the Dry Evergreen type. In dry regions the difference can be clearly seen. This forest type appears quite open with a considerable amount of bamboo and undergrowth.

    - ***Lower Mixed Deciduous Forest (LMD):*** This type of forest is located at an altitude below 200 m.

- ***Dry Dipterocarp Forest (DD):*** This type of forest occurs in open stands. The tree diameter is comparably small and the height of the stand varies from 8 to 25 m. The crowns do not spread out widely. It is normally found in places with shallow soil, where the hard pan emerges above the ground, and on latirized soil. On the most poor and shallow soils the trees are crooked and do not exceed 10 m in height: If the crown cover is less than 20% and the stand is undisturbed the vegetation type should be classified as Savannah.

  Many species characteristic for the Dry Dipterocarp forests are fire resistant and have a thick bark. Mai Sabeng (*Dipterocarpus intricatus*), Mai Chick (*Shorea obtusa*), Mai Sat (*Dipterocarpus obtusifolius*), Mai Seuak (*Terminalia tomentosa*) and Mai Hang (*Shorea siamensis*) are among these species.

- ***Coniferous Forest (S):*** The Coniferous Forest is usually single storied and open but the young growth may sometimes form a dense second storey. This forest type occurs in higher elevations with a cool climate. The characteristic species of this type are pines (Pinus kesiya or Pinus merkusii) but other coniferous trees such as i.e. Cunninghammia may also be predominant.

- ***Mixed Broadleaved and Coniferous Forest (MS):*** The MS Forest is a transition type between the coniferous and the broadleaved forest types. The coniferous trees could be mixed with either deciduous or evergreen trees. It is also found in higher elevations.

2. Potential Forest:

Previous forest areas where the crown cover has been reduced below 20% (whether from logging or shifting cultivation) are classified as Potential Forest. The potential forest includes Bamboo, old shifting cultivation areas (young secondary forests) and Temporary Unstocked areas. Potential Forest is consisted of Unstocked, Bamboo and Ray.

- ***Unstocked Forest (T):*** Unstocked Forest Areas are previous forest areas in which the crown density has been reduced to less than 20% because of logging, shifting cultivation or other heavy disturbance. If the area is left to grow undisturbed it becomes forest again. Abandoned ray and disturbed stands with a crown density less than 20% should be classified as Unstocked Forest Areas. Old ray in which seedlings, sapling and trees cover more than 20% of the area should be classified as some type of Current Forest.

- ***Bamboo (B):*** If an area is covered with bamboo and the over storey has a crown cover less than 5% it should be classified as Bamboo Forest.

- ***Swidden (Ray) (RA):*** Ray is an area where the forest has been cut and burnt for temporary cultivation of rice and other crops. The area should be classified as Ray from the time it is clear cut until one year after it has been abandoned. Areas being prepared but not yet clear-cut and areas that have been abandoned for more than 1 year should not be classified as Ray.

3. Other Land Use Types:

- ***Savannah (SH):*** is an area where the soil conditions are unsuitable for tree growth as well as for agriculture production. The tree cover in the Savannah should be at least 1% but not more than 20%. The trees are drought resistant and mostly short with graminaceous and herbaceous plants forming an under storey. Savannahs should not be confused those grass covered areas that sometimes occur after shifting cultivation. Normally, the Savannah does not occur on steep slopes but in plains.

- ***Scrub Forest (SR):*** This is an area covered with scrub and stunted trees. The soil is shallow and rocky.

- ***Barren Land and Rock (R):*** Unfertile or seriously degraded land on shallow soil and rocky areas on which neither trees nor grasses can grow.

- ***Grassland (G):*** Unfertile or degraded land on which no trees or shrubs grow. It might be an area that is too dry for tree growth that has been covered by grasses. It could also be an area that has originally been

covered by trees, but has been heavily disturbed by cutting and fire and gradually depleted. One reason for the absence of trees could be that larger areas have been deforested and the seed supply from surrounding forest has ceased. Areas burnt every year to grow fodder or for hunting purposes could also be classified as Grassland. That type of Grassland can be found on higher elevations in the Northern part of Laos. Grassland can also occur on deep sand with a high moisture content.

- ***Swamp (SW):*** Swamps are areas where the soil is saturated with water. The soil may basically be fertile but the lack of oxygen limits its agriculture or forest capacity. The Swamp could have a high ecological or environmental value and the flora and fauna may be rich.

  The typical tree species found in the Swamps are trees which can grow in water, such as *Adina cordifolia*, *Rhus succedanea* and *Barringtonia acutangula*.

4. *Other Agricultural Land (OA):*

Land being used for agricultural purposes other than crop cultivation, such as cattle grazing, should be classified as Other Agricultural Land, unless the tree cover exceeds 20%. In that case it should be classified as some type of Current Forest depending on the tree species composition.

- ***Rice Paddy (RP):*** Areas permanently being used for rice cultivation. Old paddy that has been abandoned and not in use for more than one year should not be classified as Rice Paddy.

Source: Report on the Assessment of Forest Cover and Land Use (MAF, DOF, July 2005)

A.3 AQUATIC BIOTA

Reservoir impoundment and effluent discharge from the power plant and from other activities during construction and operation will affect the surrounding water bodies, including aquatic life in local canals and rivers. Therefore, a study on aquatic biota and habitats is necessary to assess present conditions and possible project impacts, and as a basis for possible plans for future utilization or development of their aquatic resources by local communities.

A.3.1 Objectives of Study

1. Review secondary data of aquatic biota and habitats from preliminary reports and the collect primary data from the field.
2. Assess potential impacts on aquatic biota in the Project area and downstream.
3. Recommend mitigation measures, including monitoring programs.

A.3.2 Method of Study

Sampling Station

Dry season survey along Nam Ngiep River was conducted in January 2008 at ten stations: six located downstream from the proposed dam and the other four located upstream (Table 6.1 and Figure 3-2).

Table A.1 Fish and Fisheries Survey Locations along the Nam Ngiep River

No.	Name	Location			Coordinate	
		Village	District	Province	N	E
1	Station 1	Piengta	Thathom	Xieng Khouang	19°01′33.6″	103°25′09.6″
2	Station 2	Hatsamkhone	Thathom	Xieng Khouang	19°00′46.0″	103°26′40.3″
3	Station 3	Pou	Thathom	Xieng Khouang	19°00′52.5″	103°27′37.7″
4	Station 4	Houypamom	Hom	Vientiane	18°59′32.6″	103°30′10.5″
5	Station 5	Sopphuane	Hom	Vientiane	18°50′01.9″	103°26′19.9″
6	Station 6	Sopyouak	Hom	Vientiane	18°42′53.7″	103°26′40.9″
7	Station 7	Hatsaykham	Bolikhan	Bolikhamxay	18°38′41.1″	103°33′17.4″
8	Station 8	Hat Gniun	Bolikhan	Bolikhamxay	18°39′23.6″	103°35′03.6″
9	Station 9	Somseun	Bolikhan	Bolikhamxay	18°25′03.5″	103°36′22.6″
10	Station 10	Pak Ngiep	Pakxan	Bolikhamxay	18°31′58.8″	103°38′48.3″

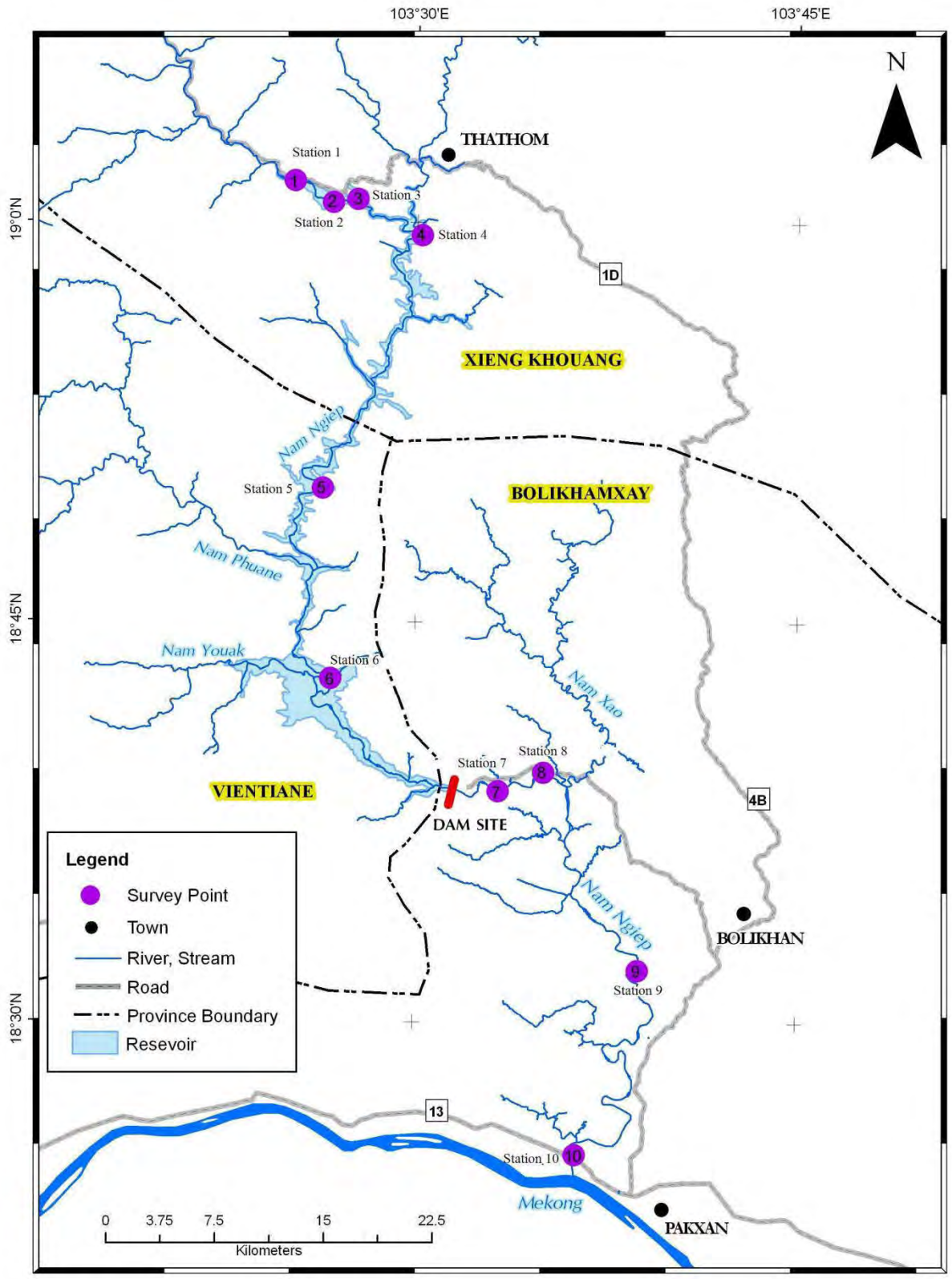

Figure A.1 ***Fish and fisheries survey locations along the Nam Ngiep River***

Examination of aquatic fauna and flora included distribution of indigenous fish species and their abundance in particular areas of the river. Plankton, benthos and aquatic plants, which provide nutrients to young fish, were also examined.

The aim of the survey was mainly to determine the existence of aquatic life in the river. Study results and other relevant data (hydrology, water quality) were used to predict possible changes in aquatic life after project development and its effect on peoples' livelihood.

Fish Sampling

Fish were collected using sampling seine net with the size of 430 x 160 cm with 5 mm mesh size. At the site, the seine net was equipped with bamboo pole at each end that was at least equal to the height of the net. Haul seine was operated and fished parallel to the river bank. Fish samples were preserved in a plastic bottle or a jar containing 10% formalin solution. The bottle was labeled with information such as date of sampling, station code, name of collector and time of collection. The samples were sent to a laboratory for species identification. In the laboratory, fish sampled from each station were identified by using a magnifier, a dissection microscope and classification guidance books (Kottelat, 2001 and Rainboth, 1996). Their productivity in the river was recorded

Plankton Sampling

Plankton sampled from those stations was conducted using a plankton net of 70 µm mesh size and a 2-litter beaker (Gajaseni, 1993). Sampling depth of water was taken at 30 cm below the water surface. Ten litters of sample were preserved in a plastic bottle containing 5% formalin solution. Information such as the code of sampling station and date were marked on the bottle. The specimens were sent to a laboratory for species identification as well as their density.

Benthic Sampling

Benthic fauna at each station was sampling using an Ekman dredge (Gajaseni, 1993). The samples were sieved by using a 1 m-mesh sieve. Each specimen was preserved in a separate bottle containing 7% formalin solution. Necessary information was labeled on the bottle. They were delivered to a laboratory for specie identification and density assessment.

A.4 WETLAND

A wide range of inland wetland habitats are found in Laos PDR. The Mekong River and its tributaries, paddy fields, small ponds, swamps, and flooded forests are among them. These habitats provide a fundamental source of food for local people as well as shelters for wildlife species such as native catfish and large waterbirds (Giant ibis and Sarus crane). Although the Lao PDR has not yet ratified the Ramsar Convention on Wetlands for the protection of wetlands of international importance as of March 2009, it well recognizes the importance of wetlands. Therefore, any significant adverse impact on wetland habitat caused by this project should be identified. In addition, the rehabilitation and restoration of any damaged wetland ecosystem should be promoted.

A.4.1 Objectives of Study

1. Identify location and pattern of wetlands found in the Project area. This information serves as baseline data for future comparison of land cover changes or wetland habitat losses due to the project.
2. Detect changes of location and patterns of wetlands and the impacts of project development on wetlands. This is useful for assessment of impact on the wetlands after project development.
3. Propose mitigation measures to reduce adverse impacts on wetlands. The proposed measures are helpful to establish future rehabilitation and restoration programs for damaged wetlands during and after the project development.

A.4.2 Method of Study

1. Compile information on wetlands from Lao and international literatures.
2. Acquire both primary and secondary data to evaluate wetlands in the Project area.
3. Assess possible impacts of the project on identified wetlands.
4. Prepare protection and mitigation measures and propose monitoring plans

Annex B

Thailand Institute of Scientific and Technological Research Biodiversity 2013 Survey Method

The following method was provided by The Thailand Institute of Scientific and Technological Research.

B.1 SURVEYS

Field investigations were undertaken in four key areas associated with the Project:

- NNP1 Project area;
- Nam Xan River Catchment;
- Huay Ngua Provincial Preserved Area; and
- Houy Soup Resettlement Site.

Surveys were undertaken by three teams comprising 25 people targeting separate taxa: vegetation (two teams of 7), terrestrial wildlife (one team of 6) and aquatic biota (one team of 5).

B.1.1 Forest and Vegetation Survey

The Forest and Vegetation Survey was designed to assess the overall status, quality, and conservation significance of existing forest/vegetation types, taking into consideration global, national and local conservation priorities; and to assess the diversity and availability of Non Timber Forest Products (NTFPs). In summary, the Forest and Vegetation Survey included the study of species diversity and the conservation status of vascular plants based on field survey and literature review. Specifically it included:

- review of literature obtained from secondary sources, including flora journals and reports on other surveys of the area;
- a vascular plant survey of 9 Study Sites (the main dam site, re-regulation dam site, resettlement site, Huay Ngua Provincial Preserved Area, Upper Nam Ngiep River and Lower Nam Ngiep River, the Upper Nam Xan River, Lower Nam Xan River, and Transmission line);

B.1.2 Methods

The forest survey team specifically surveyed for species diversity along trails and in the sampling plots. Intensive surveys were conducted on the transect lines and covered all vegetation types. Unknown plants were collected and three duplicates of leave with flowers or fruits for further analysis in the laboratory. Botanists recorded necessary information i.e. morphology, habit, colour of flowers and ecology, georeferenced location, and compiled photographic records.

The sampling plots consist of 3 types of temporary plots:

1) A circular sample plot with a radius of 17.85 meters (or 0.1 ha): data of trees which are diameter at breast height (DBH) $\geq$ 10 centimeters were recorded. Other significant information were recorded and measured such as tree species, DBH, total height, timber quality, number of log (1 log = 5 m timber), and bamboo species, including number of clumps and stems per clump.

2) Square plots of 5x5 meters (25 square meters or 0.0025 ha) were established in the middle of the circular plots. Information of small trees and/or saplings (trees whose DBH < 10 centimeters and whose height >1.3 meters), tree species, number of tree, and height, as well as NTFP species were recorded from these plots.

3) Square plots of 2x2 meters (4 square meters or 0.0004 ha) were established within the larger square plots of 5x5 meters. Data concerning plant species, number of seedling, and undergrowth vegetation was recorded.

Analyses of the data collected included specialised laboratory investigations to establish identification of voucher specimens. Quantitative analysis of the data included analysis of tree density, frequency, volume, of tree species and was determined as per Curtis and McIntosh (1950). Timber volume ($\overline{V}$) per survey plot was estimated using Thannarin (1999). Relative density (RD_i), Relative dominance (RB_i) and Relative frequency (RF_i) of a given species were also calculated. Important value Index (IVI_i) was used to determine the overall importance of each species in the community structure was calculated from the (Curtis, 1959). A Complex index of a particular forest type (CI) was also calculated and Species diversity and dominance of a given species were evaluated using Shannon–Weaver (1963) index of diversity (H').

A forest status assessment was undertaken considering the environmental factors within the forest including forest impact assessment including wood density, volume, composition, functions of the forest, and ecological value of forests and external factors. External factors include areas of forest cover, conservation and management, and anthropogenic activities in the study areas.

B.1.3 Timing

Surveys were completed during the dry season March 2013 and wet season July 2013.

B.1.4 Terrestrial Wildlife Survey

The Terrestrial Wildlife survey aimed to describe the baseline wildlife diversity of the impact zones for the purposes of assessing the potential Project impacts to terrestrial wildlife. Survey and sampling work involved developing an inventory of wildlife species (amphibians, reptiles, birds, and mammals).

B.1.5 Locations

A total of eight study areas were assessed for the Wildlife Surveys and included, the Resettlement site, Huay Ngua Provincial Preserved Area, Nam Ngiep River, Nam Xan River, Upper Nam Ngiep River, Lower Nam Ngiep River, Upper Nam Xan River, and Lower Nam Xan River.

Locations	Name of Stations	Co-ordination (Zone 48 – WGS84	
		X	Y
Phase I			
1. Huay Ngua Provincial Preserved Area	W-HN 1	356228	2059137
2. ***NAM NGIEP RIVER***	W-NN 1	339152	2090130
3. ***RESETTLEMENT SITE***	W-NN 2	334859	2077355
4. Nam Xan River	W-NX 1	370097	2056174
Phase II			
1. Lower Nam Ngiep River	W-NN1	350224	2063700
2. Upper Nam Ngiep River	W-NN2	339168	2090130
3. Upper Nam Xan River	W-NX1	373166	2082542
4. Lower Nam Xan River	W-NX2	370849	2058609

B.1.6 Methods

The methodology adopted in the wildlife survey was included a literature review of previous publications, papers, reports, internet, etc., relating about wildlife within the study areas. The Wildlife inventory of each group was collected through the following techniques:

1) Direct count: This method was carried out to count directly numbers of amphibians, reptiles, birds, and mammals by sightings during the field surveys at the survey stations. Observations and records of animal signs such as tracks, nets, burrows, droppings, hair and feathers, were also recorded. Details of the techniques used for each group include:

    i. Amphibians and reptiles: species searches were undertaken in habitats such as under logs, rocks, bark as well as digging in the buttress of trees. At night, spotlighting was used to detect nocturnal species along rivers, around poundages, and within tree canopies.

    ii. Birds: were directly observed using binoculars during day time. Some species of birds were identified using call identification during the morning or evening, when they are the most active. Birds were also caught using mist-nets under tree canopies or cross the creeks these were identified, photographed, and released.

    iii. Mammals: were observed from their signs such as tracks, scats, scratches on trees, burrows, etc. small mammals, were captured using live-traps or Sherman's traps. Bats were surveyed at night

using mist-net and harp traps placed under tree canopies or cross creeks. Some species of mammals were identified from local hunters.

For all wildlife species the habitats were recorded. In the case of unidentified these were collected and preserved and later analysed at the laboratory in the Natural History Museum-Nation Science Museum, Prathum Thani, Thailand.

2) Indirect count: was used to obtain supplementary information on wildlife by interviewing local residents who lived in or near by the Project area. Some local villagers may hunt animals for food or for sale. Local households as well as local markets were also sampled.

Habitat evaluation: was undertaken recording information on plant species acting as the sources of food and cover. Plants used for foraging and their frequency of observation will be utilised from the forest inventory.

Species Diversity: Wildlife identification of each group using keys and descriptions from the standard references (Corbet & Hill (1992), Francis (2008), and Lekagul & McNeely (1988); avian species were mainly referred to Lekagul & Round (1991) and Robson (2002); reptiles species were identified base on Taylor (1963) and Cox *et al*., (1998); and amphibian species were classified using Taylor (1962) and Chan-ard (2003).

Relative abundance of wildlife: was calculated from numbers obtained in the direct and indirect counts, species were assigned as abundant, common, and less common using a calculation formulated by Pettingil (1969).

B.1.7 Timing

Surveys were completed during the dry season March 2013 and wet season July 2013.

B.1.8 Aquatic Biota Survey

The Aquatic Biota survey aimed to determine the baseline fish biodiversity and aquatic resources of the Project Affected Area and the proposed offset sites. Sampling was conducted at different locations in Nam Ngiep, Nam Xan, Huay Ngua PPA and the Houy Soup resettlement area. This included 5 sampling sites (NNg1 through to NNg5) upstream of the proposed main dam and 3 sampling sites (NNg6 through to NNg8) downstream of the proposed main dam in the Nam Ngiep Catchment, 5 sampling sites (NX1 through to NX5) in the Nam Xan Catchment, 2 sampling sites (HN1 and HN2) in the Huay Ngua PPA and 2 sampling sites (RA1 and RA2) in the Houy Soup resettlement area.

In summary, the Aquatic Biota Surveys included:

- Collection of phytoplankton and zooplankton species using multiple plankton net surveys at each location, followed by preservation, identification and laboratory analysis at TISTR;

- Collection of benthos at multiple replicate sites using an Ekmann dredge, followed by identification and abundance counts at the TISTR laboratories; and,

- capture and identification of fish species within the main rivers and their tributaries using the help of local fishermen using multi-mesh gillnets, electrofishing, cast nets, gun and hook, as well as discussions with fishermen and other information sources.

Annex C

Species Specialist Acknowledgements

Table C.1 Species Specialist Input

Specialist	Relevant Species	Comment
Pheng Phengsintham (National University of Laos)	Flora species	Provided ground truthing and specialist comment
Ajay Desai (Asian Elephant Specialist Group)	Asian elephant	Provided comment and contacts
Kham khoun Khounboline (WWF Greater Mekong)	Asian elephant	Provided specialist comment
Daniel Challender (Pangolin Specialist Group)	Sunda pangolin	Provided alternative contact
Dr Christine Breitenmoser (IUCN Cat Specialist Group)	Cats	Provided alternative contact
Anthony Rylands (IUCN/SSC Primate Specialist Group)	Phayre's leaf monkey, Northern white cheeked gibbon, Red-shanked langur	Provided alternative contact
Carola Borries (Research Associate Professor)	Phayre's leaf monkey	Provided alternative contact
Dr Benjamin Rawson (IUCN/SSC Primate Specialist Group)	Northern white cheeked gibbon	Provided specialist comment
Dr Phiavanh Phiapalath (IUCN/SSC Primate Specialist Group)	Phayre's leaf monkey, Northern white cheeked gibbon, Red-shanked langur	Provided ground truthing and specialist comment
Dr Will Duckworth (Independent Researcher)	All mammals, birds and some reptiles	Provided specialist comment
Dr Peter Paul van Dijkp (Tortoise and Freshwater Turtle Specialist Group)	Big headed turtle	Provided specialist comment
Adre Botha (IUCN/SSC Vulture Specialist Group)	White backed vulture	Provided alternative contact
Richard Hearne (IUCN SSC Duck Specialist Group)	White-winged duck	No advice
Baz Hughes (Wildfowl and Wetlands Trust)	White-winged duck	No advice
Professor Gordon McGregor Reid	Fish species	Provided contacts
Dr Maurice Kottelat	Fish species	Provided specialist comment

Annex D

Targeted Primate Survey

Nam Ngiep 1 Hydropower Development Project

Surveys of Endangered Primate in the Inundation Area of Nam Ngiep 1 Project

Phaivanh Phiapalath, PhD

January 6, 2014

Table of Contents

1. Introduction

This report has been compiled to present results of surveys undertaken from 14 December 2013 to the 18 December 2013 for the presence, distribution and populations of endangered primate species within the inundation area of Nam Ngiep 1 Project (NNP1).

The NNP1 project is located in the triangle of Bolikhamxay, Xiengkhuang and Vientiane Province. This survey is a targeted survey to provide additional information to the EIA report as requested by the ADB to ensure that the endangered primate species and their associated habitats are identified and understood to allow for appropriate mitigation measures if any adverse impacts are identified.

Nam Ngiep Project 1 (NNP1) has an output of approximately 269 MW, the main project component consist of a relatively small reservoir (ca. 7,000 ha) with a width (0.5 km) and a length of the reservoir (ca. 70 km). The Nam Ngiep hydropower dam has its reservoir level of ca. 75 m above the river base or ca. 320 m above sea level. It is high terrace dam but narrow reservoir. There are only 6 villages and ca. 2,500 people to be resettled which is considered small population.

Nam Ngiep River flows through rocky mountain valleys as steep valleys in most parts. The river has four main tributaries, the Nam Chae, Nam Phong, Nam Siam and Nam khai as key watersheds. Another seven small tributaries have also been identified as important watersheds for NNP1. Along the river itself the proposed inundation area topography and land uses varies from section to section.

The majority of the project area is mixed deciduous forest and evergreen forest in upper mountains. The lower areas or foothills especially the upstream of Nam Chae and downstream of Nam Houy Keng Ngon are dominated by fallows, current slash and burn practice, and logging activities. According to the riparian forest characteristic the whole inundation area can be classified into 5 sections as following:

Table 1. Habitat description by sections

Section	Name of location range	Habitat description
1	Upstream of Nam Chae	Degraded habitat, fallows, bananas leaves, weeds
2	Nam Chae to Houy Kao	Some fallows, degraded habitat due to previous and current logging activity.
3	Houy Kao to Houy Keng Ngon	Quite good habitat, hilly valley, healthy riparian forest and also uphill mountains of both sides
4	Houy Keng Ngon to Houy heuafan	Some fallows and new slash and burn on the left bank and mid-lower mountain, all fallows in right bank, some logging activity.
5	Downstream of	Degraded habitat presence of grassland due to over slash

	Houy heuafan	and burn, some logging activity.

There are 11 villages located within the proposed inundation area, mainly in the upper part of the reservoir but only three villages in the lower reservoir. Due to these settlements the forest habitats of upper and lower reservoir have been modified.

NNP1 is situated in a remote area and as such a number of endangered species have been identified as potentially occurring within the project locality. Three endangered primate species have been identified from the previous biodiversity survey work as potentially occurring within the proposed inundation area of the NNP 1. This survey was conducted to establish the presence of these species and their related habitats within the inundation area.

2. Objective

- To conduct survey of Northern white cheeked Gibbon, Red-shanked Douc Langur and Phayre's Leaf Monkey in the inundation area;
- To obtain a population of the target primate species in the inundation area;
- Identify critical habitat that suitable for the target species in the project area.

3. Survey Species

Lao PDR is considered one of richest countries in terms of biodiversity in Southeast Asia. There are 24 National Protected Areas (NPAs) declared that are of conservation significance (see Fig. 1). The national protected area covers 15% of the country. Also, 49 national protection forests and over 100 provincial and district protected areas. These conservation forests support populations of critically and endangered wildlife species. Apart from these designated protected areas and protection forest it has production forest and also non-protected area. The NNP1 project area is within a non-protected area.

The Nam Ngiep project 1 area is a remote area that has been identified as potential habitat for three endangered primate species including Northern White-cheeked Gibbon, Red-shanked Douc Langur and Phayre's Leaf Monkey.

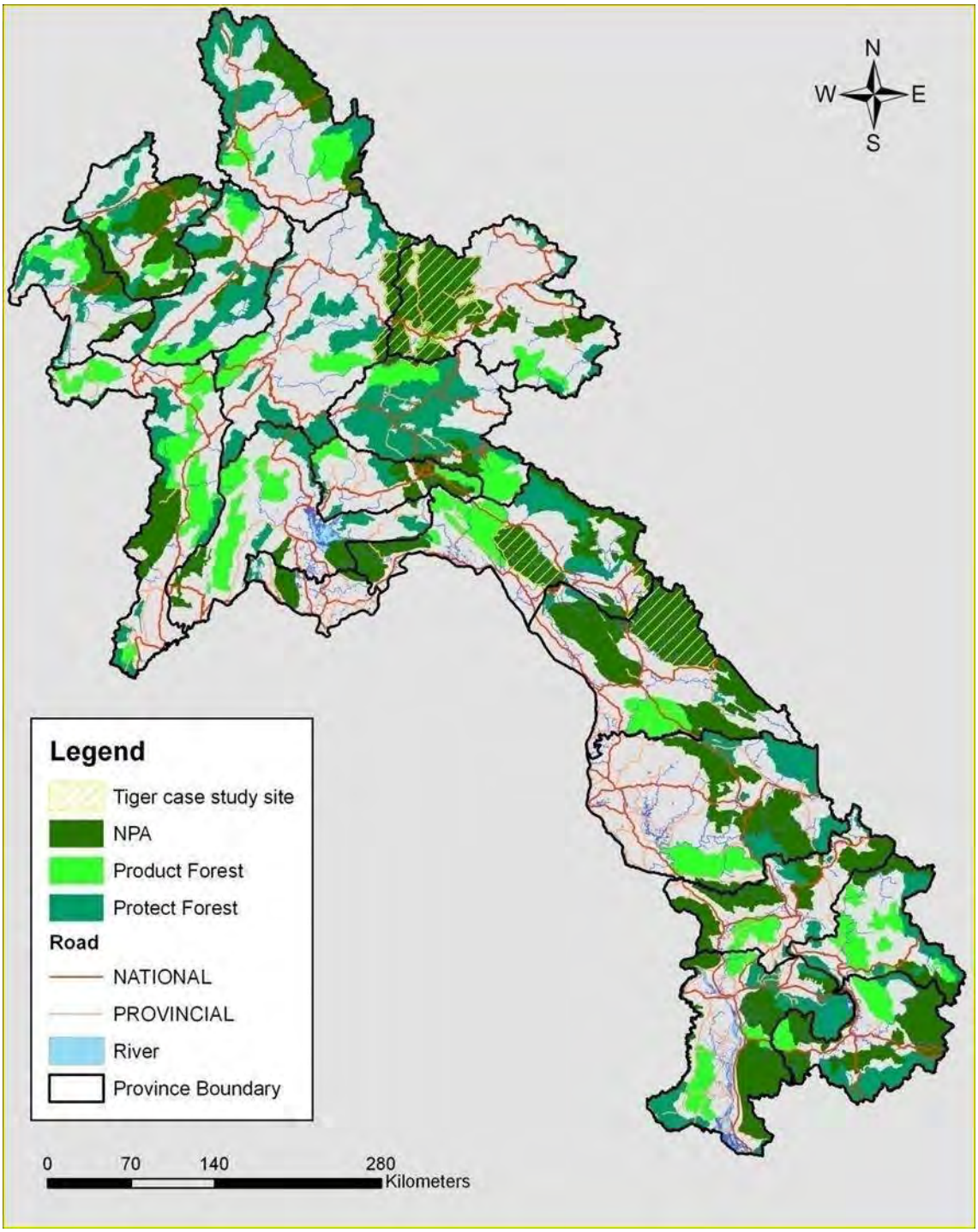

Figure 1. Map of three forest types in Lao PDR

Northern White-checked Gibbon *(Nomascus leucogenys)* - Critical Endangered

Globally: this species is critically endangered, found only in Lao DPR, China and Vietnam. Lao PDR holds nearly all of the world's remaining wild Northern White-cheeked Gibbons and may hold all the viable populations. In southern China, Xishuanbanna, Yunnan Province, close to Luang Namtha Province (Fan Pengfei *et al.* 2009) was confirmed but very low as it is probably on the verge of extinction in the wild. While, in Vietnam it has recently only been recorded in a few forests close to the Lao border, but the viability of all remaining populations is questionable. As such it is an outstanding global priority for conservation of this species.

Regionally: this species is endemic to southern China especially in Lao PDR. Within Laos, the species has been exist from northern part of Nam Kading NPA in Bolikhamxay Province which a range crossing from west at Mekong to northeast at Annamite Mountain Range as around northern Nam Kai Nam Theun NPA. Entirely this section up the northern country wide is believed to have only Northern white-cheeked Gibbon except the west of Mekong River where the distribution of White-handed Gibbon and Western Black crested Gibbon.
Nationally: the population of Northern white-cheeked Gibbon in Lao PDR is quite large as globally important population. It has a distribution range from the far north east of Lao PDR to the area of the Nam Kading River in Nam Kading NPA (Thinh *et al.,* 2010). There are several National Protected Areas (NPA) that the species' range within Lao PDR including Nam Et–Phou Louey NPA representing surely the largest patch of little-encroached and effectively managed habitat for the species. It is reported about 15 groups (WCS, 2010) found in a small proportion of the NPA but the entire gibbon population has not been estimated. Nam Kading may also hold considerable populations of this species. In both Nam Kading and Nam Et-Phou Louey NPAs the crested gibbons are key species for management and ongoing conservation is confirmed through donor support and technical input from the Wildlife Conservation Society (WCS). Populations of this species is persist in the Nam Xam NPA. The small numbers in Phou Den Din NPA, Phou Khao Khoay NPA, Phou Sabot Pongchong and Phou Phanang NPA. In addition, Thinh *et al.* (2010a) considered that *N. leucogenys* still exists outside the NPA system in northern Lao PDR in Oudomxay Province, Vangvieng District and also northern Bolikamxay Province that joins with Vientiane Province.

This species spends most time in trees and prefer most in evergreen forest. They give song in early morning and most active from November to March. They need the habitat, canopies connected for traveling. They feed on wild fruits as *Ficus* tree is best but they do rarely descend on the ground. Where a wide river that has no gallery forest of both sides closing to each other is a barrier for the species to cross so most a wide river such as Nam Ngiep River is already a barrier for the gibbon groups present in both river sides. It has a home range of ca. 40 ha but depends on habitat quality. Where best habitat quality and high

density of gibbon groups their home range is smaller than other site with low habitat quality. Estimated records of groups size of gibbons in Laos are at Hin Namno NPA is 3.8 (Phiapalath, 2009) and 3.6–3.8 for the Western Black crested Gibbon in Nam Kan NPA (Geissmann, 2007).

Red-shanked Douc Langur *(Pygathrix nemaeus)* - Endangered Species

Globally: this species is endemic to Indochina as only Lao PDR, Vietnam and Cambodia. In Vietnam, Red-shanked Douc Langur was found in Bach Ma National Park (Pham, 1993b), Phong Nha Ke Bang National Park (Pham *et al*., 2000), Phu Mat Nature Reserve (Lippold, 1998), Kong Cha Rang Nature Reserve, Kon Khi Kinh Nature Reserve (Lippold, 1995), and Son Tra Nature Reserve (Lippold, 1977; 1995). These places are mainly in Vietnam's Central Highlands with altitude between 500–1,000 m above sea level (Timmins and Duckworth, 1999).

Regionally: this species is just the same status as the global status since it is endemic to only the Indochina which cannot be found elsewhere in the world.

Nationally: In Lao PDR, their habitats lie between 14˚25´ and 18˚25´ N as Nam Kading NPA is the most northern range of the species (Timmins and Duckworth, 1999). By province, the species distribution is in Bolikhamxay Province toward southern provinces. They can be found along the Vietnam border in the east, from Nam Chat catchment to the Cambodian border in the south (Timmins and Duckworth, 1999). Recently, the species has been recorded in Laos and that confirmed at 12 locations ranging from 200 to 1,500 m a.s.l., (Timmins and Duckworth, 1999). Specifically, Nakai-Nam Theun National Protected Area and Hin Namno National Protected Area support the largest population of the species in the world (Duckworth *et al.*, 1999; Timmins and Duckworth, 1999). A small to medium population of Red-shanked Douc Langur has also been reported at other eight sites in Laos including Nam Kading National Protected Area in Bolikhamxay Province, Phou Xang He and Dong Phouvieng in Savannakhet Province, Xe Bang Nuan and Sesap in Saravanh Province, Dong Hua Sao in Champasak Province, Dong Ampham and Nam Kong in Attapeu Province, and Phou Ahyon in Sekong Province (Duckworth *et al*., 1999; Timmins and Duckworth, 1999).

Red-shanked Douc Langur is found in similar habitats to Vietnam including limestone habitats (Duckworth *et al*., 1999; Timmins and Duckworth, 1999; Walston and Vinton, 1999). The Red-shanked Douc Langur is mainly found in primary forests but also in secondary forests. They can adapt to variety of forest types including semi-evergreen, hill evergreen, sub-montane evergreen, mixed deciduous, mixed evergreen and closed broad-leaved tropical forests (Lippold, 1998).

Red-shanked Douc Langur is diurnal and arboreal, as is normally found in the group of colobids, spending a major proportion of their daytime for feeding in the wild (Lippold, 1995) – both leaves and fruits. Also, the species mainly lives in the mid to upper levels of the forest canopy. Groups of Red-shanked Douc Langurs reportedly move through the forest canopy along established routes. An adult male is the group leader and all group members follow when he moves. Females and infants are often found in the center and juvenile males bring up the rear during their locomotion (Lippold, 1995; 1998).

This species spends most time in trees and prefer most in evergreen forest. They need the habitat with connected canopies for crossing. Where a wide river it is a barrier for the species to cross from one to another side because this specie is usually not descending on the group. This species is reported they descend on ground for feeding on ground in begin dry season (Phiapalath, 2009) and also use mineral licks (Rawson et al., 2011). Group size of Red-shanked Douc Langur varies depending on habitat and human disturbance. In the past, they lived in groups of 30–50 individuals (Lippold, 1995) in Vietnam. Groups as large as 50 individuals have been reported in Kong Cha Rang Nature Reserve and Kon Khi Kinh Nature Reserve (Lippold, 1995). It is normally a group size ranging18-40 in Lao PDR (Phiapalath, 2009). Nevertheless, in areas with high pressure of human activity, the group size is much smaller, with as few as 4-5 individuals (Lippold, 1998). The home range of the species ranges is ca. 250 ha (Phiapalath, 2009).

Phayre's Leaf Monkey *(Trachypithecus phayri)* - Endangered Species

Globally: this species is found in many countries including India, Bangladesh, China, Thailand, Laos and Vietnam (Bleisch, 2008; Ruggeri and Timmins, 1996). Population of this species is quite large as expand beyond Southeast Asia.

Regionally: this species is quite good population in the region and distributed in all countries except Cambodia. Thailand has three areas that this species reported (Houy Khakhaeng and Phou Khieo National Park and northern country (Borries et al. 2011). It is also found in central and northwest Vietnam.

Nationally: although Phayre's leaf Monkey live in evergreen forest and mixed deciduous forest. This species distributes in central to northern Laos (Timmins *et al*., 2011) as reported in 7 NPAs, mainly Phou Dendin, Nam Et-Phou Loey, Nam Phoui, Nam Kan NPA, Phou Phanang, Phou

Kha Ya (Duckworth et al. 2009, Phiapalath, 2012).

This species spends a majority of time in trees and descend to the ground for using mineral licks usually once for every two weeks. The species feed on leaves including bamboo buds and wild fruits. A group size of this species is quite large as ca. 30 individuals in Nam kan NPA but range 15-30. The home range according to the study group in Phou Kieo National Park is about 80 ha (Pages et al. 2011).

4. International Standard and Requirement

As to ensure sustainable investment and development there are several key international environmental standards for which the NNP1 project must follow:

- IFC Performance Standard 6
- ADB Environment and Social Safeguard (2009)
- World Bank Safeguard Policy

Under these environmental standards a project area must determine the presence of three habitat categories *Modified habitat, Natural habitat, Critical habitat.* These habitats may contain a large population of some or more fauna and flora as the habitat may support some critical ecosystem.

The international standards are concerned about the loss of critical habitats that could result in a reduction of a population of critically or endangered species. The IFC standard 6 recognizes that protecting and conserving biodiversity; maintaining ecosystem services and; sustainably managing living natural resources are fundamental to sustainable development.

Critical habitat are areas with High biodiversity value or High Conservation Value (HCV), including habitat required for the survival of critically endangered or endangered species according to IUCN Redlist 2013. It can be areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; supporting globally significant concentrations, evolutionary processes or provide key ecosystem services; and areas having biodiversity of significance. Also, it is about those areas of international recognition such as Ramsar Site, World Natural Heritage including National Parks and National Protected Areas. Similarly, ADB and World Bank safeguards have to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process (reference?).

No project activities should be undertaken unless;

(i) there are no measurable adverse impacts such as critical habitat;

(ii) the project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species;
(iii) (iii) no mitigation measures are designed to achieve at least no net loss of biodiversity and;
(iv) any lesser impacts are mitigated.

If a project is located within a legally protected area, implement additional programs to promote and enhance the conservation aims of the protected area. In an area of natural habitats, there must be no significant conversion or degradation, unless;
(i) alternatives are not available;
(ii) (ii) the overall benefits from the project substantially outweigh the environmental costs, and
(iii) (iii) any conversion or degradation is appropriately mitigated. A combination of actions, such as post-project restoration of habitats, offset of losses through effective conservation action.

5. Survey Methods

5.1 Survey Area and Locations

The survey area was the proposed inundation area with a focus on potential habitats of the target species starting from Nam Chae to the proposed dam site. The survey area for each site was within 1-2 km from the inundation area or the river. Four survey clusters were established in the proposed inundation area and surveys were conducted by five sub-survey teams (see Fig. 2).

Specific survey routes designed where potential habitats, mineral licks and where the species have been reported by local hunters. The survey was designed to cover all potential habitats associated with the inundation area.

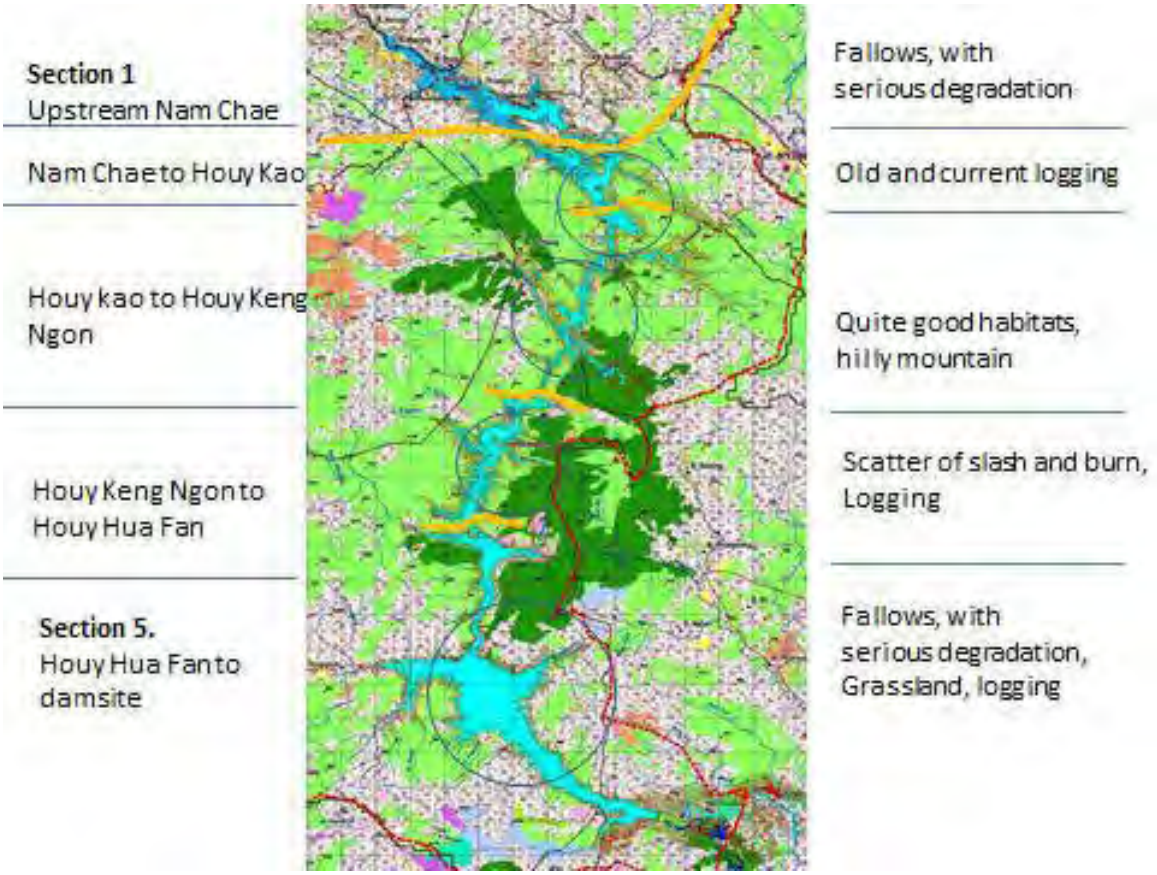

Figure 2. Map of the survey clusters

5.2 Survey Technique

Primate survey was conducted through direct field establishing listening post for gibbons and reconnaissance surveys for non-vocal primate. Additional data from village interviews was collected with boat men, hunters and elders in Ban Pou, Ban Sop phouan and Ban Sop Youak.

The surveys undertaken for other primate species which are quite different for gibbons as non-vocalization primates such as Red-shanked Douc Langur and Phayre's Leaf Monkey.

For the gibbon survey a listening post was established by each sub-team at predetermined locations that were selected based on vegetation type prior to the field trip. A total of 20 listening surveys were conducted in 5 listening posts. Each sub-team survey site were separated by about 2 km and camps were set at determined locations, waypoints to be recorded in their GPS. A short training session took place prior to departure at Ban Pou. All the sub-teams moved from the first survey cluster at Nam Chae down to the first survey cluster at downstream of Ban Sop Youak. The technique is to listen to gibbon song in early morning from 5.50 am to 7.30 am, using listening post data form. Song types and times, bearing from listen post and approximate distance were recorded. In areas with high

gibbon population more than one group would be heard. When gibbon songs are heard coming from different directions they are considered to be different groups if they start in different time. If from the same direction and same distance although more than one song, we will consider that it would be just one group. If a good call is heard we conclude that it is a group, otherwise a solo song is considered likely individual male. The distance of gibbon song locations are roughly estimated based upon how loud the song is heard, but no more than 2 km.

Given a small reservoir along the river straight, the survey for Douc Langur and Phayre's Leaf Monkey was for the total count technique as each sub-team to search for the target animals in their areas of responsibility within 1-2 km. In early morning while two persons recording gibbon song and other two people were surveying within 2 km around the camp. We used 7 sub-survey teams per day made a total of 28 sub-survey team days. Encounter a group of the target animals the site location, species and individuals of the group were recorded.

Figure 3. A sub-team 2 on listening post

Also, the two persons who had finished listening post they then started survey walk which each sub-team agreed who to go which direction from the camp and returned at 10.30 am. Direct observation, using binoculars for scanning through forest canopies or detect from seeing trees moving. Any evidence of the target species was recorded such as feeding at mineral licks by Phayre's Leaf Monkey. Data forms and guidebooks were used for the survey.

The distance from camp to camp was 2 km. Each team arrived next camp before 4.00pm and prepared their camp. Noise at camp was minimised to not disturb gibbons in the area as this would result in animals not singing in the morning.

A team wrap up was conducted in Ban Sop Youak on Dec 18, 2013 to the sub-teams findings. Each sub-team checked local names and recorded key waypoints.

Figure 4. Data summary and wrap up at Ban Sop Youak

5.3 Data Analysis

Gibbon population

In principle, a number of groups recorded and average group size of the gibbon groups as the group size to be recorded from at least two cross-lines by two sub-teams. However, the survey found only two gibbon records at single listening post so we did not necessarily analyze the data.

Douc langur and Phayre's Leaf Monkey

As the total count technique for rare species which is based on a sum of total number of groups and individuals counted by sub-teams. However, we found only one evidence of the Phayre's Leaf Monkey but no douc langur was recorded nor reported during the survey.

5.4 Survey schedule

The field work started in Dec 13-18, 2013 as 4 days used for forest survey work.

Table 2. Itinerary

Date	Activity	Location
Day 1	Travel to Paksan	Paksan town
Day 2	Travel to Ban Pou, conducted short training and left for fieldwork by boat.	Ban Pou
Day 3	First camp, conducted listening post and survey walk. Completed the first survey cluster, continue to other survey clusters	
Day 4	Field survey continued	
Day 5	Field survey continued	
Day 6	Field survey continued, travel to Ban Sop Youak, wrap up and then Vientiane	
Day 7	Debrief to technical team of NNP1	NPP1 Office
Day 8	Present results to senior and manager teams of NNP1	NPP1 Office, video Conference with ERM team
Day 9	Prepared technical report	VTE
Day 10	Prepared technical report	VTE
Day 11	Present results of the surveys to ADB teams	NPP1 Office, video Conference with ADB
	Revise the draft report	
Jan 9	Submit the report	ERM,

5.5 Participants

There are about 49 participants include boatmen and from 6 organisations including Wildlife Conservation Association (WCA) as main technical assistance, ERM, NNP1, government officers (Thathom District, Xiengkhuang), solders of Thathom District, local villagers including boatmen.

Table 3. List of participants

No	Participant	Position	Organisation
1	Phaivanh Phiapalath	Consultant. Team Leader	Wildlife Conservation Association
2	Adam Greenhagh	Consultant	ERM
3	Mickxaykone Phiemmala	Team leader Assistant	Wildlife Conservation Association
4	Sisuthone Oupaxayorvanh	Team leader Assistant	Wildlife Conservation Association

5	Vilaysack Itiem	Team leader Assistant	Wildlife Conservation Association
6	Mr. Vongphanit Viengkeo.	Technician	DoNRE, Hom District.
7	Mr. Thongmee Boualapha	Head	DAFO, Thathom District
8	Mr. Va jeu xoing	Villager	Ban Sopyouak
9	Mr. Thong ku yang	Villager	Ban Sopyouak
10	Mr. Chao xoing	Villager	Ban Sopyouak
11	Mr. Tou xoing	Villager	Ban Sopyouak
12	Mr. Kaiy xoing	Villager	Ban Sopyouak
13	Mr. Bee xoing	Villager	Ban Sopyouak
14	Mr. Pao Dau her	Villager	Ban Soppouan
15	Mr. Lai phone lor	Villager	Ban Soppouan
16	Mr. Khamkai	Villager	Ban Pou
17	Mr. Ny	Villager	Ban Pou.
18	Mr. Ket	Villager	Ban Phiengta
19	Mr. Pheng	Villager	Ban Phiengta
20	Mr. Somphet	Villager	Ban Hatsamkhone
21	Mr. Chomphet	Villager	Ban Hatsamkhone
22	Mr. Air.	Villager	Ban Pou.
23	Mr. Hong	Boatman	Ban Pou
24	Mr. Lob	Boatman	Ban Pou
25	Mr. Thone	Boatman	Ban Pou
26	Mr. Syvone	Boatman	Ban Pou
27	Mr. Lou	Boatman	Ban Pou
28	Mr. Vieng	Boatman	Ban Pou
29	Mr. Puen	Boatman	Ban Pou
30	Mr. Aoth	Boatman	Ban Phiengta
31	Mr. Phouang	Boatman	Ban Phiengta
32	Mr. Phong	Boatman	Ban Phiengta
33	Mr. Aon	Boatman	Ban Pou
34	Mr. Xiengken	Boatman	Ban Pou
35	Mr. Peuy	Boatman	Ban Pou
36	Mr. Symone	Soldier	Thathom District
37	Mr Khammy	Soldier	Thathom District
38	Mr. Bounsouk	Soldier	Thathom District
39	Mr. Khamla	Soldier	Thathom District
40	Mr. Somvang	Soldier	Thathom District
41	Mr. Xaysomphet	Soldier	Thathom District
42	Mr. Somsay	Soldier	Thathom District
43	Mr. Soulivanh	Soldier	Thathom District
44	Mr. Ngon	Soldier	Thathom District
45	Mr. Vanhthaxay	Soldier	Thathom District
46	Mr. Souksavanh	Staff	NNP1PC
47	Ms. Chanmaly	Staff	NNP1PC
48	Mr. Chao xoing	Villager	Ban Sopyouak

49	Mr. Tou xoing	Villager	Ban Sopyouak

Figure 5. Boat trip arrangement and camping

5.6 Equipment

Table 4. List of equipment

No	Equipment
1	GPS (7 units)
2	Compass (5 units)
3	Topo map of a scale: 1:50,000
4	Cameras (5) and video (1)
5	Binoculars (5 units)
6	Compass (5 units)
7	Tape recorders
8	Guidebooks
9	First Aid Kit (5 units)
10	Hand held Talki walki (5 units)
11	Satellite phone (2 units)

6. Results

6.1 Description of habitats

Majority of the habitats along the reservoir straight have been modified to agricultural land especially the upper and lower reservoirs. The area that is far from settlement such as from Houy Kao to Houy Keng Ngon remains good riparian forest.

6.1.1 Habitats in the inundation areas

According to the field observation and reconnaissance surveys the habitats along the reservoir straight can be classified into 5 sections (see Fig. 2) as following:

Section 1: Upstream of Nam Chae, this section is large but not in our survey cluster due to existing habitats have been seriously degraded by conversion to agricultural area. Various ages of fallows including existing hill rice field were observed. This section is quite gentle so both foothills and upper mountain have been totally converted. Bananas trees were observed scattered along the section.

Figure 6. Degraded riparian habitat and fallows

Section 2: Nam Chae to Houy Kao where the first survey cluster took place. This section is small and considered degraded habitat as the foothills were converted to agricultural land and change in forest canopies due to logging. Old logging road was observed in Upper Mountain of this section. It is mixed deciduous as highly dominated by bamboo forest. One mineral lick (Pong Chae) was found in this section. However, no evidence of wildlife using this mineral lick were identified and that consequently was overgrown with weeds. One small area of salt soil was found in this section.

Figure 7. Degraded forest habitats

Figure 8. Degraded forest canopies and old logging road

Figure 9. Old mineral licks (Pong Chae) and salted soil

Section 3: Houy Kao to Houy Keng Ngon where the second survey cluster took place. This section is large and considered good forest habitat as mixed deciduous forest in lower valley and evergreen in Upper Mountain. Riparian forest is still in good condition and also Upper Mountain although some old logging road was found in this section. The left bank of this section, a high density of fig trees were found as this tree is critically important for any wild animals by providing fruits all year round, fig trees were found along the survey routes of the team 1 of day 2 (T1.2). Also, the right bank a portion of evergreen forest away in uphill mountains was reported a presence of gibbons and Phayre's Leaf Monkey.

Figure 10. Good riparian forest

Figure 11. Good forest habitat

Figure 12. Fig tree (Ficus, Moraceae)

Section 4: Houy Keng Ngon to Houy huafan where the third survey cluster took place. This section is considered degraded forest habitat as portion of hill rice fields and fallows was found especially the right bank of the river has been totally converted to agricultural land while only new hill rice field found in scatter in the left bank. Evergreen in Upper Mountain remain some good habitat in the left bank such as Pha Phanong which team 3 reached the area and considered good evergreen forest (UTM 2081230/334861).

Figure 13. Portions of hill rice filed and fallow

Figure 14. Portion of forest habitat conversion

Section 5: Houy Huafan to Damsite where the fourth survey cluster tool place. This section is large and considered degraded forest habitat due to slash and burn practice such as the team 3 camped at Phou Khapha (UTM: 2068418/334585) certified as all follow in the

lower area. Most lower valleys were converted to agricultural land but some portion of evergreen forest can be found in Upper Mountains. Logging was observed in this section.

Figure 15. Degraded forest habitat

Figure 16. Habitat conversion, grassland

In conclusion, the proposed flooded area is not considered natural habitat, and consists of mainly old fallows, agricultural land and some riparian forest. There was no critical habitats or terrestrial ecosystem identified in the project area. The mineral licks are considered part of critical habitats, however, evidence of recent use was not recorded. Upper Mountain areas where the distribution of evergreen forest species was more abundant would be classed as a critical habitat if a number of endangered wildlife species are present, however given the lack of species presence and the relative condition of these areas only small population of endangered species is found in the area.

6.1.2 Records of the Endangered Primate Species

No Red-shanked Douc Langur was found nor reported. Nam Ngiep Project 1 is not in the distribution range of the species. the survey map is found in Annex.

Two records of gibbons during the survey from songs in morning. The first record by sub-team 2 at Houy Kao area heard gibbon song from northeast for about 1.5 km away and second record by sub-team 1 Houy Chili area heard gibbon song from northeast for about 2 km away. The local villagers believed that the second song would be from Phou Phahua. These groups were heard from upper mountains of the left bank.

Table 5. Listing post records of Northern White-cheeked Gibbon

Date	Location name	Coordinates		Time of song		Direction, Bearing	Distance (km)
		N	E	start	finish		
17/12/2013	Houy Kao	2069000	337719	6.10	6.30	NE, 60°	>1.5 km
18/12/2013	Houy Chili	2074329	334263	7.05	7.20	NE, 44°	2 km

According to the provisional data, 5 groups of this species were reported throughout the project area – both sides but predominately in the upper mountain areas which are away from the inundation area. There will be two groups in evergreen forest of Phou Thin and Phou Sam Liem of the far right bank and other three groups in evergreen forest of Phou Phahua and Phanoy of the left bank. Populations of this species are already fragmented by the river and habitat conversion.

One evidence of Phayre's Leaf Monkey was recorded on December 16, 2013 by sub-team 5 at Pong Chor (mineral lick) UTM: 2096370/342601 from hand prints as were found on the bamboo tree. The hand print of this animal is smaller and longer hand print compared to other sympatric primate. During the survey this species was well reported and that it was shot occasionally by hunters. One was shot last year at Houy Khai which a picture of the dead animal was taken.


Figure 17. Handprint of Phayri

According to the provisional data, there are about 10-13 groups present in the NNP1 watershed as below:

Location	Estimate Group	Left or right bank
1. Houy Chae area	1	left
2. Houy San area	1	right
3. Houy Khai area	3	right
4. Houy So area	1	left
5. Houy Lang Nong area	1	right
6. Pong Chor area	2	left
7. Houy Wai area	1	right
8. Pong Dinkhao area	1	left
9. Phou Phaheua	2	left
10. Phou Phanoy	2	left

About 6 groups of Phayri were reported in the right bank and other 7 groups in the left bank. The populations of Phayre's Leaf Monkey in both sides of Nam Ngiep River have already been fragmented.

Phayre's Leaf Monkey used mineral licks as part of its behavior ecology. The animal uses a mineral lick for food digesting. Mineral licks were surveyed and identified along the river. There are 10 mineral licks, of which 3 mineral licks are used by wild animals including Pong Xang, Pong Chor, and Pong Din kao. These mineral licks are known by local villagers. The mineral licks that are not used by wild animals today are due to the habitats surrounding the mineral licks being converted. Mineral lick is not only important for this langur but also other wildlife species particularly ungulate group.

Figure 18. Pong Sa, old mineral lick

No	Name of mineral licks	Coordinates (UTM)	Elevation (m)	Remarks
1	Pong Chae	2101417/0342528	319	flooded
2	Pong Sa	2101338/0342220	320	flooded
3	Pong Xang	2096370/0342601	316	flooded
4	Pong Chor	2096591/0343145	314	flooded
5	Pong Din deng	2099057/0342108		flooded
6	Pong Lang nong	2092468/0337406		flooded
7	Pong Houy hok			
8	Pong Din kao	2078410/0329472		flooded
9	Pong Keua	2005021/0334840		flooded
10	Pong Houy Chili			

These mineral licks will be flooded but some mineral licks were reported in Phou Thin and Sam Liem area of the right bank will remain after inundation. It is believed that another

side of Phou Phanoy and Phou Phaheua around Nam Ma River may have some mineral licks. The mineral licks in these areas that are not flooded will be used by the animals.

6.2 Records of some vulnerable species

There are three vulnerable species were recorded by chance during the survey including Stump-tailed Macaque, Northern Pig-tailed Macaque and Sambar Deer. There are 2 records of Stump-tailed Macaque from feeding sites (UTM 2100721/0342698; 2069692/0337253), 2 records of Northern Pig-tailed Macaque from hand print in soft soil UMT 20941432/ 0339279; 2080048/0331580. One Northern Pig-tailed Monkey was shot dead during the survey by local hunter on 17 December, 2013. Sambar Deer was recorded 4 times (UTM 2101338/0342220; 2096591/0343145; 20941432/0339279; 2088511/0341116).

Figure 19. Pictures of vulnerable species


Figure 20. Evidence of Stumped-tailed Macaque and Northern Pig-tailed Macaque

6.3 Key wildlife habitats

The key wildlife habitats that the gibbons and Phayre's Leaf Monkey were reported are in Phou Thin, Phou Pha Noy, Phou Pha hua, Phou Sam Liem. These locations are mainly evergreen forest and some mixed deciduous forest. Also, important watershed for NNP1.

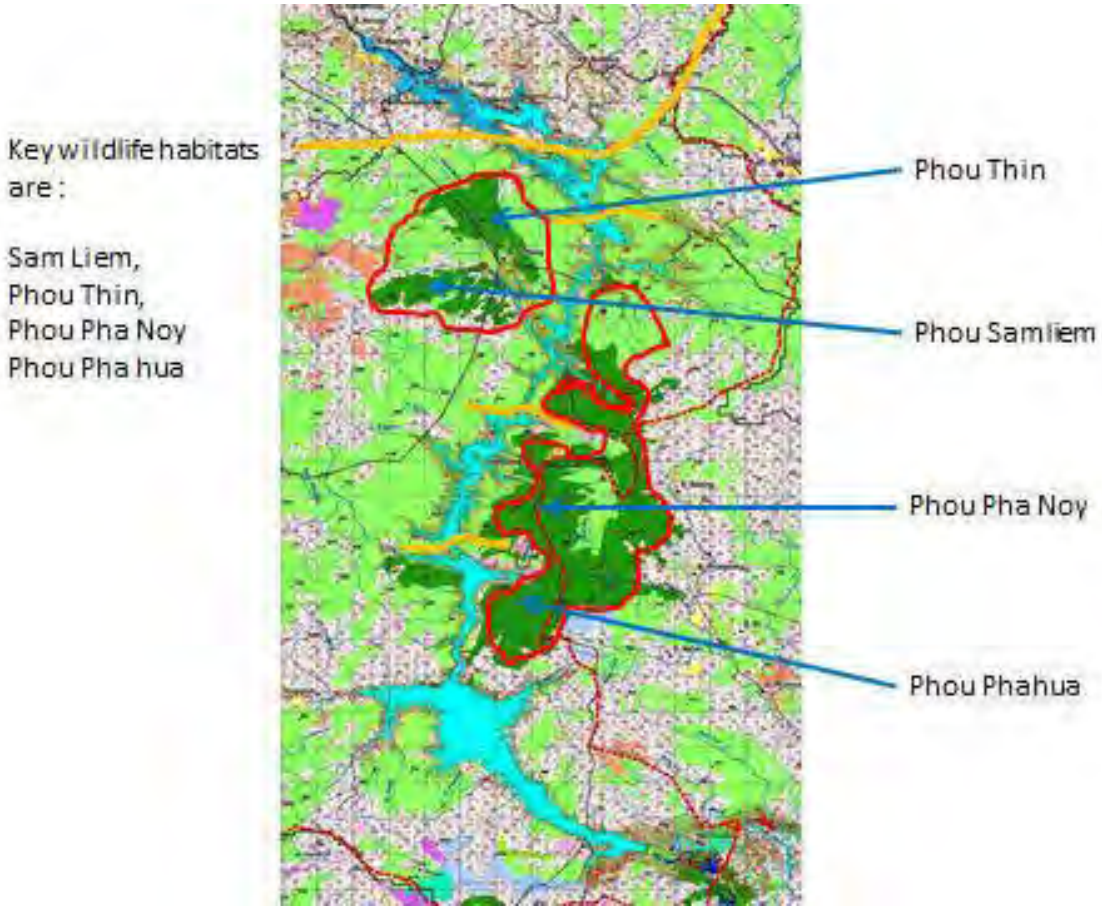

Figure 21. Map of the important wildlife habitat

6.4 Threats

Threat to wildlife and wildlife habitat is high in the area. Logging camps were found at Nam Chae, upstream of Ban Sop Phouan, downstream of Ban Sop Youak. According to the village interviews, Lao private firm receive quota for logging from the government but Vietnamese Loggers are hired to do log in the area. Hunting is common and that we found a number of gun man still holding a local gun. Hunting Phayre's Leaf Monkey is well reported in the area so the pressure from hunting is high in the area. Most hunters are local hunter, the Hmong people mainly in Sop Phouan, Sop Youak, and also Ban Pou and Ban Phiangta. Slash and

burn practice is an issue which made most forest habitat of upstream and downstream reservoir converted.

Figure 22. Logging camp of Vietnamese

7. Discussions

Nam Ngiep Project 1 hydropower project area has low biodiversity value. There has no particular critical habitats identified in the project area. Although gibbons are present in the project area their habitats are not be relevant to the inundation area. Population of this species remains very low in the area.

Phayre's Leaf Monkey has some minor impact due to their mineral licks will be flooded but mitigation measures are possible. The Phayre's Leaf Monkey population in Nam Ngiep project area is considered low. The global population of this species is large and distributed in many countries including India and Bangladesh. Therefore, the population of this monkey in the Nam Ngiep Project 1 is not significant. Apart from this in Lao PDR, the species is recorded in 7 National Protected Areas (NPAs) and some outside NPAs particularly the northern country. Once, the species will not impact by the development of Nam Ngiep 1 project. With availability of biodiversity offset plan by enhancing forest habitat and ban on wildlife hunting in the area will help better protect the species.

8. Recommendations

- Habitat rehabilitation as to make connectivity by leaving fallows to naturally grow and enrich where necessary.
- Artificial mineral licks to be established where possible especially in the area close to water body, mud flat etc. The potential location should be further identified and that the area is closed to the important habitats of Phayre's Leaf Monkey.
- Ban on wildlife hunting wildlife in the project area which regulation of wildlife and forest management should be developed.
- Develop a biodiversity offset plan for watershed protection, forest management and to support relevant local government departments for effective management of the Nam Ngiep watershed
- Ensure soil erosion protection in place (*Kok kkai*)

Figure 23. Mai Khai, as natural bank protection tree

Ensure maintaining flows of the main tributaries as to maintain fish breeding site when most part of Nam Ngiep is lost to the inundation.

Figure 24. Nam Hok, the small tributary of Nam Ngiep

9. Conclusion

NNP1 is a small and long reservoir thus is considered good dam according to the World Bank publication (Ledec & Quintero 2003) due to its small reservoir, narrow and length with minor impacts on natural habitats. Minor impacts would occur on only Phayre's Leaf Monkey and there would be no impact on the gibbons within the project area due to the low populations in the project area, and those populations being predominately located outside of the inundation area. Therefore, the development of Nam Ngiep 1 hydropower project will comply with international standard of IFC and safeguard policies of the World Bank as well as the ADB regarding *terrestrial biodiversity*.

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Annexes

Data forms

Listening post data form

Date	Location name	Coordinates		Time of song		Direction	Distance (km)	Type of song	Notes
		N	E	start	finish				

Observation data form for reconnaissance

Date	Time	Location name	Coordinates		Species (G, D, L)	Individual	Total estimate	Activity	Habitat type, distance from the river
			N	E					

Waypoints

❖ **Team 1**

- **Survey Camps**

ID	X	Y
1	342143	2100586
2	340230	2093334
3	335913	2086154
4	334263	2074329

- **Survey Pionts**

ID	X	Y
1	342199	2100662
2	342698	2100721
3	343043	2100941
4	342692	2101035
5	342620	2101192
10	340179	2091968
11	340203	2091846
12	340433	2091636
13	341206	2091923
14	335918	2086166
15	335851	2086250
16	335603	2086256
17	335498	2086186
18	335724	2085849
19	334377	2074072
20	334429	2074014
21	334513	2073988
22	334553	2074036

ID	X	Y
1	342035	2100568

2	342027		2100570
3	350018		2063605
4	340081		2092098
5	339869		2091904
6	335930		2086192
7	335931		2086192

ID	X	Y
1	342419	2100835
2	342419	2100686
3	342866	2100851
4	340286	2092934
5	340236	2092504
6	340484	2092057
7	340881	2091991
8	340137	2092470
9	334978	2086028
10	335342	2086028
11	334776	2074085
12	334958	2074003

- **Team 2**

- **Survey Camps**

ID	X	Y
1	342493	2099442
2	334300	2090263
3	333223	2080964
4	337719	2069000

- **Survey Points**

ID	X	Y
1	342027	2099954
2	334506	2090611
3	334400	2090839
4	333222	2080961

5	337252	2069692
6	337653	2069367
7	337653	2069367
8	337252	2069642
9	337252	2069642
10	342499	2099452
11	342496	2049476
12	342493	2099442
15	333550	2080614
16	334561	2090855
18	337252	2069692
19	337482	2069629
20	337555	2069429
21	337724	2068916
22	342457	2099878
23	341698	2099726
24	333915	2090983
25	332803	2081430
26	333207	2081835

❖ **Team 3**

- **Survey Camps**

ID	X	Y
1	340690	2094950
2	334041	2085549
3	334861	2081230
4	334584	2068418

- **Survey Points**

ID	X	Y
1	340413	2094950
2	340254	2095188

3	339817	2095268
4	335410	2080838
5	335749	2080792
6	335428	2081078
7	333486	2085436
8	333129	2085674
9	332851	2085992
10	332415	2085992
11	331780	2085436
12	335232	2081150
13	335590	2081309
14	335431	2081706
15	335153	2081706
16	334042	2068577
17	333685	2068498
28	333288	2068458
29	333010	2068140
20	332732	2067863

❖ **Team 4**

- **Survey Camps**

ID	X	Y
1	339863	2091303
2	339243	2089391
3	333317	2079725
4	333795	2067348

- **Survey Points**

ID	X	Y
1	339279	2094132
2	341116	2088511
3	331580	2080048
4	332476	2066630

5	339558	2089556
6	339916	2089357
7	340313	2089119
8	340828	2088961
9	341067	2088087
10	333685	2066910
11	333327	2066910
12	333010	2066831
13	332613	2067069
15	332692	2079991
16	332415	2079991
17	332137	2080110
18	331145	2080229
19	339360	2091191
20	339201	2091389
21	339201	2091667
22	339003	2091437
23	338804	2091794
24	339042	2091874

❖ **Team 5**

- **Survey Camps**

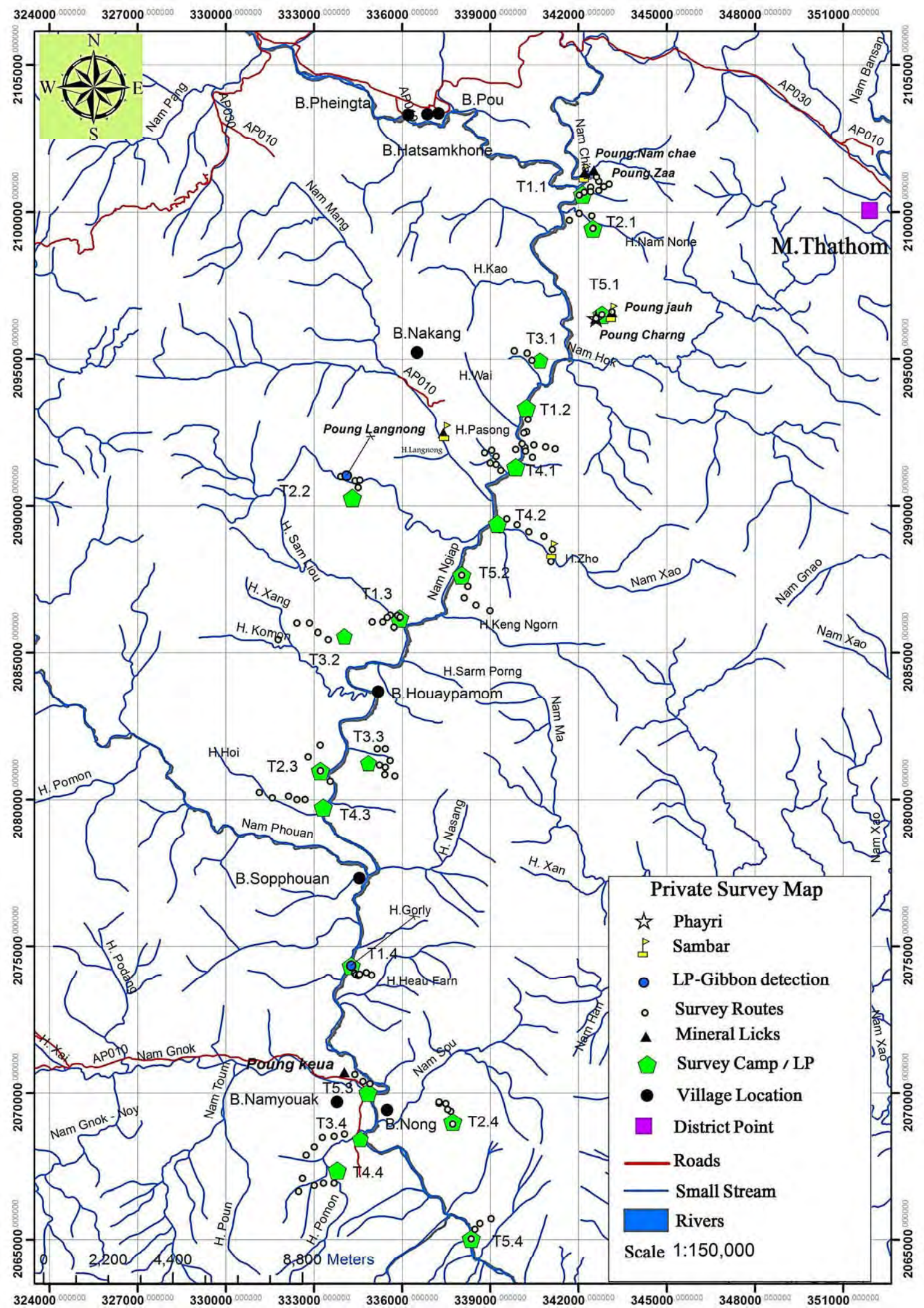
ID	X	Y
1	342800	2096490
2	338023	2087620
3	334840	2070018
4	338356	2065021

- **Survey Points**

ID	X	Y
1	342800	2096490
2	342601	2096370
3	343145	2096591

4	338023	2087620
5	338118	2086850
8	338356	2065021
9	338650	2065546
10	338475	2065348
11	339031	2065705
12	334903	2070309
13	334665	2070389
14	334387	2070627
15	338237	2087240
16	338515	2086605
17	338991	2086407

Data forms


N
W
E
S
B.Pheingta
B.Pou
B.Hatsamkhone
B.Nakang
B.Houaypamom
B.Sopphouan
B.Namyouak
B.Nong
M.Thathom
Poung Nam chae
Poung Zaa
Poung jauh
Poung Charng
Poung Langnong
Poung keua
H.Nam None
H.Kao
H.Wai
H.Pasong
H.Langnong
H.Zho
H.Keng Ngorn
H.Sarm Porng
H.Hoi
H.Gorly
H.Heau Farn
T1.1
T1.2
T1.3
T1.4
T2.1
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T2.3
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T3.3
T3.4
T4.1
T4.2
T4.3
T4.4
T5.1
T5.2
T5.3
T5.4
Nam Pang
Nam Mang
Nam Chia
Nam Hok
Nam Ngiap
Nam Xao
Nam Gnao
Nam Ma
Nam Phouan
Nam Gnok
Nam Gnok - Noy
Nam Toum
Nam Spu
Nam Ham
Nam Bansap
H. Sam Lou
H. Xang
H. Komon
H. Pomon
H. Nasang
H. Xan
H. Podang
H. Xai
H. Poun
AP010
AP030
Private Survey Map
Phayri
Sambar
LP-Gibbon detection
Survey Routes
Mineral Licks
Survey Camp / LP
Village Location
District Point
Roads
Small Stream
Rivers
Scale 1:150,000
0
2,200
4,400
8,800 Meters
324000
327000
330000
333000
336000
339000
342000
345000
348000
351000
2105000
2100000
2095000
2090000
2085000
2080000
2075000
2070000
2065000

Annex E

Flora Survey Results 2013

Lao Names	Families/Thai Names	Scientific Names		Main Dam site	Re- regulation Dam site	Resettlement	Transmission Line	Nam Ngeip		Nam Xan		Huay Ngua	Status	Remark
								Upper	Lower	Upper	Lower			
	DRYOPTERIDACEAE													
ຜັກກູດຂາວ	ผักกูดขาว	*Diplazium esculentum* (Retz.) Sw.	TerF			X	X	X		X			LC	
	MARSILEACEAE													
ຜັກແວ່ນ	ผักแว่น	*Marsilea crenata* C.Presl	AqF	X	X	X	X	X		X		X	LC	
	SCHIZAEACEAE													
ກະຈອດໜູ	ลิเภายุ่ง	*Lygodium microphyllum* (Car.) R.Br.	CF			X	X	X	X	X	X	X	LC	
	CYCADACEAE													
ຜ້າວໂຄກ	ปรง	*Cycas pectinata* Buch.-Ham.	S									X	VU	
ຜ້າວຕ່ຳ	มะพร้าวเต่า	*Cycas simplicipinna* (Smitinand) K.D.Hill	S	X				X		X			NT	
	GNETACEAE													
ໝ້ວຍ	เมื่อย	*Gnetum montanum* Markgr.	WC	X	X			X		X		X	LC	
	AMARANTHACEAE													
ຜົ້ງແພວ	ผักเป็ดไทย	*Alternanthera sessilis* (L.) DC.	H	X	X	X	X	X		X		X	LC	
ໝາກມ່ວງ	มะม่วง	*Mangifera indica* L.	T			X	X	X	X	X	X		DD	
	APOCYNACEAE													
ຕີນປັດ	สัตบรรณ	*Alstonia scholaris* (L.) R.Br.	T	X	X	X	X	X	X	X	X	X	LC	
ມູກໃຫຍ່	โมกใหญ่	*Holarrhena pubescens* Wall. ex G.Don	T						X				LC	
	CELASTRACEAE													
ກະເມັ້ງ	กะเม็ง	*Eclipta angustata* Umemota & H.Koyama	H	X	X	X	X	X	X	X	X	X	LC	

Lao Names	Families/Thai Names	Scientific Names		Main Dam site	Re- regulation Dam site	Resettlement	Transmission Line	Nam Ngeip		Nam Xan		Huay Ngua	Status	Remark
								Upper	Lower	Upper	Lower			
	CONVOLVULACEAE													
ຈິງຈໍ້	จิงจ้อ	*Aniseia martinicensis* (Jacq.) Choisy	HC	X	X	X	X	X		X		X	LC	
	DATISCACEAE													
ພຸງ	สะพุง	*Tetramelos nudiflora* R.Br.	T	X	X	X	X	X	X	X	X	X	LC	
	DIPTEROCARPACEAE													
ບາກເຫຼືອງ	กระบาก	*Anisoptera costata* Korth	T								X	X	EN	
ຍາງຂາວ	ยางนา	*Dipterocarpus alatus* Roxb. ex G.Don	T					X	X		X	X	EN	
ຍາງແດງ	ยางแดง	*Dipterocarpus turbinatus* Gaertn.f.	T	X	X			X		X		X	CR	
ແຄນຫີນ	ตะเคียนหิน	*Hopea ferrea* Laness.	T					X					EN	
ແຄນເຣືອ	ตะเคียนทอง	*Hopea odorata* Roxb.	T	X	X	X	X	X	X	X	X	X	VU	
ແຄນຄະຍອມ	พะยอม	*Shorea roxburghii* G.Don	T			X	X	X	X	X	X	X	EN	
	EBENACEAE													
ໝາກພັບໄຂ່ນົກ	มะพลับไข่นก	*Diospyros apiculata* Hiern	T	X	X	X	X	X		X		X	LC	
	EUPHORBIACEAE													
ໄຄ້ຜາດ	ไคร้น้ำ	*Homonoia riparia* Lour.	S	X	X	X	X	X	X	X	X	X	LC	
	GUTTIFERAE													
ອາຫວນ	กะทังหัน	*Calophyllum thorelii* Pierre	T	X	X	X	X	X		X		X		
ຕ໊ອເຫຼືອງ	ติ้วเกลี้ยง	*Cratoxylum cochinchinense* (Lour.) Blume	T	X	X	X	X	X	X	X	X	X	LC	
ຕ໊ອສົ້ມ	ติ้วขาว	*Cratoxylum formosum* (Jack) Dyer	T	X	X	X	X	X	X	X	X	X	LC	

Lao Names	Families/Thai Names	Scientific Names		Main Dam site	Re- regulation Dam site	Resettlement	Transmission Line	Nam Ngeip		Nam Xan		Huay Ngua	Status	Remark
								Upper	Lower	Upper	Lower			
	HYDROPHYLLACEAE													
ຜັກບິ້ອ່ງນ	ปอผี	*Hydrolea zeylanica* (L.) Vahl	H	X	X	X	X	X		X		X	LC	
	LAURACEAE													
ໝາກດູກ	มะดูก	*Beilschmiedia roxburghiana* Nees	T	X	X	X	X	X	X	X	X	X	LC	
	LEGUMINOSAE-CAESALPINOIDEAE													
ແຕ້ຂ່າ	มะค่าโมง	*Afzelia xylocarpa* (Kurz) Craib	T	X	X	X	X	X	X	X	X	X	EN	
ແຕ້ໜາມ	มะค่าลิง	*Sindora siamensis* Teijsm. & Miq.	T	X	X	X	X	X	X	X	X	X	LC	
	LEGUMINOSAE-PAPILIONOIDEAE													
ໂສນຫາງໄກ່	โสนหางไก่	*Aeschynomene indica* L.	H	X	X	X	X	X	X	X		X	LC	
ຂະຍຸງ	พะยูง	*Dalbergia cochinchinensis* Pierre	T					X				X	VU	
ຄຳພີ້ເຫຼືອງ	ชิงชัน	*Dalbergia oliveri* Gamble	T	X	X	X	X	X		X		X	EN	
	LENTIBULARIACEAE													
ຫຍ້າຮັ່ງໄກ່	สาหร่ายข้าวเหนียว	*Utricularia aurea* Lour.	AqH	X	X	X	X	X		X		X	LC	
	MELIACEAE													
ສ້ັງກະໂຕ້ງ	สังกะโต้ง	*Aglaia lawii* (Wight) C.J.Saldanha ex Ramamoorthy	T	X	X	X	X	X	X	X		X	LC	
ຕາເສືອ	ตาเสือ	*Aphanamixis polystachya* (Wall.) R.Parker	T	X	X	X	X	X		X	X	X	LC	
	MYRISTICACEAE													
ເລືອດຄວາຍໃບໃຫຍ່	เลือดควายใบใหญ่	*Knema furfuraceae* (Hook.f. & Thomson) Warb.	T					X			X			

Lao Names	Families/Thai Names	Scientific Names		Main Dam site	Re- regulation Dam site	Resettlement	Transmission Line	Nam Ngeip		Nam Xan		Huay Ngua	Status	Remark
								Upper	Lower	Upper	Lower			
ກົກທອມເລືອດ	เลือดแรด	*Knema globularia* (Lam.) Warb.	T	X	X	X	X	X	X	X	X	X	LC	
	MYRTACEAE													
ຫວ້າຂົນ	หว้าขน	*Syzygium vestitum* Merr. & L.M.Perry	ST						X			X	VU	
	POLYGONACEAE													
ຜົ່ງພຸດ	ผักไผ่น้ำ	*Persicaria attenuat*a (R.Br.) Soják subsp. *pulchera* (Blume) K.L.Wilson	H	X	X	X	X	X		X		X	LC	
	RUBIACEAE													
ໝາກດັນນ້ຳ	มะดันน้ำ	*Morinopsis capillaris* Kurz	S							X			VU	
	SAPINDACEAE													
ຂີ້ໜອນ	ขี้หนอน	*Zollingeria dongnaiensis* Pierre	T			X	X	X	X	X	X	X	DD	
	SCROPHULARIACEAE													
ໜວດປາດຸກ	หนวดปลาดุก	*Lindernia anagallis* (Burm.f.) Pennell	H	X	X	X	X	X		X		X	LC	
	THEACEAE													
ຕຳເສົ່າ	ตำเสา	*Ternstroemia wallichiana* (Griff.) Engl.	T					X		X		X	VU	
	THYMELAEACEAE													
ເກດສະໜາ	กฤษณา	*Aquilaria crassna* Pierre ex Lecomte	T							X			CR	Cultivated
	UMBELLIFERAE													
ຜັກໜອກ	บัวบก	*Centella asiatica* (L.) Urb.	H	X	X	X	X	X		X		X	LC	
	VERBENACEAE													
ຫຍ້າເກັດປາ	หญ้าเกล็ดปลา	*Phyla nodiflora* (L.) Greene	CrH	X	X	X	X	X	X	X	X	X	LC	

Lao Names	Families/Thai Names	Scientific Names		Main Dam site	Re- regulation Dam site	Resettlement	Transmission Line	Nam Ngeip		Nam Xan		Huay Ngua	Status	Remark
								Upper	Lower	Upper	Lower			
	ARACEAE													
ບອນ	บอน	*Colocasia esculenta* (L.) Schott	H	X	X	X	X	X	X	X	X	X	LC	
ຜັກກົບ	ผักกบ	*Cryptocoryne crispatula* Engl.	AqH					X		X			LC	
ຜັກຫນາມ	ผักหนาม	*Lasia spinosa* Thwaites	H	X	X	X	X	X		X		X	LC	
	COMMELINACEAE													
ຫຍ້າກາບ	ผักปลาบ	*Commelina benghalensis* L.	H	X	X	X	X	X	X	X	X	X	LC	
ຄໍ່ກ໊ວ	ผักปลาบช้าง	*Floscopa scandens* Lour.	H	X	X	X	X	X		X	X	X	LC	
	CYPERACEAE													
ຜ໊	กกสามเหลี่ยม	*Actinoscirpus grossus* (L.f.) Goetgh. & D.A.Simpson	H	X	X	X	X	X		X		X	LC	
ຜ໊ກະນາກ	กกขนาก	*Cyperus difformis* L.	H	X	X	X	X	X		X		X	LC	
ຜ໊ຈ໋ດອກຂົນ	กกช่อดอกขน	*Cyperus digitatus* Roxb.	H	X	X	X	X	X		X		X	LC	
ຫຍ້າແຫ້ວໝູ	หญ้าแห้วหมู	*Cyperus rotundus* L.	H	X	X	X	X	X		X		X	LC	
ຫຍ້າຄົມບາງກົມ	หญ้าคมบางกลม	*Fuirena ciliaris* (L.) Roxb.	H	X	X	X	X	X		X		X	LC	
	GRAMINEAE													
ຫຍ້າເຟົ້າ	เลา	*Saccharum spontaneum* L.	G	X	X	X	X	X	X	X	X	X	LC	
	XYRIDACEAE													
ຕານ	ตาน	*Xyris complanata* R.Br.	H				X						LC	
	ZINGIBERACEAE													
ໜາກແໜ	เร่ว	*Amomum uliginosum* K.D.König	H	X	X	X	X	X		X		X	LC	
Total				**397**	**390**	**410**	**408**	**513**	**278**	**462**	**317**	**446**		

Remarks	X = occurrance					
	[1] Habit					
	2 Status refers to IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>					
	AqH	=	Aquatic Herb	ScanS	=	Scandent Shrub
	B	=	Bammboo	ST	=	Shrubby Tree
	C	=	Climber	T	=	Tree
	CrH	=	Creeping Herb	US	=	Undershrub
	Ex	=	Exotic	Vu		Vulnerable
	G	=	Grass	WC	=	Woody Climber
	H	=	Herb	S	=	Shrub
	HC	=	Herbaceous Climber	S/ST	=	Shrub/Shrubby Tree
	EN	=	Endagered			
	VU	=	Vulnerable			
	NT	=	Near Threaten			
	LR/NT	=	Lower Risk/least concern ver. 2.3			

Annex F

Fauna Survey Results 2013

Table F.1 Species diversity, abundance, conservation status, and IUCN status of mammals in the study areas

Family/Common Name	Scientific Name	Abundance[1]	Distribution of wildlife						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Family Tupaiidae (Treeshrews)															
Northern Treeshrew*	*Tupaia belangeri*	LC	X	X			X	X							X
Family Sciuridae (Squirrels and Flying Squirrels)															
Black Giant Squirrel*	*Ratufa bicolor*	LC	X				X	X		X				X	
Gray-bellied Squirrel	*Callosciurus caniceps*	C	X	X			X	X							X
Pallas's Squirrel	*Callosciurus erythraeus*	LC	X	X			X	X							X
Indochinese Flying Squirrel*	*Hylopetes phayrei*	LC	X	X			X	X							X
Large Brown Flying Squirrel*	*Petaurista philippensis*	LC	X												X
Maritime Striped Squirrel*	*Tamiops maritimus*	LC	X	X			X	X							X
Family Muridae (Mice and Rats)															
House Mouse*	*Mus musculus*	C		X											X
Oriental House Rat *	*Rattus tanezumi*	C				X									X
Long-tailed Giant Rat*	*Leopoldamys sabanus*	C	X			X	X	X							X
Large Bamboo Rat	*Rhizomys sumatrensis*	C	X	X			X			X					X
Lesser Bamboo Rat*	*Cannomys badius*	LC	X	X			X	X							X
Family Manidae (Pangolins)															
Sunda Pangolin*	*Manis javanica*	LC	X			X	X	X				X			
Family Felidae (Cats and Tigers)															

Family/Common Name	Scientific Name	Abundance[1]	Distribution of wildlife						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Asiatic Golden Cat*	*Pardofelis temminckii*	LC	X				X	X	X					X	
Leopard Cat*	*Prionailurus bengalensis*	LC	X				X	X	X						X
Leopard*	*Panthera pardus*	LC	X						X					X	
Tiger*	*Panthera tigris*	LC	X						X			X			
Family Ursidae (Bears)															
Himalayan Black Bear*	*Ursus thibetanus*	LC	X						X				X		
Sun Bear*	*Helarctos malayanus*	LC	X				X	X	X				X		
Family Hystricidae (Porcupines)															
Asiatic Brush-tailed Porcupine	*Atherurus macrourus*	LC	X			X	X	X		X					X
Malayan Porcupine*	*Hystrix brachyura*	LC	X			X	X	X		X					X
Family Viveridae (Civets and Linsang)															
Small Indian Civet*	*Viverricula indica*	LC	X	X			X	X							X
Large Indian Civet*	*Viverra zibetha*	LC	X				X							X	
Common Palm Civet*	*Paradoxurus hermaphroditus*	LC	X	X			X	X		X					X
Masked Palm Civet*	*Paguma larvata*	LC	X				X			X					X
Small-toothed Palm Civet*	*Arctogalidia trivirgata*	LC	X				X	X							X
Spotted Linsang*	*Prionodon pardicolor*	LC	X												X
Binturong*	*Arctictis binturong*	LC	X				X	X		X			X		

Family/Common Name	Scientific Name	Abundance[1]	Distribution of wildlife						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Family Herpestidae (Mongooses)															
Small Asian Mongoose*	*Herpestes javanica*	LC	X	X		X	X	X		X					X
Family Canidae (Wild Dogs)															
Dhole*	*Cuon alpinus*	LC	X				X		X			X			
Golden Jackal*	*Canis aureus*	LC	X				X	X	X						X
Family Mustelidae (Weasels, Otters, Badgers)															
Smooth-coated Otter*	*Lutrogale perspicillata*	LC	X				X	X	X				X		
Asian Small-clawed Otter*	*Aonyx cinerea*	LC	X				X	X	X				X		
Large-toothed Ferret Badger*	*Melogale personata*	LC	X							X					(DD)
Hog Badger*	*Arctonyx collaris*	LC	X				X	X		X				X	
Family Vespertilionidae (Vesper Bats)															
Lesser Bamboo Bat	*Tylonycteris pachypus*	C	X		X		X	X		X					X
Family Loridae (Lorises)															
Pygmy Slow Loris*	*Nycticebus pygmaeus*	LC	X				X	X	X				X		
Bengal Slow Loris*	*Nycticebus bengalensis*	LC	X				X	X	X				X		
Family Cercopithecidae (Old World monkeys)															
Phayre's Leaf Monkey*	*Trachypithecus phayrei*	LC	X				X	X		X		X			
Northern Pig-tailed Macaque*	*Macaca leonina*	LC	X				X	X		X			X		

Family/Common Name	Scientific Name	Abundance[1]	Distribution of wildlife						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Assam Macaque*	*Macaca assamensis*	LC	X							X				X	
Stump-tailed Macaque*	*Macaca arctoides*	LC	X				X	X		X			X		
Family HOMINIDAE (Great Apes and Humans)															
Northern White-cheeked Gibbon	*Nomascus leucogenys*	LC	X				X	X	X		X				
Family Suidae (Pigs)															
Wild Boar	*Sus scrofa*	C	X			X	X	X							X
Family Tragulidae (Chevrotains)															
Lesser Oriental Chevrotain*	*Tragulus kanchil*	LC	X	X		X	X	X		X					X
Family Cervidae (Deer)															
Barking Deer	*Muntiacus vaginalis*	LC	X			X	X	X		X					X
Sambar	*Rusa unicolor*	LC	X				X	X	X				X		
Family Bovidae (Cattle, Antelopes, and Goats)															
Southwest China Serow*	*Capricornis milneedwardsii*	LC	X				X	X	X					X	
Total		**-**	**46**	**12**	**1**	**9**	**39**	**35**	**15**	**17**	**1**	**4**	**10**	**7**	**24**

Remarks: * = inquiry data	X = occurrence	
[1]Abundance:	[2]Conservation Status: refers to the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF, dated 8th Dec. 2003	[3]IUCN Red List Status: IUCN (2012)
VC = very common		CR = critically endangered
C = common		EN = endangered
LC = Less common	Reserved species (Category 1)	VU = vulnerable
	Protected species (Category 2)	NT = near threaten
		LC = least concern
		DD = Data Deficeient

Table F.2 Species diversity, abundance, conservation status, and IUCN status of birds in the study areas.

Family/Common Name	Scientific Name	Migratory Status[1]	Abundance[2]	Distribution of wildlife						Conservation Status[3]		IUCN Red List Status[4]				
				Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan								
				Upper	Lower			Upper	Lower	Restricted (List I)	(Protected (List II)	CR	EN	VU	NT	LC
Family Anhingidae (Darters)																
Oriental Darter	*Anhinga melanogaster*	R						X							X	
Family Ardeidae (Herons, Bitterns, and Egrets)																
Chinese Pond Heron	*Ardeola bacchus*	M	C	X												X
Cattle Egrett	*Bubulcus ibis*	R	C	X				X	X							X
Black Bittern	*Ixobrychus flavicollis*	M	VC	X												X
Family Acciptridae (Hawks, Kites, Eagles, and Vultures)																
Crested Serpent-eagle	*Spilornis cheela*	R	LC	X		X										X
Shikra	*Accipiter badius*	R	C			X	X									X
Rufous-winged Buzzard	*Butastur liventer*	R	LC					X	X							X
Family Phasianidae (Pheasants)																
Scaly-breasted Partridge	*Arborophila chloropus*	R	LC	X				X	X							X
Red Junglefowl	*Gallus gallus*	R	LC	X			X									X
Siamese Fireback *	*Lophura diardi*	R	LC					X	X	X						X
Silver Pheasant *	*Lophura nycthemera*	R	LC					X	X	X						X
Grey Peacock-pheasant*	*Polyplectron bicalcaratum*	R	LC					X	X	X						X

Family/Common Name	Scientific Name	Migratory Status[1]	Abundance[2]	Distribution of wildlife						Conservation Status[3]		IUCN Red List Status[4]				
				Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	(Protected (List II)	CR	EN	VU	NT	LC
				Upper	Lower			Upper	Lower							
Family Scolopacidae (Sandpipers, Snipes)																
Common Sandpiper	*Actitis hypoleucos*	M	LC	X												X
Family Columbidae (Doves and Pigeons)																
Orange-breasted Green-pigeon	*Treron bicinctus*	R	LC			X					X					X
Spotted Dove	*Stigmatopelia chinensis*	R	C	X	X	X					X					X
Emerald Dove	*Chalcophaps indica*	R	C			X		X								X
Family Psittacidae (Parrots)																
Vernal Hanging-parrot	*Loriculus vernalis*	R	LC	X												X
Blossom-headed Parakeet	*Psittacula roseata*	R	C			X					X					X
Red-breasted Parakee	*Psittacula alexandri*	R	C			X				X						X
Family Cuculidae (Cuckoos)																
Plaintive Cuckoo	*Cacomantis merulinus*	R	LC	X	X	X	X	X	X							X
Greater Coucal	*Centropus sinensis*	R	C	X	X	X	X	X	X	X						X
Lesser Coucal	*Centropus bengalensis*	R	LC	X	X			X								X
Green-billed Malkoha	*Phaenicophaeus tristis*	R	LC	X				X	X							X
Family Strigidae (Owls)																
Collared Scops-Owl	*Otus bakkamoena*	R	LC	X	X	X	X	X	X		X					X

Family/Common Name	Scientific Name	Migratory Status[1]	Abundance[2]	Distribution of wildlife						Conservation Status[3]		IUCN Red List Status[4]				
				Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan								
				Upper	Lower			Upper	Lower	Restricted (List I)	(Protected (List II)	CR	EN	VU	NT	LC
Family Caprimulgidae (Nightjars)																
Great Eared-nightjar	*Eurostopodus macrotis*	R	LC	X				X	X							X
Large-tailed Nightjar	*Caprimulgus macrurus*	R	LC	X	X											X
Family Apodidae (Swifts)																
Brown-backed Needletail	*Hirundapus giganteus*	R	C	X	X	X		X	X							X
Fork-tailed Swift	*Apus pacificus*	R	C	X	X											X
Asian Palm-swift	*Cypsiurus balasiensis*	R	C					X	X							X
Family Alcedinidae (Kingfishers)																
Common Kingfisher	*Alcedo atthis*	M	LC	X				X	X		X					X
Blue-eared Kingfisher	*Alcedo meninting*	R	LC	X												X
White-throated Kingfisher	*Halcyon smyrnensis*	R	LC	X	X											X
Family Coraciidae (Rollers)																
Asian Dollarbird	*Eurystomus orientalis*	R	LC	X												X
Indian Roller	*Coracias benghalensis*	R	LC	X	X		X	X	X							X
Family Bucerotidae (Hornbills)																
Oriental Pied Hornbill	*Anthracoceros albirostris*	R	LC	X				X	X		X					X
Great Hornbill*	*Buceros bicornis*	R	LC					X	X	X					X	
Wreathed Hornbill*	*Aceros undulatus*	R	LC					X	X	X						X

Family/Common Name	Scientific Name	Migratory Status[1]	Abundance[2]	Distribution of wildlife						Conservation Status[3]		IUCN Red List Status[4]				
				Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan								
				Upper	Lower			Upper	Lower	Restricted (List I)	(Protected (List II)	CR	EN	VU	NT	LC
Family Megalaimidae (Barbets)																
Lineated Barbet	*Megalaima lineata*	R	LC		X	X	X	X	X							X
Green-eared Barbet	*Megalaima faiostricta*	R	LC	X		X		X	X							X
Coppersmith Barbet	*Megalaima haemacephala*	R	LC			X	X									X
Family Eurylaimidae (Broadbills)																
Long-tailed Broadbill	*Psarisomus dalhousiae*	R	LC	X												X
Family Hirundinidae (Swallows)																
Barn Swallow	*Hirundo rustica*	M	C	X												X
Red-rumped Swallow	*Hirundo daurica*	M	C	X	X		X									X
Family Motacillidae (Pipits and Wagtails)																
Grey Wagtail	*Motacilla cinerea*	M	C	X	X			X	X							X
Family IRENIDAE (Fairy-Bluebirds)																
Asian Fairy-bluebird	*Irena puella*	R	LC	X				X	X							X
Family Pycnonotidae (Bulbuls)																
Black-headed Bulbul	*Pycnonotus atriceps*	R	LC	X	X	X		X	X							X
Sooty-headed Bulbul	*Pycnonotus aurigaster*	R	C													X
Black-crested Bulbul	*Pycnonotus melanicterus*	R	C	X	X	X	X	X	X							X
Stripe-throated Bulbul	*Pycnonotus finlaysoni*	R	C					X	X							X
Streak-eared Bulbul	*Pycnonotus blanfordi*	R	C	X	X	X	X	X	X							X

Family/Common Name	Scientific Name	Migratory Status[1]	Abundance[2]	Distribution of wildlife						Conservation Status[3]		IUCN Red List Status[4]				
				Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan								
				Upper	Lower			Upper	Lower	Restricted (List I)	(Protected (List II)	CR	EN	VU	NT	LC
Grey-eyed Bulbul	*Iole propinqua*	R	LC	X		X		X	X							X
Family Dicruridae (Drongos)																
Black Drongo	*Dicrurus macrocercus*	R	C	X	X											X
Bronze Drongo	*Dicrurus aeneus*	R	LC	X												X
Greater Racket-tailed Drongo	*Dicrurus paradiseus*	R	LC	X	X	X		X	X							X
Family Corvidae (Crows, Jays, and Magpies)																
Large-billed Crow	*Corvus macrorhynchos*	R	LC					X	X							X
Family Timaliidae (Babblers)																
White-browed Scimitar-babbler	*Pomatorhinus schisticeps*	R	LC			X	X									X
Puff-throated Babbler	*Pellorneum ruficeps*	R	LC	X	X	X	X	X	X							X
Pin-striped Tit-babbler	*Macronous gularis*	R	C	X	X	X	X	X	X							X
Family Sylviidae (Old World Warblers)																
Thick-billed Warbler	*Acrocephalus aedon*	M	C					X	X							X
Common Tailorbird	*Orthotomus sutorius*	R	LC	X	X	X	X	X	X							X
Family Turdidae (Thrushes)																
Blue Whistling-thrush	*Myophonus caeruleus*	R	C	X												X
Oriental Magpie-robin	*Copsychus saularis*	R	C	X	X		X	X	X							X
White-rumped Shama	*Copsychus malabaricus*	R	LC	X			X	X	X							X

Family/Common Name	Scientific Name	Migratory Status[1]	Abundance[2]	Distribution of wildlife						Conservation Status[3]		IUCN Red List Status[4]				
				Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan								
				Upper	Lower			Upper	Lower	Restricted (List I)	(Protected (List II)	CR	EN	VU	NT	LC
Stonechat	*Saxicola torquatus*	M	C	X												X
Family Muscicapidae (Flycatchers)																
Asian Brown Flycatcher	*Muscicapa dauurica*	M	LC	X		X	X	X	X							X
Tickell's Blue-flycatcher	*Cyornis tickelliae*	R	LC			X										X
Family Monarchidae (Monarchs)																
Black-naped Monarch	*Hypothymis azurea*	R	LC	X	X	X		X	X							X
Family Laniidae (Shrikes)																
Brown Shrike	*Lanius cristatus*	M	LC				X	X	X							X
Family Strurnidae (Starlings and Mynas)																
Common Myna	*Acridotheres tristis*	R	C				X				X					X
White-vented Myna	*Acridotheres grandis*	R	C					X	X							X
Hill Myna	*Gracula religiosa*	R	LC	X	X	X	X				X					X
Family Nectaniidae (Sunbirds and Spiderhunters)																
Olive-backed Sunbird	*Nectarinia jugularis*	R	C	X	X		X	X	X							X
Streaked Spiderhunter	*Arachnothera magna*	R	LC	X	X											X
Family Dicaeidae (Flowerpeckers)																
Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	R	LC			X	X									X
Family Passeridae (Sparrows)																
Eurasian Tree Sparrow	*Passer montanus*	R	LC				X									X

Family/Common Name	Scientific Name	Migratory Status[1]	Abundance[2]	Distribution of wildlife						Conservation Status[3]		IUCN Red List Status[4]				
				Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan								
				Upper	Lower			Upper	Lower	Restricted (List I)	(Protected (List II)	CR	EN	VU	NT	LC
Family Estrildidae (Munias)																
Scaly-breasted Munia	*Lonchura punctulata*	R	C	X	X	X										X
Total		**-**	**-**	**50**	**27**	**29**	**24**	**43**	**40**	**7**	**8**	**0**	**0**	**0**	**2**	**73**
Remarks are overleaf																

Remarks:	* = inquiry data	X = occurrence		[4]IUCN Red List Status: IUCN (2012)
	[1]Migratory Stattus	[2]Abundance:	[3]Conservation Status: refers to the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF, dated 8th Dec. 2003	CR = critically endangered
	M = migratory species	VC = very common		EN = endangered
	R = resident species	C = common	Reserved species (Category 1)	VU = vulnerable
		LC = Less common	Protected species (Category 2)	NT = near threaten
				LC = least concern

Table F.3 Species diversity, abundance, conservation status, and IUCN status of reptiles in the study areas.

Family/Common Name	Scientific Name	Abundance[1]	Distribution of wildlife						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Family Testudinidae (Land Tortoises)															
Elongated Tortoise*	*Indotestudo elongata*	LC					X	X		X		X			
Family Trionychidae (Softshell Turtles)															
Southeast Asian Softshell Turtle *	*Amyda cartilaginea*	LC	X	X		X	X	X		X			X		
Family Platysternidae (Big-headed Turtle)															
Big-headed Turtle*	*Platysternon megacephalum*	LC	X				X		X			X			
Family Bataguridae (Asian Pond Turtles)															
Southeast Asian Box Turtle*	*Cuora amboinensis*	LC					X	X		X			X		
Snail-eating Turtle*	*Malayemys subtrijuga*	LC	X			X				X			X		
Siamese Temple Turtle*	*Siebenrockiella crassicollis*	LC	X				X	X					X		
Family Gekkonidae (Geckos)															
Tokay Gecko	*Gekko gecko*	LC	X	X	X	X	X	X				Not Listed			
Common House Gecko	*Hemidactylus frenatus*	C	X	X	X	X	X	X							X
Flat-tailed House Gecko	*Hemidactylus platyurus*	C					X					Not Listed			
Family Agamidae (Agamid Lizards)															
Forest Garden Lizard	*Calotes emma*	C	X				X					Not Listed			
Blue crested lizard*	*Calotes mystaceus*	LC	X	X								Not Listed			

Family/Common Name	Scientific Name	Abundance[1]	Distribution of wildlife						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Common Garden Lizard	*Calotes versicolor*	LC	X	X	X		X	X				Not Listed			
Scale-bellied Tree Lizard*	*Acanthosaura lepidogaster*	C					X	X							X
Asian Water Dragon	*Physignathus cocincinus*	LC	X			X	X	X		X		Not Listed			
Spotted Flying Dragon	*Draco maculatus*	LC					X	X							X
Family Uromastycidae (Spinytail Lizards)															
Butterfly Lizard*	*Leiolepis belliana ocellata*	LC				X						Not Listed			
Family Scincidae (Skinks)															
Long-tailed Sun Skink	*Eutropis longicaudata*	LC	X	X								Not Listed			
Common Sun Skink*	*Eutropis multifasciata*	LC	X	X		X						Not Listed			
Spotted Forest Skink	*Spenomorphus maculatus*	LC					X	X				Not Listed			
Family Varanidae (Monitor Lizards)															
Clouded Monitor*	*Varanus bengalensis*	LC	X			X	X	X		X					X
Common Water Monitor*	*Varanus salvator*	C	X	X		X	X	X		X					X
Family Pythonidae (Pythons)															
Reticulated Python*	*Broghammerus reticulatus*	LC	X	X		X	X	X	X			Not Listed			
Family Colubridae (Colubrid Snakes)															
Common Mock Viper	*Psammodynastes pulverulentus*	LC		X			X	X				Not Listed			
Red-necked Keelback*	*Rhabdophis subminiatus*	LC					X	X							X

Family/Common Name	Scientific Name	Abundance[1]	Distribution of wildlife						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan								
			Upper	Lower			Upper	Lower	Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
Green Cat Snake	*Boiga cyanea*	LC		X			X	X					Not Listed		
Red-tailed Green Ratsnake*	*Gonyosoma oxycephalum*	LC	X				X	X							X
Radiated Ratsnakes*	*Coelognathus radiatus*	LC	X			X	X	X					Not Listed		
Indo-Chinese Rat Snake*	*Ptyas korros*	LC	X	X		X	X	X					Not Listed		
Oriental Ratsnake*	*Ptyas mucosa*	LC	X	X		X	X	X					Not Listed		
Common Bronze-back*	*Dendrelaphis pictus*	LC	X	X		X							Not Listed		
Deuve's Water Snake	*Homalopsis nigroventralis*	LC						X							X
Checkered Keelback*	*Xenochrophis piscator*	LC					X	X							X
Plumbeous Water Snake*	*Enhydris plumbea*	LC	X	X		X	X	X							X
Family Elapidae (Elapid Snakes)															
King Cobra*	*Ophiophagus hannah*	LC	X	X			X		X				X		
Indo-Chinese Spitting Cobra *	*Naja siamensis*	LC	X	X		X				X			X		
Malayan Krait*	*Bungarus candidus*	LC	X	X											X
Banded Krait	*Bungarus fasciatus*	LC	X	X		X	X						Not Listed		
Family Viperidae (Vipers)															
Malayan Pit Viper*	*Calloselasma rhodostoma*	LC	X	X		X									X
Pope's Tree Viper*	*Trimeresurus popeiorum*	LC	X	X		X									X
Total		**-**	**27**	**21**	**3**	**19**	**28**	**24**	**3**	**8**	**0**	**2**	**6**	**0**	**13**

Remarks:	* = inquiry data	X = occurrence	
	[1]Abundance:	[2]Conservation Status: refers to the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF, dated 8th Dec. 2003	[3]IUCN Red List Status: IUCN (2012)
	VC = very common		CR = critically endangered
	C = common		EN = endangered
	LC = Less common	Reserved species (Category 1)	VU = vulnerable
		Protected species (Category 2)	NT = near threaten
			LC = least concern
			NA = not listed

Table F.4 Species diversity, abundance, conservation status, and IUCN status of amphibians in the study areas.

Family/Common Name	Scientific Name	Abundance[1]	Distribution of wildlife						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Family Bufonidae (Typical Toads)															
Black-spectacled Toad	*Duttaphrynus melanostictus*	C	X	X			X	X							X
Bony-headed Toad	*Ingerophrynus galeatus*				X										X
Family Dicroglossidae (True Frogs)															
East Asian Bullfrog	*Hoplobatrachus rugulosus*	LC	X	X		X	X	X							X
Asian Grass Frog	*Fejervarya limnocharis*	C	X	X	X	X	X								X
Large-headed Frog*	*Limnonectes kuhlii*	C	X		X	X	X	X							X
Family Ranidae (Typical Frogs)															
Pointed-tongued Floating Frog	*Occidozyga lima*	C	X	X		X	X	X							X
Dark-sided Frog	*Hylarana nigrovittata*	C	X		X		X								X
Unidentified	*Hylarana cf. nigrovittata*							X				Not Listed			
Giant Asian River Frog*	*Limnonectes blythii*	LC	X				X	X						X	
Unidentified	*Odorrana cf. livida*	C					X	X				Not Listed			
Unidentified	*Rana* sp.	LC			X							Not Listed			
Family Rhacophylidae (Old World Tree Frogs)															
White-lipped Tree Frog	*Polypedates leucomystax*	C	X	X		X									X
Family Microhylidae (Microhylid Frogs, Froglets)															

Family/Common Name	Scientific Name	Abundance[1]	Distribution of wildlife						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan								
			Upper	Lower			Upper	Lower	Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
Malaysian Narrowmouth Toad	*Kaloula pulchra*	C				X	X	X							X
Arcuate-spotted Pygmy Frog	*Microhyla heymonsi*	C					X								X
Ornamented Pygmy Frog	*Microhyla ornata*	C	X	X											X
Beautiful Pygmy Frog	*Microhyla pulchra*	C	X	X		X	X	X							X
Ornate Chorus Frog	*Microhyla fissipes*	C				X	X	X							X
Berdmore's Narrow-mouthed Frog	*Microhyla berdmorei*	C			X		X	X							X
Total		**-**	**10**	**7**	**6**	**8**	**13**	**11**	**0**	**0**	**0**	**0**	**0**	**1**	**14**

Remarks: * = inquiry data

X = occurrence

[1]Abundance:

A = very common

C = common

LC = Less common

[2]Conservation Status: refers to the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF, dated 8th Dec. 2003

Reserved species (Category 1)

Protected species (Category 2)

[3]IUCN Red List Status: IUCN (2012)

CR = critically endangered

EN = endangered

VU = vulnerable

NT = near threaten

LC = least concern

NA = not listed

Annex G

Aquatic Biota Survey Results 2013

Family/Common Name	Scientific Name	Abundance[1]	Distribution						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Family Notopteridae															
Bronze featherback	*Notopterus notopterus*	C		1			1								X
Family Sundasalangidae															
Mekong noodlefish	*Sundasalanx mekongensis*	LC		7											X
Family Clupeidae															
Thai river sprat	*Clupeichthys aesarnensis*	VC	2												X
Family Cyprinidae															
Asiatic minnow	*Paralaubuca typus*	C		15											X
Glass barb	*Parachela oxygastroides*	C		2											X
Salmon carp	*Raiamas guttatus*	VC	4				2	2							X
-	*Opsarius koratensis*	VC	92	24	1		4	18							X
Mackerel barb	*Opsarius pulchellus*	C	5												X
Leaping barb	*Laubuca caeruleostigmata*	C	13					16				X			
Laos danio	*Devario laoensis*	LC			1										X
Queen danio	*Devario regina*	LC	1												X
Flying minnow	*Esomus metallicus*	C	3												X
Apollo shark minnow	*Luciosoma bleekeri*	VC	15	20			5	6		X					X
	Rasbora atridorsalis	C				1									
Pale rasbora	*Rasbora aurotaenia*	LC						3							X

Family/Common Name	Scientific Name	Abundance[1]	Distribution						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Slender rasbora	*Rasbora daniconius*	C	7					7							X
Rosefin rasbora	*Rasbora dusonensis*	C	6					2							
Sidestripe rasbora	*Rasbora paviana*	VC	1	8	1	25		56							X
Scissor-tail rasbora	*Rasbora trilineata*	C						2							X
Common carp*	*Cyprinus carpio*	LC						1					X		
White eye barb	*Cyclocheilichthys repasson*	LC	5												X
	Labiobarbus leptocheila	LC		1											X
	Mystacoleucus atridorsalis	VC	5	10	2			37							X
Spiny barb	*Mystacoleucus marginatus*	VC	336	750	34	1	7	41							X
Sikuk barb	*Sikukia gudgeri*	VC	6	106	32	1	14	66							
Java barb	*Barbonymus gonionotus*	VC	20	6	2		4								X
Goldfin tinfoil barb	*Hypsibarbus malcomi*	LC		1											X
Golden belly barb	*Hypsibarbus vernayi*	C	2	1											X
Golden barb	*Hypsibarbus wetmorei*	VC	5	21		1		14							X
Mekong shoveljaw carp	*Onychostoma gerlachi*	LC						1							
Golden Poropuntius	*Poropuntius normai*	C	2												X
Yellow tail brook barb	*Poropuntius deauratus*	VC	139	22	13	21	3	191				X			
	Poropuntius laoensis	VC	92	10			3								X
	Scaphiodonichthys acanthopterus	LC	210												X

Family/Common Name	Scientific Name	Abundance[1]	Distribution						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Bandan sharp-mouth Barb	*Scaphognathops bandanensis*	C			3			1					X		
Spotted hampala barb	*Hampala dispar*	LC		1											X
Tranverse-bar barb	*Hampala macrolepidota*	VC	27	4		1	7	1							X
Golden swap barb	*Puntius aurotaeniatus*	LC	1												X
Swamp barb	*Puntius brevis*	VC	61			4		79							X
Red cheek barb	*Systomus orphoides*	C	1				1								X
Tiger barb	*Systomus partipentazona*	LC						1							X
	Puntius rhombeus	VC	96		1			26							X
	Pethia stoliczkana	LC	5												X
	Bangana lippus	LC	9												
Sucker barb	*Barbichthys laevis*	LC		1											X
Mrigal carp*	*Cirrhinus cirrhosus*	LC		2									**X**		
Mud carp	*Cirrhinus molitorella*	C	8				2							**X**	
	Hemiculterella macrolepis	LC	8												
Lineated silver mud carp	*Henicorhynchus lineatus*	C	4	1											X
Lesser silver mud carp	*Henicorhynchus lobatus*	VC	3	32			2	1							**X**
	Henicorhynchus ornatipinnis	LC	13												X
Siamese mud carp	*Henicorhynchus siamensis*	VC						3							
Siver mudminnow	*Osteochilus hasselti*	VC	3	1			1	2							X

Family/Common Name	Scientific Name	Abundance[1]	Distribution						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Dusky face carp	*Osteochilus lini*	LC		2											X
Striped bony-lip carp	*Osteochilus microcephalus*	LC	1												X
Mekong algae eater	*Crossocheilus atrilimes*	LC	2												X
Siamese flying fox	*Crossocheilus oblongus*	LC	1												X
Silver Flying fox	*Crossocheilus reticulatus*	VC	2	7		4									X
Stonelapping minnow	*Garra cambodgiensis*	LC		1											X
	Garra fasciacauda	LC		1											X
	Mekongina erythrospila	VC	1	2										X	
Family Nemacheilidae															
	Nemacheilus pallidus	VC	31	27	3			10							X
	Nemacheilus platiceps	VC			1	1									
	Schistura kengtungensis	VC	17	1				2							X
	Schistura magnifluvis	C	1												X
Nichol's Brook Loach	*Schistura nicholsi*	VC	4	4		1									X
Family Cobitidae															
Jaguar loach	*Yasuhikotakia splendida*	C		1	4								X		
Horseface loach	*Acantopsis choirorhynchos*	VC	1	7	38			21							X
	Lepidocephalichthys furcatus	VC	2		3			8							
Dwarf horseface loach	*Lepidocephalichthys hasselti*	C	1					14							

Family/Common Name	Scientific Name	Abundance[1]	Distribution						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Family Gyrinocheilidae															
Honeysucker	*Gyrinocheilus aymonieri*	LC		1											X
Family Bagridae															
Yellow catfish	*Hemibagrus nemurus*	VC	2		22	1	3	3							X
Redtail catfish	*Hemibagrus wyckioides*	VC	2				8			X					X
Striped catfish	*Mystus mysticetus*	LC						4							X
Long finn mystus	*Mystus singaringan*	LC			44										X
Bubblebee catfish	*Pseudomystus siamensis*	VC		3	11	2									X
Family Siluridae															
Butter Catfish	*Ompok bimaculatus*	LC						1							
Family Schilbeidae															
Mekong bachcha	*Clupisoma sinensis*	LC	1												X
Family Sisoridae															
Goonch	*Bagarius bagarius*	C	1	7										X	
Giant goonch	*Bagarius yarrelli*	C		1										X	
	Glyptothorax laosensis	C	2												X
Family Clariidae															
Walking catfish	*Clarias batrachus*	C			2			7							X
Family Belonidae															

Family/Common Name	Scientific Name	Abundance[1]	Distribution						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Freshwater garfish	*Xenentodon cancila*	VC		8	2	6	17	37							
Family Syngnathidae															
Giant pipefish	*Doryichthys boaja*	LC				3									X
Family Synbranchidae															
Asian swamp eel	*Monopterus albus*	VC	5			10		4							X
Family Mastacembelidae															
Peacock eel	*Macrognathus siamensis*	C						4							X
Tiretrack spiny eel	*Mastacembelus armatus*	VC	16	5	1		1	15							X
Flower spiny eel	*Mastacembelus favus*	C			1										X
Family Ambassidae															
Iridescent glassy perchlet	*Parambassis apogonoides*	C				1		5							X
Family Pristolepididae															
Malayan leaffish	*Pristolepis fasciata*	C					1	7							X
Family Eleotridae															
Marble goby	*Oxyeleotris marmorata*	C		5											X
Family Gobiidae															
Mekong Bumblebee goby	*Brachygobius mekongensis*	C		2		3									X
Mekong Rock goby	*Papuligobius ocellatus*	C	1			1									X
Family Osphronemidae															

Family/Common Name	Scientific Name	Abundance[1]	Distribution						Conservation Status[2]		IUCN Red List Status[3]				
			Nam Ngiep		Huay Ngua	Resettlement Site	Nam Xan		Restricted (List I)	Protected (List II)	CR	EN	VU	NT	LC
			Upper	Lower			Upper	Lower							
Threestripe gourami	*Trichopsis schalleri*	C						1							X
Croaking gourami	*Trichopsis vittata*	C				1									X
Family Channidae															
Dwarf snakehead	*Channa gachua*	VC	58	17	12	3	1	76							X
Great snakehead	*Channa marulius*	VC	2				1								X
Striped snakehead	*Channa striata*	C	3					1							X
Family Tetraodontidae															
Greenbottle pufferfish	*Auriglobus nefastus*	C						3							X
Target puffer	*Monotrete leiurus*	VC	1	9	1	1	1	19							X
Arrowhead puffer	*Tetraodon suvattii*	LC						1							X
Total no. of fishes			**1,368**	**1,158**	**235**	**93**	**89**	**820**							
Total no. of species			**59**	**44**	**24**	**22**	**22**	**45**		**2**		**2**	**4**	**4**	**79**

Remarks:	* = Introduced species	[2]Conservation Status: refers to the Regulation of	[3]IUCN Red List Status: IUCN (2013)
	[1]Abundance:	the Ministry of Agriculture and Forestry No.	CR = critically endangered
	X = occurrence	0360/MAF, dated 8th Dec. 2003	EN = endangered
	VC = very common		VU = vulnerable
	C = common		NT = near threaten
	LC = Less common		LC = least concern

Annex H

Critical Habitat Candidate Species Profiles

Species	*Afzelia xylocarpa*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species at the main dam, re-regulation dam, resettlement area, transmission line, Huay Ngua and upper and lower Nam Ngiep sampling plots. NUL ground-truthing of the access road did not detect the species within the search areas.
	Indirect -
Distribution	The species is native to Cambodia, India, Lao PDR, Myanmar, Thailand and Viet Nam. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment and it was also detected in upper and lower Nam Xan sampling plots. Specialists advice from Dr Pheng Phengsintham indicates that the distribution in Lao PDR includes Vientiane capital, Phouhin Namno National Biodiversity Conservation Area (pers. comm. 7/12/2013).
Population	Limited information is available regarding the population size of the species locally and globally however the direct data indicates a number of records locally.
Habitat	This tree is reported to grow in dense forest habitats and in transitional areas between evergreen and dry open dipterocarp forest. Altitude range of 100-650m in areas with uniform rainfall range, 1000-1500mm/year, a dry season od 5-6 months, mean annual temperature of 20-32°C is listed. Flowers March-April, fruiting September-December.
Threats	In Viet Nam the timber is values for carpentry. Other reports suggest the tree is harvested for medicinal purposes, pulp for cigarettes as well as wood turning
Summary	This species has been noted within a number of sampling plots during survey of the Nam Ngiep and Nam Xan catchment hence it appears that the species is disturbed across the region. The species is also known from Vientiane and a protected area in the south of Lao PDR. Given the distribution of known records it is considered **unlikely that the Project area sustains >10 per cent of the global population (Tier 1), or, habitat of significant important or containing nationally important concentrations (Tier 2).** Measures such as planting and management of harvesting threats locally will assist in managing the local population of the species.
References	Nghia, N.H. 1998. *Afzelia xylocarpa*. In: IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 26 August 2013. Danida Forest Seed Centre Seed Leaflet No. 6 September 2000 *Afzelia xylocarpa* (Kurz) Craib

Species	*Anisoptera costata*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species in a sampling plot within the Huay Ngua PPA survey in lower mixed deciduous forest habitat. The species was also detected in the lower Nam Xan survey location. DFRM road corridor survey identified 254 stems of the species. NUL ground-truthing survey identified the species within and outside of the proposed access road corridor. *Indirect* -
Distribution	The species is native to Brunei, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam (Ashton, 1998c). It is not reported to be native to Lao PDR. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment.
Population	Limited information is available regarding the population size of the species locally and globally however the recent survey noted the species as a dominant tree species within the proposed access road and in the adjacent area.
Habitat	It is reported to grow in semi-evergreen dipterocarp, evergreen and humid lowland forest.
Threats	The species is an economic tree and used for house construction.
Summary	This species was detected in the Huay Ngua PPA survey locations (by TISTR 2013) and more recently during ground-truthing of the disturbance corridor (by NUL 2013). The species is not native to Lao PDR and as such is not considered a priority biodiversity value. **The species is not a candidate for critical habitat within the Project area.**
References	Ashton, P. 1998. *Anisoptera costata*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 12 September 2013.

Species	*Dalbergia oliveri*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species within the main dam, re-regulation dam, resettlement area, transmission line, upper Nam Ngiep, Huay Ngua amd upper Nam Xan survey areas. NUL ground-truthing of the access road did not detect the species within the search areas. *Indirect* -
Distribution	This species is not native to Lao PDR. It is native to Myanmar, Thailand and Viet Nam. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment.
Population	Limited information is available regarding the population size of the species locally and globally.
Habitat	It is reported to be scattered among dense evergreen and semi-deciduous forest of up to 1200 m elevation.
Threats	
Summary	The species is not native to Lao PDR and as such is not considered a priority biodiversity value. **The species is not a candidate for critical habitat within the Project area.**
References	Nghia, N.H. 1998. *Dalbergia oliveri*. In: IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 26 August 2013.

Species	*Dipterocarpus alatus*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species in upper and lower Nam Ngiep survey locations as well as Huay Ngua and lower Nam Xan survey locations. NUL ground-truthing survey identified the species along the JICA Road and outside of the access road corridor.
	Indirect -
Distribution	This species is not native to Lao PDR. It is native to Bangladesh, Cambodia, India, Myanmar, Philippines, Thailand and Viet Nam. The species is common in Southeast Asian countries. Phengsintham (2013) notes recording the species in several Lao PDR provinces including Vientiane capital, Bolikhamxay, Khammouane, Savannekhet, Saravane, Champasak and Attapeu.
Population	Limited information is available regarding the population size of the species locally and globally however the NUL survey noted the species both within the proposed access road and in the adjacent area.
Habitat	In Indo-China and Thailand the species occurs gregariously along river banks, and in the Philippines it is found in mixed dipterocarp forest. It is a tropical tree of dense evergreen and mixed dense forest.
Threats	The major threat to the species is habitat loss. In Cambodia it is a valued construction timber and resin used for proofing and traditional medicine.
Summary	This species was detected in the Project area at a number of survey locations. The species is not native to Lao PDR and as such is not considered a priority biodiversity value. **The species is not a candidate for critical habitat within the Project area.**
References	Ashton, P. 1998. *Dipterocarpus alatus*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013.

Species	*Dipterocarpus turbinatus*
Candidate Criteria	Criterion 1 – The species is listed as Critically Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species at main dam, re-regulation dam, upper Nam Ngiep and the Huay Ngua PPA as well as lower Nam Xan survey locations. NUL ground-truthing of the proposed assess road did not detect the species within the search areas. ERI 2007 survey recorded the species in dry evergreen forest, mixed deciduous forest and unstocked forest in the main dam survey area.
	Indirect -
Distribution	The species is native to Bangladesh, Cambodia, India, Lao PDR, Myanmar, Thailand and Viet Nam. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment. Hossain and Nath note that in Bangladesh the species scattered in the tropical ever-green forests and tropical semievergreen forests of Chittagong, Chittagong Hill Tracts, Cox's Bazar and Sylhet while in Myanmar the species has a comparatively wide distribution in tropical semievergreen forestsand tropical moist deciduous forest. Dr Pheng Phengsintham indicated that the distribution in Lao PDR includes Vientiane province (pers. comm. 7/12/2013).
Population	Limited information is available regarding the population size of the species locally and globally.
Habitat	The species is found in mixed deciduous, evergreen and semi-evergreen forests. It is reported to often occur in wet dense forest.
Threats	In some countries the resin of the tree is used to prepare torches.
Summary	This species has been noted within a number of the Project area survey locations and affords a distribution across a number of countries outside Lao PDR. Given the distribution of known records it is considered **unlikely that the Project area sustains >10 per cent of the global population (Tier 1), or, habitat of significant important or containing nationally important concentrations (Tier 2).** Measures such as planting and management of harvesting threats locally will assist in managing the local population of the species.
References	Ashton, P. 1998. *Dipterocarpus turbinatus*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013. Hossain, M. K. and Nath, P.K. Part II Species Descriptions: *Dipterocarpus turbinatus* Gaertn. Institute of Forestry and Environmental Sciences, Chittagong University, Bangladesh

Species	*Hopea ferrea*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species in upper Nam Ngiep survey locations however the species was not detected in other survey areas. ERI 2007 survey recorded the species in mixed deciduous forest and unstocked forest in the main dam survey area.
	Indirect -
Distribution	The species is native to Cambodia, Malaysia, Myanmar, Thailand and Viet Nam. This species is not native to Lao PDR.
Population	Limited information is available regarding the population size of the species locally and globally.
Habitat	
Threats	The species is commercially traded as an important timber tree.
Summary	This species was detected in the Project area at a number of survey locations. The species is not native to Lao PDR and as such is not considered a priority biodiversity value. **The species is not a candidate for critical habitat within the Project area.**
References	Ashton, P. 1998. *Hopea ferrea*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.2. www.iucnredlist.org. Downloaded on 16 December 2013.

Species	*Shorea roxburghii*, White Meranti
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species in resettlement, transmission line, upper and lower Nam Ngiep and Huay Ngua PPA as well as upper and lower Nam Xan survey locations. The NUL ground-truthing survey (2013) of the proposed access road did not detect the species within the search areas.
	Indirect -
Distribution	The species is native to Cambodia, India, Lao PDR, Malaysia, Myanmar, Thailand and Viet Nam. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment. Phengsintham (2013) notes recording the species in several Lao PDR provinces including Vientiane capital, Savannekhet and Road no 13.
Population	Limited information is available regarding the population of the species, though healthy regenerating subpopulations are reported in the south of India.
Habitat	The species is considered unusual for its adaptation to withstand adverse climatic conditions and soil types. It occurs in dry evergreen or deciduous forest and bamboo forest, often on sandy soils.
Threats	
Summary	This species has been noted within a number of the Project area survey locations and affords a distribution across a number of countries outside Lao PDR. Given the distribution of known records it is considered **unlikely that the Project area sustains >10 per cent of the global population (Tier 1), or, habitat of significant important or containing nationally important concentrations (Tier 2).** Measures such as planting and management of harvesting threats locally will assist in managing the local population of the species.
References	Ashton, P. 1998. *Shorea roxburghii*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 12 September 2013.

Species	*Vatica cinerea*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey did not record the species. A survey undertaken by the Department of Forestry Resource Management along a section of the proposed access road detected one individual. NUL ground-truthing did not detect the species within the search area.
	Indirect -
Distribution	This species is not native to Lao PDR. Is native to Cambodia, Malaysia, Myanmar, Thailand and Viet Nam.
Population	Limited information is available regarding the size of the population of the species and habitat preferences.
Habitat	This small species is reported to flourish in exposed areas, occurring on rocky, dry land and in bamboo forest.
Threats	
Summary	The species is not native to Lao PDR and as such is not considered a priority biodiversity value. **The species is not a candidate for critical habitat within the Project area.**
References	Ashton, P. 1998. *Vatica cinerea*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 12 September 2013.

Species	*Aonyx cinerea*, Asian small-clawed otter
Candidate Criteria	Criterion 1 – The species is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. ERI 2007 biodiversity survey did not record the species.
	Indirect Biodiversity village surveys in 2013 apparently recognised the species in the upper Nam Ngiep area. Note: Verbal village information on otters is close to impossible to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Small-clawed otter presence in the Project area. However, otters as a group are readily recognised and because no otter species remains widespread or common in Lao PDR, the information at group level remains of value. Reports of otters may also include Eurasian otter *Lutra lutra* as well as the two species treated here.
Distribution	The species has a large distribution range, extending from India, eastward through south-east Asia to the Philippines, and north to Taiwan and southern China.
Population	A reliable population estimate of the Asian Small-clawed otter is lacking. Duckworth et al (1999) noted that the species was then probably widespread in Lao PDR with populations considered to be of moderate global significance. In northern Lao PDR, records have been noted in Nam Kading and Nam Theun, with other records in central and southern Lao PDR (Duckworth et al 1999). Since then, massive declines in otters across northern southeast Asia render it likely that the species has disappeared from, or been reduced to non-viably low populations within, some or many of the Lao PDR catchments it formerly inhabited.
Habitat	Habitat use apparently varies across its wide range. In Indonesia, the typical habitats of the species in are wetland systems having pools and stagnant water, including shallow stretches, with depths less than one metre. In the Western Ghats of India, it seems tied to streams through forest and tree plantations in evergreen and semi-evergreen areas, with no records from the sort of agricultural and urban landscapes it typically uses in Java. Original habitat use in lao PDR is unknown; recent hunting is likely to have removed uit from accessible and even some remote areas. Asian small-clawed otters have a high climatic and trophic adaptability in south and south-east Asian tropics, occurring from coastal wetlands up to mountain streams.
Threats	Throughout Asia the main threat to the species is trade-driven hunting. The drivers and dynamics of this are poorly understood, particularly in southeast Asia. Habitat destruction due to development activities may be a local threat, but the species remains widespread in Java in, for example, towns and paddy-dominated landscapes. Other threats might include degradation of water quality due to the use of agrochemicals in catchments, and reduction in prey due to over-exploitation. In Lao PDR over the last 15 years these have all been, if relevant at all, dwarfed by the effects of hunting.
Summary	The general patterns in northern southeast Asia suggest it is unlikely that hunting will not have reduced this species to very low numbers in the Project area. There is no situational reason to expect an anomalously high survival in the Project area (which could potentially now qualify as critical habitat) and the record is a weak indication of the species, but this cannot be excluded. The key threats relate to hunting and degradation of aquatic environments and although current information does not confirm critical habitat, the precautionary approach should be considered and the threats to the species should be managed throughout the Project construction and operation and

Species	*Aonyx cinerea*, **Asian small-clawed otter**
	within any Biodiversity Offset Design.
References	Hussain, S.A. & de Silva, P.K. 2008a. Aonyx cinerea. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 07 November 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Canis aureus*, Golden jackal
Candidate Criteria	Criterion 1 – The species is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect Biodiversity village surveys in 2013 apparently recognised the species in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised the species reporting it as very common at Ban Xomxuen, Ban Kanyong and Ban Pakheuang thugh never encountered at Ban Pou, Ban Pakyong or Ban Don. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	The species is widespread in north and north-east Africa, occurs in the Arabian Peninsula, parts of Europe, Turkey, Syria, Iraq, Iran, Central Asia, the entire Indian subcontinent, and east and south to Sri Lanka, Myanmar, Thailand and parts of Indo-China. The species is fairly common throughout its range. Duckworth et al. 1999 noted the species to occur in southern Lao PDR (Xe Pian and Dong Khanthung) though there are provisional records in northern and central Lao PDR. It has since been found on the Nakai plateau (before inundation) and Phou Phanang NPA northwest of Vientiane.
Population	
Habitat	All records in Lao PDR and surrounding areas come from deciduous dipterocarp forest and other open, deciduous forests, and also, in areas where hunting is relatively low, cleared evergreen areas. There are no records from interior evergreen forest. As such, the species is highly restricted in Lao PDR, because most suitable habitats are too heavily hunted for it to survive. It seems, for example, to be on the brink of extinction on the Nam Ngum plain.
Threats	Hunting, apparently primarily as by-catch or in retaliation for livestock-killing is the main threat in Lao PDR; there is no evidence of any trade demand. Given its tolerance of habitat degradation (and, in fact, it is likely to have benefitted in southeast Asia from encroachment into evergreen forest areas, where hunting is relatively low, as indicated by the recent colonisation of Khao Yai NP and environs, Thailand), the Lao PDR population could be much higher than it presently is.
Summary	The species has a large global range; Lao PDR is on the edge of this. Numbers in the Project area are likely insignificant given the much larger, and growing populations in Thailand and probably Cambodia. Although numbers in Lao PDR are now probably small, there is no reason to indicate the Project area has any particular role for conserving the species compared with the many other landscapes of similar habitat in the country. **As such the Project area is considered unlikely to be critical habitat for the species.**
References	Jhala, Y.V. & Moehlman, P.D. 2008. Canis aureus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 06 November 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Capricornis milneedwardsii*, Southwest China serow
Candidate Criteria	Criterion 1 – The species is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. ERI 2007 biodiversity survey did not record the species.
	Indirect Biodiversity village surveys in 2013 apparently recognised the species in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised the species reporting it as very common at Ban Xomxuen, common at Ban Pakyong though never encountered at Ban Pou, Ban Kanyong, Ban Pakheuang or Ban Don.
Distribution	This species occurs in much of Myanmar, Cambodia, south and central China, Lao PDR, Thailand, and Viet Nam.
Population	No total estimates of population size have been made, however in Lao PDR, this species is still widespread, and despite heavy hunting, it is consistently present in areas of suitable habitat.
Habitat	Accounts from throughout the species range report the species inhabits rugged steep hills and rocky places, especially limestone regions up to 4,500 m. However, the species is also routinely recorded (by camera-trapping) in hill and mountain forest areas with gentler terrain.
Threats	Threats to the species include hunting, to which it seems remarkably resilient. Habitat loss for agricultural expansion, and habitat degradation from clearance for firewood and timber, are also negatively affecting the population somewhat, in large parts through fragmenting and increasing accessibility to areas of remaining unconverted habitat.
Summary	Serows plausibly remain widespread and locally common in the Project area, but this is equally true of much of hilly north and central Lao PDR. **The Project area is only a small proportion of the nation's total such habitat and as such would not be expected to constitute critical habitat.**
References	Duckworth, J.W., Steinmetz, R. & Pattanavibool, A. 2008. Capricornis milneedwardsii. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 07 November 2013.

Species	*Cuon alpinus*, Dhole/Asian wild dog
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. ERI 2007 biodiversity survey did not record the species. *Indirect* Biodiversity village surveys in 2013 apparently recognised the species in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised the species reporting that it is very commonly encountered in Ban Pou, Ban Xomxuen, Ban Pakyong and Ban Don though never encountered in Ban Kanyong and Ban Pakheuang villages. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	The species is native to Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Kazakhstan, Kyrgyzstan, Lao PDR, Malaysia, Mongolia, Myanmar, Nepal, Russian Federation, Tajikistan, Thailand and Viet Nam. The species is thought to have ranged over most of Lao PDR, Cambodia, Viet Nam and Thailand although reliable site-specific information is scarce. Duckworth et al 1999 note the species to occur in north Lao (Phou Khaokhoay) and in southern Lao (Dong Hua Sao, Xe Pian and Dong Khanthung) and there are mote recent records from various other survey areas such as the Nakai plateau and Nam Et Phou Louey NPA.
Population	It is estimated that fewer than 2,500 mature individuals remain in the wild with a declining population trend. The Lao PDR population is not known, although the species evidently remains considerable more widespread in Lao PDR than do the big cats.
Habitat	The species is found in a wide variety of vegetation types including primary, secondary and degraded tropical dry and moist deciduous forest, evergreen and semi-evergreen forests, dry thorn forests, grassland scrub forest mosaics and alpine steppe. Habitat selection factors include the availability of medium to large ungulate prey, water, presence of other large carnivores, suitability of breeding sites and human population levels.
Threats	The most important threat in Lao PDR is likely to be hunting, although this is usually as bycatch in retaliation for livestock killing; as yet there is no evidence of significant trade demand. Secondary threats include habitat loss, depletion of prey population, interspecific competition, persecution and possibly disease.
Summary	Dholes plausibly remain widespread and perhaps even locally common in the Project area; but this is equally true of much of hilly north and central Lao PDR. **The Project area is only a small proportion of the nation's total such habitat and as such would not be expected to constitute critical habitat.**
References	Durbin, L.S., Hedges, S., Duckworth, J.W., yson, M., Lyenga, A. and Venkataraman, A. (IUCN SSC Canid Specialist Group – Dhole Working Group) 2008. Cuon alpinus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2 www.iucnredlist.org. Downloaded 16 December 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Elephas maximus*, Asian elephant
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Stakeholder village surveys in 2013 recognised the species reporting it is not commonly encountered in Ban Pakyong and never seen in Ban Pou, Ban Xomxuen and Nam Xan villages. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	The species is native to Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, Sri Lanka, Thailand and Viet Nam (Choudhury et al. 2008). Populations in Lao PDR are now numerically insignificant compared with those of south Asia, but in the context of even steeper declines in Vietnam and China and similar ones in Cambodia, they are highly significant in the maintenance of ancestral range. The species in Lao PDR is reported to be widely, but very patchily distributed in forested areas (highlands and lowlands) with potentially important populations Nam Phouy west of the Mekong and in northern Lao PDR; in Phou Phanang and Phou Khao Khoay in Vientiane Province; Nakai Nam Theun NPA and surrounding in Khammouane Province; Phou Xang He NPA in Savannakhet Province; Dong Ampham, Dong Khanthung, Xe Pian, close to Cambodian border; and Nam Et, Nam Xam, Phou Dendin, and Nam Ha in the north, close to the Vietnamese and Chinese borders. However recent information on most of these areas is sparse. Near the Project area, potentially important elephant populations have been reported at Phou Phanang and Phou Khao Khoay to the west (approximately 20 km) and Nam Xan. An area to the east (approximately 20 km) of Huay Ngua PPA is considered important for a population of elephants that links to Nam Kading National Protected Area (pers comm. Kham khoun Khounboline 19/11/2013).
Population	It was estimated in 2003 that the global population of the species is between 41,410 and 52,345 (however this has been contested) which includes between 500 and 1000 in Lao PDR. Estimate of national population is expected to be larger than the 200-500 estimated in Lair (1997) and the Lao PDR population has been considered to be the most important national population for conservation in Indochina. However, ongoing declines in Lao PDR and recent discoveries in Cambodia suggest this statement may require modification.
Habitat	The species is found in many habitat types up to atleast 1200 m, remaining widely distributed in forested, hilly areas. The species is a generalist occurring in grassland, evergreen forest, semi-evergreen forest, moist deciduous forest, dry deciduous forest, dry thorn forest, scrublands and cultivated and secondary forests. The Asian elephant is an herbivore requiring large amounts of food per day. Their dung contributes to germinating seed dispersal. The home range varies but is considered to be large with ranges in excess of 60,000 ha recorded in India and only 16,000 ha range in Sri Lanka.
Threats	The overwhelming threat to the species in Lao PDR and surroundings is hunting, both for trade and resulting from crop destruction. Subsidiary threats

Species	*Elephas maximus*, Asian elephant
	include habitat loss, degradation and fragmentation, chiefly because these increase the likelihood of human-elephant conflict and enhance the ease of poaching. Large areas of prime elephant habitat in Lao PDR have already lost the species.
Summary	The location of the indirect records is mainly to the east of the Project area and to the north, outside the Project area. Similarly there are a number of locations noted for the species other countries. As such, the **Project area is not considered likely to be part of one of 10 or fewer habitat areas or required to sustain greater than 10 per cent of the global population (C1 Tier 1).** The Project area is not a known important area in Lao PDR for the species however suitable habitat exists.
References	Choudhury, A., Lahiri Choudhurym D.K., Desai, A., Duckworth, J.W., Easa, P.S., Johnsingh, A.J.T., Fernando, P., Hedges, S., Gunawardena, M., Kurt, F., Karanth, U., Lister, A., Menon, V., Riddle, H., Rubel, A. and Wikramanayake, E. (IUCN SSC Asian Elephant Specialist Group) 2008. *Elephas maximus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 03 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Helarctos malayanus*, Sun bear
Candidate Criteria	Criterion 1 – The species is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the preserved area. Biodiversity village surveys in 2013 apparenlty recognised the species to occur in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised the species, reporting that it is not commonly encountered in Ban Pakyong and is never seen in Ban Pou, Ban Xomxuen and Nam Xan villages. The Project EIA (2007) notes the species occurrence outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on bears is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Sun bear presence in the Project area. However, the species's wide distribution in Lao PDR, its known use of habitats similar to those in the Project area, and its level resilience to human activities all suggest it could well inhabit the Project area.
Distribution	The species is native to numerous countries (Bangladesh; Brunei Darussalam; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Thailand; Viet Nam). Sun bears occur in mainland south-east Asia as far west as Bangladesh and northeastern India, as far north as southern Yunnan Province in China, and south and east to Sumatra and Borneo, respectively. The species now occurs very patchily through much of its former range. Duckworth et al 1999 note the species to occur in central Lao PDR (Nakai-Nam Theun) and in southern Lao (Phou Ahyon, Dong Ampham, Nam Ghong Provincial PA, Dong Hua Sao and Xe Pian); at this stage there had been few relevant surveys in northern highlands of Lao PDR. Subsequent records from, e.g., Nam Et-Phou Louey NPA; suggest a former wide occurrence in that part of the country.
Population	Reliable estimates of sun bear populations are lacking.
Habitat	Sun bears rely on tropical forest habitat and in mainland south-east Asia inhabit seasonal ecosystems with a long dry season (3–7 months), during which rainfall is 1,000m.
Threats	The major threat to sun bears in Lao PDR is commercial hunting.
Summary	Sun bears plausibly occur in the Project area; but this is equally true of much of Lao PDR. **The Project area is only a small proportion of the nation's total such habitat and as such would not be expected to constitute critical habitat.**
References	Fredriksson, G., Steinmetz, R., Wong, S. & Garshelis, D.L. (IUCN SSC Bear Specialist Group) 2008. Helarctos malayanus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 06 November 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Lutrogale perspicillata*, Smooth-coated otter
Candidate Criteria	Criterion 1 – The species is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. ERI 2007 biodiversity survey did not record the species. *Indirect* Biodiversity village surveys in 2013 apparently identified the species to occur in the upper Nam Ngiep area. Note: Verbal village information on otters is close to impossible to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Smooth-coated otter presence in the Project area. However, otters as a group are readily recognised and because no otter species remains widespread or common in Lao PDR, the information at group level remains of value. Reports of otters may also include Eurasian Otter (*Lutra lutra*) as well as the two species treated here.
Distribution	The species is distributed through much of south Asia and south-east Asia. Its distribution is largely continuous from Indonesia, through south-east Asia, and westwards from southern China to India and Pakistan, with an isolated population in Iraq.
Population	Reliable estimates of its population are not available (Hussain 2008b). Duckworth et al (1999) notes records from Xe Pian and Nam Ghong PPA as well as many signs of large otters in various localities. Duckworth et al (1999) noted that the species was probably widespread in Lao PDR with populations considered to be of moderate global significance. Since then massive declines in otters across northern southeast Asia render it likely that the species has disappeared from, or been reduced to non-viably low populations within, some or many of the Lao PDR catchments it formerly inhabited.
Habitat	Habitat use may vary across its wide range, but in general it seems mostly to occur in areas of gentle terrain, in both flowing and standing wetlands.
Threats	Throughout Asia the main threat to the species is trade-driven hunting The drivers and dynamics of this are poorly understood, particularly in SE Asia. Habitat destruction due to development activities may be a local threat but the species occurs in significant numbers in south India and – where not yet hunted out – north and central India in reservoirs and on major rivers flowing amid purely agricultural landscapes. Other threats might include degradation of water quality due to the use of pesticides in catchments, and reduction in prey due to over-exploitation. In Lao PDR over the last 15 years these have all been if relevant at all, dwarfed by the effects of hunting.
Summary	The general patterns in northern southeast Asia suggest it is likely that hunting will have reduced this species to very low numbers in the Project area. There is no situational reason to expect an anomalously high survival in the Project area (which could potentially now qualify as critical habitat), and the record is a weak indication of the species, but this cannot be excluded. The key threats relate to hunting and degradation of aquatic environments and although current information does not confirm critical habitat, the precautionary approach should be considered and the threats to the species should be managed throughout the Project construction and operation and within any Biodiversity Offset Design.
References	Hussain, S.A., de Silva, P.K. & Mostafa Feeroz, M. 2008b. *Lutrogale perspicillata.* In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 06 November 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Manis javanica*, Sunda pangolin
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not directly record the species. One was photographed in the lower Nam Ngiep area in early 1999 that had reportedly been collected 30 minutes' walk in a village from the village of Ban Sopyouk; two more unidentified pangolins were seen then in Ban Houaypamom, reportedly collected a few hours' walk away. Specific location information is unavailable.
	Indirect The Huay Ngua MP (2010) notes presence of pangolins, assumed to be the species within the preserved area. Stakeholder village surveys in 2013 recognised pangolins, assumed to be the species is commonly encountered in Ban Pou (of Nam Ngiep) and Ban Pakheuang (of Nam Xan) and less common in Ban Xomxuen, Ban Pakyong and Ban Kanyong. He species is noted as very common at Ban Don village. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: There is some uncertainty associated with these indirect data sources for the species as there can be confusion between *Manis javanica* and the other pangolin species of Lao PDR, Chinese pangolin *M. pentadactyla*. However, pangolins as a group are readily recognised and because no pangolin species remains widespread or common in Lao PDR, the information at group level remains of value.
Distribution	The species ranges of much of mainland Southeast Asia, including southern Myanmar through central and southern Lao PDR, Thailand, central and southern Viet Nam, Cambodia, Peninsular Malaysia, Sumatra, Java and Borneo. In Lao PDR it is expected that the species is restricted to the Mekong plain and adjacent foothills to around 900 m, with potential occurrence in the Bolaven Plateau. Duckworth et al 1999 noted records from many survey areas in the 1990s. However very high levels of trade-driven hunting since hen suggest that pangolins are likely now to be very rare and plausibly widely extirpated from suitable habitat in Lao PDR.
Population	The species is rarely observed and as such population size information is unavailable. The species is noted as common in parts of Singapore and relatively common Sabah though reports of substantial declines are noted in areas of Viet Nam and Lao PDR.
Habitat	Found in primary and secondary forest as well as cultivated areas, gardens and plantations. The species inhabits hollows for sleeping and den sites and as such primary forest might occupy more individuals because they contain higher numbers of older, larger trees with suitable hollows. The species is largely nocturnal and solitary, feeding on ants and termites. Home range size has been estimated at 6.97 ha.
Threats	The overwhelming threat to the species is hunting for (formerly) local use and (now, almost entirely) international trade (skins, scales, meat). Pangolins are highly adaptable to some modified habitats (those with sufficient food), where not hunted.
Summary	There is some uncertainty associated with the indirect data sources for the species as there can be confusion between *Manis javanica* and other pangolin species. The key threat to the species is hunting and although current information does not confirm critical habitat, the precautionary approach should be considered and the threats to the species should be managed throughout the Project construction and operation and within any Biodiversity Offset Design.

Species	*Manis javanica*, **Sunda pangolin**
References	Duckworth, J.W., Pattanavibool, A., Newton, P. and Nguyen Van Nhuan. 2008. *Manis javanica*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 17 December 2013. Duckworth, J.W., Satler, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Nomascus leucogenys*, Northern white-cheeked gibbon
Candidate Criteria	Criterion 1 – The species is listed as Critically Endangered on the IUCN Red List. It also has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey recorded a vocalisation of a gibbon assumed to be the species in the upper Nam Ngiep survey area in the main dam inundation area. Targeted primate survey was undertaken in November 2013 by Dr Phaivanh Phiapalath of the IUCN SSC/Primate Specialist Group which reported two records (vocalisation) of gibbons in uphill mountain area outside the inundation area.
	Indirect -
Distribution	The species is native to Lao PDR and Viet Nam and (now very much reduced) in China. In Lao gibbons probably of this species have been recorded widely in the northern highlands, potentially south into the northern Annamites in Nakai-Nam Theun and Nam Kading NPAs. However, ongoing challenges in identifying gibbons to species render many claims provisional. The gibbons of the Nam Ngiep catchment may include this species, but may also include, or even be entirely comprised of Southern white-cheeked gibbon *N. siki*.
Population	Population numbers are highest in Lao PDR due to larger tracts of natural habitat remaining in comparison to Viet Nam and China where forest habitat is much more fragmented and hunting has been in general, at higher levels for longer.
Habitat	The species is strictly arboreal though there is very little behavioural ecology information, including home range extent. Habitat includes tall primary and heavily degraded evergreen and semi-evergreen forest. The diet is dominated by fruits and some small amounts of leaves and insects. Anecdotal reports suggest group sizes of 3-4 individuals. Targeted primate survey identified a number of key habitat areas for the species, thought located outside the inundation area.
Threats	Hunting has been so heavy in much of Lao PDR that many forest blocks have now lost gibbons entirely or support only tiny numbers. However, in some areas local traditional beliefs have resulted in the survival of potentially viable numbers in areas where almost all other wildlife species of similar, or even much lower, sensitivity to offtake have been seriously reduced. These areas are particularly important in retaining gibbons in the northern half of Lao PDR, but general erosion of these beliefs is high threat to these remnant populations.
Summary	Key habitat areas for the species are reported by Dr Phaivanh Phiapalath at Phou Thin, Phouru Pha Noy, Phou Pha hua and Phou Sam Liem. These locations are outside the Project area though must be considered for indirect impact. **As such the Project area is not considered to be critical habitat** however threat management should be considered.
References	Bleisch, B., Geissmann, T., Manh Ha,., Rawson, B. and Timmins, R.J. 2008a. *Nomascus leucogenys*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013.

Species	*Nycticebus bengalensis*, Bengal slow loris
Candidate Criteria	Criterion 1 – The species is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect Biodiversity village surveys in 2013 apparently recognised the species to occur in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised lorises, reporting to be as very common at all the villages surveyed: Ban Pou, Ban Xomxuen, Ban Pakyong, Ban Kanyong, Ban Pekheuang and Ban Don. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	The species has a broad distribution in south-east Asia and occurs in: Bangladesh, Cambodia, southern China, north-eastern India, Lao PDR, Myanmar, Thailand, and Viet Nam (except the south).
Population	In Lao PDR, the population seems to be large and occurs in both large forest tracts and in degraded and fragmented areas. In the 1990s large lorises were among the most common species seen during spotlight surveys in much of central and southern Lao PDR (the north had no comparable surveys), and – in the absence of repeat survey – the limited credible village information gathered since then suggests no major declines within remaining suitable habitat.
Habitat	The species is arboreal and nocturnal, and inhabits tropical evergreen rainforest, semi-evergreen forest, and moist deciduous forest (Streicher 2008b).
Threats	The species is hunted and traded for food, traditional medicine, sport and as pets. Presently, in Lao PDR, this seems to be at lower levels than in countries such as Cambodia, although an escalation of hunting pressure may occur. The species' habitat is being reduced by farming, human settlement, infrastructure development (roads, dams and transmission lines) and fires, but very large areas remain in Lao PDR and the species is not yet anywhere close to being threatened by habitat factors.
Summary	This loris plausibly remains widespread and common in the Project area, but this is equally true of much of Lao PDR. **The Project area is only a small proportion of the nation's total such habitat and as such would not be expected to constitute critical habitat.**
References	Streicher, U., Singh, M., Timmins, R.J. & Brockelman, W. 2008b. *Nycticebus bengalensis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on **07 November 2013**.

Species	*Nycticebus pygmaeus*, Pygmy slow loris
Candidate Criteria	Criterion 1 – The species is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect Biodiversity village surveys in 2013 apparently recognised the species to occur in the upper Nam Ngiep area. Stakeholder village surveys in 2013 recognised lorises, apparently this species, as very common at all the villages surveyed: Ban Pou, Ban Xomxuen, Ban Pakyong, Ban Kanyong, Ban Pekheuang and Ban Don. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	This species is found east of the Mekong River in eastern Cambodia, southernmost China (south-eastern Yunnan), Lao PDR, and Viet Nam. In China it is not clear if individuals recorded are wild animals or captured animals brought into China from Viet Nam.
Population	In Lao PDR, the population seems to be large and occurs both in large forest tracts and in degraded and fragmented areas. In the 1990s small lorises were among the most common species seen during spotlight surveys in some parts of central and southern Lao PDR (the north had no comparable surveys), and – in the absence of repeat surveys – the limited credible village information gathered since then suggests no major declines within remaining suitable habitat.
Habitat	This species has been sighted in a wide variety of habitats, including primary evergreen and semi-evergreen forest, forest on limestone, secondary and highly degraded habitats, and bamboo thickets. It seems to be more common below 600 m.
Threats	In Viet Nam and Cambodia the species is threated by exploitation for medicinal purposes. Levels of exploitation in Lao PDR are significantly lower so far, but escalation may occur. Habitat loss, due to agriculture (woody plantations, annual crops and so forth), and human settlement, may be resulting in localized declines.
Summary	This loris plausibly remains widespread and common in the Project area, but this is equally true of much of Lao PDR. **The Project area is only a small proportion of the nation's total such habitat and as such would not be expected to constitute critical habitat.**
References	Streicher, U., Ngoc Thanh,V., Nadler,T., Timmins, R.J. & Nekaris, A. 2008a. Nycticebus pygmaeus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 07 November 2013. Duckworth, J.W., Satler, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Panthera pardus*, Leopard
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not directly record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village interviews in 2013 apparently recognised the species has been seen in the upper Nam Ngiep area. The Project EIA (2007) does not note the species. Note: Verbal village information on cats is close to impossible to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Leopard presence in the Project area.
Distribution	The species also occurs across most of sub-Saharan Africa, as remnant populations in north Africa, and in the Arabian peninsula and Sinai/Judean Desert (Egypt/Israel/Jordan), south-western and eastern Turkey and through southwest Asia and the Caucasus into the Himalayan foothills, India, China and the Russian Far East as well as Java and Sri Lanka. The species distribution includes Lao PDR. In the 1990s there were rather few confirmed records during extensive surveys (Duckworth et al. 1999) but methods were not very suitable for finding the species. There have been few records since (again in part reflecting the limited application of suitable methods). However, the extreme rarity with which big cat signs are now found in most of Lao PDR means that the species's distribution in the country is probably now highly fragmented.
Population	There is no reliable global population estimate, and population estimates for India and Africa are considered unreliable. Many populations west of southeast Asia are believed to be increasing, and there are high levels of human-leopard conflict. In Lao PDR the identification of the species by local reports and signs is challenging and many claims are over-confident (as proven almost whenever skins or other relicts are available to be examined). The species might still be widespread in the Bolikhamxay province though at very low density (IEWMP 2006).
Habitat	In south-east Asia, the species is found in all forest types, from tropical rainforest to the temperate deciduous and alpine coniferous (up to 5,200 m in the Himalaya), and also in dry scrub and grasslands.
Threats	The massive declines in Indochina have been driven at least almost entirely by hunting. Suitable habitat remains widespread in Lao PDR but mostly no longer supports the species, at least at potentially viable levels.
Summary	Given the large range of the species, certainty of records and secondary information from local village representatives it is **unlikely that the Project area and immediate surrounds supports greater than 10 per cent of the global population or habitat of significant importance.** The key threat to the species is hunting and although current information does not confirm critical habitat and there is uncertainty of the relevance of the villege interview data, the precautionary approach should be considered and the threats to the species should be managed throughout the Project construction and operation and within any Biodiversity Offset Design.

Species	*Panthera pardus*, Leopard
References	Henschel, P., Hunter, L., Breitenmoser, U., Purchase, C., Khorozyan, I., Bauer, H., Marker, L., Sogbohossou, E. and Breitenmoser-Wursten, C. 2008. *Panthera pardus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org Downloaded 3 November 2013 Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Panthera tigris*, Tiger
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List. It also has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not directly record the species. *Indirect* Biodiversity village interviews in 2013 apparently recognised the species has been seen in the upper Nam Ngiep area and stakeholder village surveys in 2013 noted the species is less common in Ban Pou (upper Nam Ngiep area) and never seen in Ban Xomxuen, Ban Pakyong, Ban Kanyong, Ban Pakheuang and Ban Don. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on cats is close to impossible to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Tiger presence in the Project area.
Distribution	There are thirteen range countries for the tiger including Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, Russia, Thailand and Viet Nam. Duckworth et al. (1999) presented confirmed or plausible records from many areas of Lao PDR in the 1990s, but very heavy hunting in the interim cautions against assuming that Tigers persist in these sites (mostly not subsequently surveyed). It is possible that only one population remains in Lao PDR, in Nam Et-Phou Louey NPA, and those other recent Tiger indications, where not based on misidentification, are wandering animals.
Population	Population size estimates in 42 protected source sites are 2154 individuals and estimates outside protected areas is poorly known. Global Tiger Recovery program estimates the population as 3948 across range countries. The Lao PDR population is likely to be a few dozen at most and possible already much smaller than that.
Habitat	The availability of sufficient prey base or large ungulates is a major habitat requirement for the species. It is estimated a tiger needs to kill 50 large prey animals per year. The species is generally solitary. Home range is dependent on prey availability but can be up to 10,000 ha.
Threats	Main threats to the species include illegal trade and habitat loss.
Summary	Given the large range of the species, certainty of records and secondary information from local village representatives it is **unlikely that the Project area and immediate surrounds supports greater than 10 per cent of the global population or habitat of significant importance.** The key threat to the species is hunting and although current information does not confirm critical habitat and there is uncertainty of the relevance of the villege interview data, the precautionary approach should be considered and the threats to the species should be managed throughout the Project construction and operation and within any Biodiversity Offset Design.
References	Chundawat, R.R., Habib, B., Karanth, U., Kawanishi, K., Ahmad Khan, J., Lyman, T., Miquelle, D., Nyhus, P., Sunarto, S., Tilson, R. and Sonam Wang 2011. Panthera tigris. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded 21 August 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Pardofelis temminckii*, Asiatic golden cat
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. A shot individual was photographed in the lower Nam Ngiep in early 1999 that had reportedly been killed in a village near chickens, though specific location details are unavailable.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village interviews in 2013 apparently recognised the species in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised the species, reporting it is common at Ban Kanyong however never encountered at all other villages surveyed: Ban Pou, Ban Xomxuen, Ban Pakyong, Ban Pekheuang and Ban Don. The Project EIA (2007) notes the species occurrence outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on cats is close to impossible to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Asian golden cat presence in the Project area. However, the 1999 record from in/near the area, the species's known use of such habitats and its somewhat higher resilience to human activities than of the big cats all suggest it should be in the Project area, and may perhaps be widespread.
Distribution	The species occurs from the Himalayan foothills into China and south-east Asia, and is native to: Bangladesh; Bhutan; Cambodia; China; India; Indonesia (Sumatera); Lao PDR; Malaysia; Myanmar; Nepal; Thailand; Viet Nam.
Population	In 1990s surveys in Lao PDR Golden Cat was the second-most widely recorded cat species, with several records from outside the protected area system, suggesting a high population. However, recent camera-trapping in Nakai-Nam Theun NPA suggests that a decade of heavy snaring has now greatly depleted populations in the surveyed parts of that protected area. While Golden Cat evidently remained common in Nam Et-Phou Loeuy until at least few years ago, this exceptional area retained even Tigers. Nakai-Nam Theun NPA is likely to be a better predictor for the typical situation in Lao PDR, and it may be that numbers across Lao PR are typically now much lower than in the 1990s.
Habitat	The species is primarily found in forest habitats ranging from tropical and subtropical evergreen to mixed and dry deciduous forest; it is evidently very tolerant of degradation and perhaps, where not hunted, of fragmentation.
Threats	The species is threatened in Lao PDR by indiscriminate snaring and other forms of hunting, driven largely by illegal trade in the species' pelt and bones.
Summary	This cat plausibly persists, perhaps widely, in the Project area, but this is equally true of much of Lao PDR. **The Project area is only a small proportion of the nation's total such habitat and as such would not be expected to constitute critical habitat.**
References	Sanderson, J., Mukherjee, S. Wilting, A., Sunarto, S., Hearn, A., Ross, J. and Khan, J.A. 2008. *Pardofelis temminckii*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org Downloaded 3 November 2013 Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/WCS/Centre for Protected Areas and Watershed Management.

Species	*Prionailurus bengalensis*, Leopard cat
Candidate Criteria	Included at request
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect Biodiversity village interviews in 2013 apparently recognised the species has in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised the species, reporting it as very common at Ban Pakheuang and Ban Don, common at Ban Xomxuen and Ban Kanyong however never encountered at Ban Pou or Ban Pakyong. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on cats is close to impossible to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Leopard Cat presence in the Project area. However, the species's wide distribution in Lao PDR, its known use of habitats similar to those in the Project area, and its high resilience to human activities all suggest it should be in the Project area, and is plausibly widespread and common.
Distribution	The species occurs from the India into northeast and south-east Asia.
Population	Generally distributed and common across its south-east Asian range, and typically the most commonly encountered small cat on recent surveys. Its current status in Lao PDR is unclear, but all indications are that it remains widespread and common.
Habitat	The species is found widely in forest habitats (ranging from tropical and subtropical evergreen to mixed and dry deciduous forest) and is highly tolerant of deforestation provided some dense low-level cover remains, being common, for example, in various plantations, and even persisting in peri urban Bangkok and Hanoi, far from any forest..
Threats	The species is apparently not threatened, at least in southeast Asia. In areas of very heavy hunting, such as much of Lao PDR, numbers are doubtless much reduced, but there is no evidence yet for significant extirpation.
Summary	Leopard cat plausibly remains widespread and perhaps locally common in the Project area; but this is equally true of much of Lao PDR. **The Project area is only a small proportion of the nation's total such habitat and as such would not be expected to constitute critical habitat.**
References	Sanderson, J., Mukherjee, S. Wilting, A., Sunarto, S., Hearn, A., Ross, J. and Khan, J.A. 2008. *Pardofelis temminckii*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org Downloaded 3 November 2013 Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Prionailurus viverrinus*, Fishing cat
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Stakeholder village surveys in 2013 apparently recognised the species, reporting it is common in Ban Kanyong and Ban Don of Nam Xan while noted the species as less common Ban Pou and Ban Pakyong of Nam Ngiep River. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on cats is close to impossible to assign to species despite the often overconfident presentation in interview reports. Fishing cat is so widely misidentified in South-east Asia (e.g. Duckworth *et al*. 2010) yet so universally reported in verbal village information that these reports should not be taken as even weakly indicative of Fishing cat presence in the Project area. In fact, there is no confirmation that the species occurs in Lao PDR at all. Most of the valid recent records from southeast Asia are from coastal areas, and while there are historical specimens from a few inland areas, there are too few inland records to make a habitat-based prediction of Fishing cat's likely status in the Project area.
Distribution	The species is native to Bangladesh, Bhutan, Cambodia, India, perhaps Indonesia, perhaps Lao PDR, Myanmar, Nepal, Sri Lanka, Thailand and Viet Nam. The species is primarily found in wetland habitats, which are increasingly being settled, degraded and converted; its occurrence may now be highly localised in southeast Asia, and is almost certainly so, away from the coast. The species has not been seen captive or in trade in Lao PDR suggesting that it is extremely rare or not likely to occur (pers comm. Will Duckworth 15/11/2013).
Population	Population estimates are not well understood. There are very few reports from Lao, all either certain or plausible errors. It is possible that the species is extinct or never occurred in Lao PDR; it is inconceivable that, if present, it is other than extremely rare. This is also true of Cambodia even though a sizeable number of captive animals have been reported in this latter country. In southeast Asia recent records are infrequent suggesting a decline in populations.
Habitat	Past statements on habitat use in SE Asia are confounded by incorporation of information from misidentified animals. Almost all recent SE Asian records are from the coast, although a few historical specimens prove inland occurrence. All such latter records seem to have been from the level lowlands, in areas with many standing waterbodies. The species is thought to feed mainly on fish but also small rodents, reptiles and amphibians. Home ranges reported in Nepal ranged between 400 and 1600 ha.
Threats	Main threats to the species include wetland destruction and degradation.
Summary	There is no reason to think that Fishing cat inhabits the Project area, but equally it cannot be excluded that it does so. However, the Project area's habitat is not distinct in any way from typical Lao hill-country, and **so there is no reason to conclude that the Project area could be considered critical habitat for the species.** This assessment remains particularly provisional given the uncertainty surrounding the species's distribution and habitat use in inland SE Asia.

Species	*Prionailurus viverrinus*, Fishing cat
References	Mukherjee, S., Sanderson, J., Duckworth, W., Melisch, R., Khan, J., Wilting, A., Sunarto, S. and Howard, J.G. 2010. *Prionailurus viverrinus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 03 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Pygathrix nemaeus*, Red shanked douc langur
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. Targeted primate survey was undertaken in November 2013 by Dr Phaivanh Phiapalath of the IUCN SSC/Primate Specialist Group which detected no douc langur.
	Indirect Stakeholder village surveys in 2013 identified that the villagers indicated to never encounter this species at any of the villages surveyed. The Project EIA (2007) notes the species occurrence outside the Project area based on a secondary data source though no location is specified.
Distribution	The species is native to Lao PDR and Viet Nam, and perhaps Cambodia. The IUCN mapped distribution does not include the Study area. Timmins and Duckworth (1999) and Coudrat et al. (2012) traced no records northwest of Nam Kading NPA (where the species is rare and localised) so it is quite plausible the Project area lies outside the species's range. There are a few verbal reported from Pho Khao Khoay NPA (west of the Project area) but these may reflect mistaken interpretation, e.g. from people who saw them elsewhere. However, the area between Nam Kading NPA and Phou Khao Khoay NPA (and even the latter protected area itself) remains poorly surveyed and the true status of the doucs in it is open to question.
Population	IUCN reports the population of the species in Lao is likely to be larger than in other areas. In Lao the largest and most important global population occurs in Nam Theun basin and surrounds which includes a number of protected areas and is to the south of the Project area.
Habitat	The species is found in primary and secondary evergreen and semi-evergreen broadleaf forest. It is mainly folivorous.
Threats	Main threats to the species include hunting for subsistence use and traditional medicine as well as, probably now only to a low extent, the pet trade.
Summary	The Project area is outside the range of the species and targeted primate survey in 2013 did not detect the species.
References	Ngoc Thanh, V., Lippold, L., Timmins, R.J., and Manh Ha, N. 2008. *Pygathrix nemaeus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 03 September 2013.

Species	*Rusa unicolor*, Sambar
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village interviews in 2013 apparently recognised the species in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised the species reporting it as very common at Ban Pou, Ban Kanyong and Ban Pakheuang, common at Ban Pakyong and Ban Don, however less commonly encountered at Ban Xomxuen. Note: There is some uncertainty associated with these indirect data sources for the species, in particular with respect to the frequency of encounters. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	The species occurs from India and Sri Lanka in the west, along the southern Himalayas and through south China to Taiwan. Further south it occurs in Bangladesh, throughout mainland south-east Asia and many of the main islands of the Greater Sundas (Timmins et al. 2008). Duckworth et al 1999 noted that the species occurred in numerous survey areas in north Lao, central and southern Lao. However with ongoing very heavy hunting since then in the country, many local extirpations may have occurred.
Population	In Lao PDR, Sambar was described as very common in 1940 and widespread at low numbers in the 1990s. Sites surveyed between 2004 and 2007 have shown major declines. The remaining Lao populations are centred around areas with extensive open, or at least broken, habitat amid forest (Timmins et al. 2008).
Habitat	Habitat is reported as wooded areas, more commonly in broken areas amid semi-evergreen forest but also open deciduous forest and unbroken evergreen forest.
Threats	There are major, ongoing, declines in Viet Nam, Lao PDR, Cambodia and Thailand which can plausibly only be driven by hunting, because suitable habitat for Sambar is abundant in these countries but is almost or actually bereft of the species (Timmins et al. 2008).
Summary	If the reports that Sambar is locally common in the Project area are accurate, the area may be important habitat on a national scale. There are large remaining populations in some other countries. **As such the Project area is not considered to be critical habitat for the species** however measures should be employed to understand the importance of the population on a national level.
References	Timmins, R.J., Steinmetz, R., Sagar Baral, H., Samba Kumar, N., Duckworth, J.W., Anwarul Islam, Md., Giman, B., Hedges, S., Lynam, A.J., Fellowes, J., Chan, B.P.L. & Evans, T. 2008. Rusa unicolor. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 07 November 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Trachypithecus phayrei*, Phayre's leaf monkey
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List. Its treatment in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF is ambiguous; it is not mentioned by English or scientific name, but is best seen as listed as Restricted, taking the entity translated as Silvered Langur to in fact refer to all grey langurs (=leaf monkeys).
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. Targeted primate survey was undertaken in November 2013 by Dr Phaivanh Phiapalath of the IUCN SSC/Primate Specialist Group which reported one record (vocalisation) and three mineral licks were found within the area. A shot individual was photographs in the lower Nam Ngiep in early 1999 however specific location information is unavailable. *Indirect* Biodiversity village surveys in 2013 suggested the species in the main dam inundation area. Stakeholder village surveys in 2013 apparently recognised the species, reporting that it is very common in Ban Pou, common at Ban Xomxuen and Ban Kanyong however is never encountered at Ban Pakyong, Ban Pakheuang or Ban Don. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Although interviews cannot reliably distinguish the various taxa of *Trachypithecus* inhabiting Lao PDR, on geographical grounds Indochinese Silvered Leaf Monkey *T. germaini* can be eliminated, and the Project area seems to support little if any habitat rugged enough for François's Leaf Monkey (sensu lato) *T. fancoisi*.
Distribution	The species is native to Bangladesh, China, India, Lao PDR, Myanmar, Thailand and Viet Nam (Bleisch et al., 2008b). In Lao PDR the species has been confirmed only in the northern parts (including the Project area), perhaps extending marginally into central Lao PDR. Viet Nam records are from less than five areas. In Thailand there are good populations in Nam Nao National Park and Phukhio Wildlife Sanctuary and Western Forest complex. In Lao PDR, Timmins et al. (2013) note the species to occur from the Mekong Valley up to at least 800m, with one record (at a mineral lick) at 1125m.
Population	Populations are generally small and isolated. China has reported healthy populations in a number of reserves though overall the species population is reported on serious decline globally. Timmins et al. (2013) noted recent Lao records only from ten survey areas (in some, merely objectively identified as grey leaf monkeys, but which on range can be assumed to be this species), with little evidence for large numbers in any survey area.
Habitat	The species inhabits primary and secondary evergreen and semi-evergreen forest, mixed moist deciduous forest as well as bamboo areas, light woodlands and near tea plantations. In Lao it seems to be particularly occurring in edge and degraded areas, which suggest high tolerance to habitat perturbation, but, because such areas are often on the margins of wilderness areas, elevated rick from hunting. It is a predominantly arboreal species that is folivorous. Home range extent not reported.

Species	*Trachypithecus phayrei*, Phayre's leaf monkey
Threats	The main threat to the species In Lao PDR is hunting, its effects may be exacerbated by the species's habitat use. Most of the areas within the species's geographic range large enough to have remotes cores with relatively lower hunting have such areas above 800m, and thus probably support few if any of this species. However, the numbers of records from outside the protected area system and fairly close to heavy human activity suggest higher resilience to hunting than shown by, for example, Red-shanked douc langur.
Summary	This species is probably among the mammal species for which the Project area provides a significant contribution to national conservation prospects. However, even at the national level it is implausible that the Project area supports close to 10 per cent of the population, given that it comprises far less than 10% of the species's presumed present area of occupancy in today's Lao PDR. **As such the Project area is not considered to be critical habitat for the species.** Key habitat areas for the species are reported by Dr Phaivanh Phiapalath at Phou Thin, Phouru Pha Noy, Phou Pha hua and Phou Sam Liem. These locations are outside the Project area though must be considered for indirect impact.
References	Bleisch, B., Brockelman, W., Timmins, R.J., Nadler, T., Thun, S., Das, J. and Yongcheng, L. 2008b. Trachypithecus phayrei. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Ursus thibetanus*, Himalayan black bear
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village interviews in 2013 arecognised bears apparently this species as been seen in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised the species, reporting it is common in Ban Kanyong and Ban Pakheuang however less common in Ban Pou, Ban Xomxuen and Ban Pakyong and never encountered at Ban Don. The Project EIA (2007) notes the species occurrence outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on bears is close to impossible to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Sun bear presence in the Project area. However, the species's wide distribution in Lao PDR, its known use of habitats similar to those in the Project area, and its level resilience to human activities all suggest it could well inhabit the Project area.
Distribution	The species is native to numerous countries (Afghanistan; Bangladesh; Bhutan; Cambodia; China; India; Iran, Islamic Republic of; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Lao People's Democratic Republic; Myanmar; Nepal; Pakistan; Russian Federation; Taiwan, Province of China; Thailand; Viet Nam). The species occupies a narrow band from south-eastern Iran eastward through Afghanistan and Pakistan, across the foothills of the Himalayas, to Myanmar. It occupies all countries in mainland south-east Asia except Malaysia. Duckworth et al. (1999) traced few certain records from 1990s surveys which, however, used methods unsuitable to generate records confirmed to species level (as distinct from as unidentified bears). More recent information (suggested by a number of captive cubs_ suggests a surprising wide occurrence in Lao PDR's northern highlands, including outside the protected area system.
Population	No rigorous population estimates exist for this species in Lao PDR, but it can safely be assumed to be much reduced even if not yet very widely extirpated. . Estimates available include 8-1400 bears in Japan (though perhaps no longer valid), 5-6000 in Russia, 7-9000 in India, 1000 in Pakistan and 15-46000 in China, however here are concerns regarding the reliability of these estimates.
Habitat	The species occupies a variety of forested habitats in Lao PDR, including highly degraded landscapes.
Threats	The overriding threat to the species in Lao PDR is commercially driven hunting for skins, paws and gall bladders.
Summary	The Project area's habitat is not distinct in any way from typical Lao hill-country, and **so there is no reason to conclude that the Project area could be considered critical habitat for the species.**
References	Garshelis, D.L. & Steinmetz, R. (IUCN SSC Bear Specialist Group) 2008. Ursus thibetanus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 06 November 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/WCS/Centre for Protected Areas and Watershed Management.

Species	*Aceros undulatus*, Wreathed hornbill
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect Biodiversity village survey indicated that hornbills apparently identified as this species, reporting it as less commonly encountered in the upper and lower Nam Xan only.
Distribution	The global extent of occurrence for the species is extremely large. Surveys in the 1990s recorded the species widely across Lao PDR, although only in small numbers in many areas Duckworth et al. (1999); there is recent information only from few areas, reflecting patchy survey but some local extirpations are likely to have occurred in the intervening period.
Population	The species is reported to be locally common in several areas across its range. The global population has not been quantified. In Lao PDR populations were already extremely low in some areas by the 1990s and based on general hunting patterns declines are assumed to have continued.
Habitat	The species is report to occur in evergreen forest from lowlands to at least 1300m. Range extends into deciduous forest to visit fruit trees
Threats	The primary threat to the species in Lao PDR is hunting; many large tracts of prime habitat support only small numbers, or none, because of this threat.
Summary	Wreathed hornbill plausibly still occurs in the Project area but probably only in low numbers. Its status is similar across large parts of Lao PDR. **The Project area is small in proportion to the nation's total suitable habitat and as such is most unlikely to constitute critical habitat.**
References	Birdlife International 2012. Aceros undulates. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded 18 December 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Buceros bircornis*, Great hornbill
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Biodiversity village survey apparently recognised the species, reporting it as less commonly encountered in the upper and lower Nam Xan only. Note: Verbal village information on hornbills is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Great Hornbill presence in the Project area. In most of Lao PDR Great Hornbill is much more declined than Wreathed Hornbill, and most village reports of 'great hornbills' and taken by the interviewers to mean Great Hornbill in fact probably refer to Wreathed Hornbill.
Distribution	The species has a wide distribution, occurring in China, India, Nepal, Bhutan, Bangladesh, Myanmar, Thailand, Lao PDR, Vietnam, Cambodia, Malaysia and Indonesia. Surveys in the 1990s recorded the species in a fair number in areas across Lao PDR, although almost invariably in small numbers (Duckworth et al. 1999); there is recent information only from few areas, reflecting patchy survey but some local extirpations are likely to have occurred in the intervening period.
Population	Although the species has a large range it occurs at low densities and is patchily distributed. In Lao PDR, the species was formerly common but now (although still widespread) is scarce. Based on population estimates in India, the species global population is estimated at 10,000 to 70,000 individuals. It is probably best placed in the band 20,000-49,999 individuals.
Habitat	This species frequents evergreen, semi-evergreen and mixed deciduous forests, ranging out into open deciduous areas to visit fruit trees and ascending slopes to at least 1,560 m. The species is perhaps most common in unlogged forest.
Threats	The primary threat to the species in Lao PDR is hunting; many large tracts of prime habitat support only small numbers, or none, because of this threat.
Summary	Great hornbill plausibly still occurs in the Project area but probably only in low numbers. Its status is similar across large parts of Lao PDR. **The Project area is small in proportion to the nation's total suitable habitat and as such is most unlikely to constitute critical habitat.**
References	BirdLife International. 2013. *Buceros bircornis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Cairina scutulata*, White winged duck
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Stakeholder village surveys in 2013 apparently recognised the species, reporting it as common in Ban Xomxuen and Ban Pakyong of the Nam Ngiep River though never seen in Ban Pou. In Nam Xan River villagers responded that the species is common in Ban Kanyong and Ban Don and very common in Ban Pakheuang. The Project EIA (2007) notes the species occurrence outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on ducks and other swimming birds is impossible reliably to assign to species despite the often overconfident presentation in interview reports. In particular, inept interview teams almost invariably record White-winged Duck almost anywhere in Lao PDR that villagers report ducks of any species. Given that the considerable specific search effort for White-winged Duck in the 1990s and to a lesser extent in the 2000s found only few areas to support the species, and that competently executed interview surveys very rarely find reports that conform in morphological and behavioural aspects with White-winged Duck, it is obvious that most purported White-winged Duck interview claims are in error. The same is assumed to hold here. However, the habitat is suitable for the species, and would surely have held it previously, and it cannot be excluded that small numbers remain.
Distribution	The species is native to Bangladesh, Cambodia, India, Indonesia, Lao PDR, Myanmar, Thailand and Viet Nam. Duckworth et al (1999) note 2 – 3 population centres for the species in Lao PDR. There are no recent (post-1950) records or convincing reports of the species in Lao PDR from north of the Nakai plateau, there are also no historical reports, but in the light of highly limited survey efforts, the species is assumed to have been overlooks in the many Mekong tributary systems upstream of the Nam Kading to atleast the Nam Sang. Recent intensive activity in the Nam Theun catchment suggests that very small numbers may survive for some years in areas where conventional survey under practical levels of effort cannot guarantee to find then, even by sign. Therefore, the actual status (extirpated vs reduced to very small numbers) in north Lao PDR in and since the 1990s cannot be determined.
Population	Estimates of global population report 450 individuals in India, low hundreds in Myanmar, 100 in Cambodia and 150 in Indonesia. Precautionary estimates places the global population between 350 and 1500 individuals. Total numbers in Lao PDR are likely to be no more than a few dozen, and probably now are many fewer.
Habitat	The species occur in stagnant or slow-flowing wetlands (natural and artificial) within or adjacent to evergreen, deciduous or swamp forest. Individuals roost and nest in the tree hollows. The species is secretive and forages at night on seeds, aquatic plants, grain, rise, small fish and invertebrates. Duckworth et al (1999) note records from slower moving stretches of forested streams and rivers, and pools in forests, up to 600 m.
Threats	The primary threat to the species in Lao PDR is hunting, apparently mainly for local use; many large tracts of prime habitat support only small numbers, or none, because of this threat. The threat from hunting is exacerbated by the

Species	*Cairina scutulata*, White winged duck
	species's habitat use: riverine and riparian forest habitats, and are among those most heavily used and degraded by human activity. Thus, although there seems to be no trade demand for the species in Lao PDR, incidental/opportunistic hunting occurs throughout its Lao PDR range at levels sufficient for widespread local extirpation.
Summary	White winged duck might possibly still occur in the Project area but at best only in very low numbers. Despite major loss of habitat in the last half century, tracts similar in extent and condition to the Project area remain in many parts of Lao PDR. The Project area is only a small proportion of the national's total suitable habitat and as such it is **unlikely to constitute critical habitat.**
References	BirdLife International. 2012c. *Cairina scutulata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Centropus sinensis*, Greater coucal
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey recorded the species in Huay Ngua PPA the upper and lower Nam Ngiep, resettlement site, and upper and lower Nam Xan.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	This species has an extremely large distribution and is native to: Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and Viet Nam.
Population	The global population size has not been quantified, but the species is reported to be common almost everywhere throughout its range. National population sizes have been estimated at c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in China; and c.100-10,000 breeding pairs in Taiwan. It is widespread and generally abundant, including in areas with very heavy human use and bird hunting pressure, across Lao PDR.
Habitat	Habitat is noted to be forest edge, scrub, tall secondary growth and grassland including ponds and villages.
Threats	There are no threats to Greater coucal populations in Lao PDR. Although it is often hunted, it seems resilient to current levels, and while populations may by below carrying capacity in heavily settled areas, there has been no significant contraction of range. The species has doubtless benefitted hugely from the major conversion and degradation of Lao PDR's forests over the last century.
Summary	Greater coucal is probably abundant over the deforested and degraded parts of the Project area. **This is so across Lao PDR however the Project area constitutes an insignificant proportion of the nation's total suitable habitat and as such does not constitute critical habitat.**
References	BirdLife International. 2012. *Centropus sinensis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Gyps bengalensis*, White backed vulture
Candidate Criteria	Criterion 1 – The species is listed as Critically Endangered on the IUCN Red List Criterion 3 – The species may be considered congregatory
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Project EIA (2007) notes the species occurrence outside the Project area based on a secondary data source though no location is specified. Note: Despite their distinctive physical appearance and habits, and unique Lao name, vultures are surprisingly widely reported by incompetent interviews across parts of Lao PDR from where they have been extirpated for many decades. Extensive field observation and careful interview shows that resident vultures are extirpated from all but the southernmost two provinces of Lao PDR. Himalayan griffon *G. himalayensis* and Cinereous vulture *Aegypius monachus* are erratic vagrants from the north which presumably could occur anywhere in Lao PDR, although so far there have been no record of either.
Distribution	The species is native to Afghanistan, Bhutan, Cambodia, India, Iran, Lao PDR, Myanmar, Nepal, Pakistan, Thailand and Viet Nam (BirdLife International 2012a). In Lao PDR Duckworth et al 1999 note that historically the species was widespread and common however recent records come only from Champasak and Attapu provinces. There have been no records or credible reports since 1999 from any other province in Lao PDR.
Population	The global population of the species is estimated between 2500 and 9999 mature individuals which equates to between 3,500-15,000 individuals. Viable populations in South-east Asia are known in Myanmar and Cambodia. The IUCN mapped distribution identifies the species is 'possibly extinct' in Lao PDR and much of Thailand and Cambodia.
Habitat	The species occurs mainly in plains and less commonly in hilly regions. It is known to utilise light woodland, villages, cities and open areas. The species is thought to forage over a vast range, primarily on carrion. Vultures play a role in the wider landscape as providers of ecosystems services, relied upon to dispose of animal and human remains in India. The species is reported to form considerable aggregations when feeding, and use communal roosting sites, breeding in colonies and as such may be considered a congregatory species.
Threats	Major decline in the south Asian population has been attributed to veterinary drugs used to treat domestic livestock poisoning individuals. However, the southeast Asian population has declined hugely before the introduction of these drugs, apparently through declines in food supply: hunting driven collapse of wild large mammal populations and changes in livestock carcase disposal practices. Remaining use of Lao PDR by this species may depend entirely on ranging from Cambodia, where birds are maintained by specific feeding ('vulture restaurants').
Summary	Given the ease of finding this species when present and the high levels of survey in the general region of Lao PDR within which lies the Project area, there is no chance that the interview reports collected in fact refer to a resident population of this or any other vulture. **This the Project area does not constitute critical habitat**
References	Birdlife International 2013. *Gyps bengalensis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded 18 December 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Lophura diardi*, Siamese fireback
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper and lower Nam Xan however did not recognise its presence in Nam Ngiep and Huay Ngua visited areas. Stakeholder village surveys in 2013 recognised the species as very common in Ban Pou and Ban Xomxuen of the Nam Ngiep River though common in Ban Pakyong. In Nam Xan River villagers responded that the species is very common in Ban Kanyong, Ban Pakheuang and Ban Don. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on pheasants in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Siamese fireback presence in the Project area. However, the area contains suitable habitat in its lower-lying parts, and the species is extremely resilient to hunting and forest degradation (it may even benefit from some level of the latter). Thus, it is highly likely that Siamese fireback inhabits the area.
Distribution	The species occurs in Thailand, Lao PDR, Cambodia and Vietnam. 1990s surveys recorded the species widely across lower-lying parts of Lao PDR.
Population	The species is locally common in much of its range. The total population is suspected to number 20,000-49,999 individuals based on a conservative estimate of c.2,000 individuals in Cambodia and an estimate of c.5,000 individuals in Thailand; the Lao PDR population is likely to dwarf both of these.
Habitat	The species occurs in evergreen, semi-evergreen and bamboo forest, secondary growth and scrub, often near roads and tracks through the forest, chiefly in the plains and foothills to 500 m, but occasionally much higher.
Threats	This species is declining in Lao PDR in proportion to wholesale conversion of lowland and lower-hill forest to plantations and other uses. However, very large areas of suitable habitat persist, and there are a sufficient number of records in the last decade to be sure that the species is not threatened in Lao PDR. Despite earlier concerns, it is now clear the species is highly resilient to hunting, perhaps including large-scale snaring, although this largely takes place in forests above it main altitudinal range.
Summary	Siamese fireback is very likely to occur, perhaps widely, in the Project area. Nonetheless, the **Project area constitutes an insignificant proportion of suitable habitat across Lao PDR, so does not constitute critical habitat**.
References	BirdLife International. 2013. *Lophura diardi*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/WCS/Centre for Protected Areas and Watershed Management.

Species	*Lophura nycthemera*, Silver pheasant
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper and lower Nam Xan however did not recognise its presence in Nam Ngiep and Huay Ngua visited areas. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on pheasants in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Silver pheasant presence in the Project area. However, the area contains suitable habitat in its higher-lying parts, and the species is extremely resilient to hunting and forest degradation in Lao PDR. Thus, it is highly likely that Silver pheasant inhabits the area.
Distribution	The species occurs broadly across south-east Asia. The species is native to Thailand, Myanmar, Lao PDR, Vietnam, Cambodia and southern China.
Population	The global population size of the Silver Pheasant has not been quantified, but the species is reported to be widespread and seemingly common in suitable habitat. The population size in China has been estimated at c.10,000-100,000 breeding pairs (BirdLife International 2013). Lao PDR supports large populations as the species is widespread and locally common.
Habitat	Occurs in hill and montane forest (mainly evergreen) and tall secondary growth. Generally found between 500m and 2020m although occasionally down to 200m.
Threats	Silver pheasant is declining in Lao in proportion to wholesale conversion of occupied hill forest to plantations and other uses. However, very large areas of suitable habitat persist, and there are a sufficient number of records in the last decade to be sure that the species is not threatened in Lao PDR. Despite earlier concerns, it is now clear the species is highly resilient to hunting, perhaps including large-scale snaring (most of which occurs in this species's main altitudinal range), although this is so far not well assessed.
Summary	Silver Pheasant is very likely to occur, perhaps widely and commonly, in the Project area. Nonetheless, the Project area constitutes an insignificant proportion of suitable habitat across Lao PDR, so does **not constitute critical habitat**. This remains so even if one treats the various morphologically distinctive races as separate conservation units.
References	BirdLife International. 2013. *Lophura nycthemera*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Pavo muticus*, Green peafowl
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Note: Verbal village information on pheasants in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. This is so even for the morphogically distinctive Green peafowl, which is often confused/amalgamated with Crested argus (*Rheinardia ocellata*) but also often is 'reported' from outside the plausible present-day range of either. In the context of huge range contraction of Green peafowl in Lao PDR in the last 60 years and the great rarity of surviving remnant populations outside of Savannakhet, these interview reports are most sensible taken as in error.
Distribution	The IUCN mapped distribution across the Project area is mapped as 'possibly extinct'. Birdlife International recognises almost 2,500 ha on the south-western periphery of PKK as an Important Bird Area (IBA) where individuals have been heard at a roosting site in 1994, 1995 and 2002, and were credibly reported as still present in 2009. All other remnant populations of Green peafowl confirmed in Lao PDR since 1990 are al far to the south of the Project area.
Population	The estimates of global population size are 15,000-30,000 individuals. Birdlife International (2003) notes while the population is of moderate to high national significance, it is of low global significance given the larger populations in parts of Cambodia. Duckworth et al 1999 report five areas that are likely to retain populations large enough to be viable in Lao PDR, including PKK.
Habitat	The species has been reported to occupy a variety of habitats including primary and secondary, tropical and subtropical, evergreen and deciduous forest types, mixed coniferous forest, swamp forest, open woodland, forest edge, bamboo, grasslands, savannah, scrub and farmland edge.
Threats	The main threat to the species in Lao PDR is hunting, including egg collection. Habitat modification and fragmentation may locally compound the problem. These threats have led to widespread extirpation across Lao PDR and adjacent countries.
Summary	Assuming that the interview reports are in error, there is **no reason to consider that the Project area constitutes critical habitat**. However, the rather anomalous survival of the small population around Ban Nakhaty, Phou Khao Khoay NPA, emphasises the possibility that other remnants may also survive, and it cannot be excluded that the Project area might support one. Such a population could be significant at the national level.
References	BirdLife International. 2012. *Pavo muticus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 12 September 2013 Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Polyplectron bicalcaratum*, Grey peacock-pheasant
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper and lower Nam Xan however did not recognise its presence in Nam Ngiep and Huay Ngua visited areas. Note: Verbal village information on pheasants in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Grey peacock-pheasant presence in the Project area. However, the area contains extensive suitable habitat, and the species is extremely resilient to hunting and forest degradation. Thus, it is highly likely that Grey peacock-pheasant inhabits the area, and it is quite probably common.
Distribution	The species is native to Bangladesh, Bhutan, Cambodia, China, India, Lao PDR, Myanmar, Thailand and Viet Nam.
Population	The population size has not been quantified however it is not believed to be <10,000 mature individuals. The species is reported to be locally common to fairly common and rare. The population is suspected to be declining owing to habitat loss and degradation and, locally, overexploitation. It remains widespread and common almost across the Lao PDR.
Habitat	Occurs in evergreen forest from lowlands to 1850 m. The species is reported to be tolerant to degradation of forest.
Threats	As with other evergreen forest pheasants in Lao PDR, although hunting is very high within this species's habitats, it seems highly resilient to offtake. There are thus no serious threats to the species in Lao PDR presently, although its population is presumably declining in proportion to the conversion of forest to plantations and other non-forest habitats.
Summary	Grey Peacock Pheasant is very likely to occur, perhaps widely and commonly, in the Project area. Nonetheless, the Project area constitutes an insignificant proportion of suitable habitat across Lao PDR, so **does not constitute critical habitat**.
References	BirdLife International. 2012. *Polyplectron bicalcaratum*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Psittacula alexandri*, **Red-breasted parakeet**
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey recorded the species in Huay Ngua PPA. The survey did not detect the species the Nam Ngiep, Nam Xan or resettlement site areas.
	Indirect Biodiversity village surveys in 2013 apparently recognised the species, reporting it is common in Huay Ngua. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on parakeets in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Red-breasted parakeet presence in the Project area. However, the area contains some suitable habitat and there are recent records from relatively nearby (lower Nam Kading plain; Pakxan wetlands) so it is quite plausible that Red-breasted parakeet inhabits the area, although, given general recent trends in its population in Lao PDR, it is unlikely to be common.
Distribution	The species has a broad distribution and is native to Bangladesh; Bhutan; Cambodia; China; India; Indonesia; Lao PDR; Myanmar; Nepal; Thailand; and Viet Nam.
Population	The global population size has not been quantified; however the species is reported to be generally common. The species has been heavily traded, and 125,695 wild-caught individuals have been recorded in international trade since 1981. In Lao, Duckworth et al 1999 report flocks exceeding 1000 to occur (recorded in southern Lao PDR) but in most areas rarely number more than 20-30. The species has particularly declined in the northern half of the country, and has been widely extirpated.
Habitat	In Lao the species occurs in deciduous forests and adjacent secondary growth, mostly below 400m.
Threats	Four species of parakeets occur in Lao PDR the populations of all of them have probably declined hugely although this is based on status documented in neighbouring countries (where flocks are typically much larger than in Lao PDR, especially in Cambodia, China and, locally, in Vietnam) rather than on direct evidence of decline: historical Lao information is insufficiently precise. Declines have been particularly severe in the northern half of the country, where suitable habitat is naturally more fragmented and in smaller patches. The decline is assumed to have been driven by the cagebird trade, because there is no evidence of other trade in significant volumes, and ample suitable habitat remains widespread but supporting only very small numbers.
Summary	Accepting the likelihood of this species's occurrence in the Project area, it is however **unlikely, that in the context of the much larger numbers remaining in parts of Central and South Lao PDR, that the Project area could comprise critical habitat.**
References	BirdLife International. 2012. *Psittacula alexandri*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Anhinga melanogaster*, Darter
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey recorded the species in the upper Nam Xan: at least two birds.
	Indirect Verbal village information on large waterbirds in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. These are particular problems with Darter in that name assigned to it (on what basis is apparently undocumented), *nok kho ngou* (snake-necked bird) is widely assigned by rural lowland Lao to Purple Heron *Ardea purpurea*.
Distribution	The species occur widely in South and South-east Asia. In Lao it was historically widespread and common, but suffered a massive decline during the latter 20th century, so that during the 1990s it was recorded in few survey areas, and only in small numbers. Effective protection of major breeding colonies in Cambodia has resulted in a rapidly rising number of visitors to Lao PDR usually in the late dry season and wet season; however, some birds can apparently now be seen all year. There seems to be no evidence of re-establishment of breeding in Lao PDR, but this may not be far away (if indeed it has not already happened, undocumented).
Population	In Lao PDR and surrounding countries, numbers are low except for Cambodia, which supports large breeding numbers. These disperse widely during non-breeding season. Numbers now using Lao PDR are unclear; in the 1990s there were probably no more than a few dozen per year, but now there are likely to be in the hundreds or perhaps even the low thousands.
Habitat	In Lao PDR a wide variety of waterbodies, from forest streams to large ope reservoirs, is used. This is typical of the species elsewhere in its range. The species is probably independent of forests.
Threats	Overharvest evidently drove the major declines in mainland SE Asia and when the large numbers breeding around the Great Lake of Tonle Sap were given effective protection in the early 2000s, the decline rapidly reversed. Pot-hotting of visitors to Lao PDR is likely to be widespread, but presently an insignificant proportion of the Cambodian population visits the country. Breeding re-establishment in Lao PDR may well be severely restrained by this factor: almost all waterbodies and –course used by the species are navigable.
Summary	Darters in Lao PDR's forest rivers are presently widely scattered in small numbers. The Project area would support only a small proportion of the number visiting Lao PDR presently, which are moreover, mobile (much suitable habitat remains unoccupied); and in any case the reservoir might actually improve Darter habitat in the Project area. **Thus, the Project area does not comprise critical habitat.**
References	Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Ichthyophaga humilis*, Lesser Fish Eagle
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* None: but the species is easily overlooked unless specifically searched for. *Indirect* None: but the species cannot be detected by village reports. The Project area holds some potentially suitable habitat (see below), but it is probably fairly localised in the Project area, if it occurs at all.
Distribution	Widespread in tropical Asia. In Lao PDR, formerly widespread but now reduced to a few centres of population; still occurs from the far north (Nam Ou) to the far south.
Population	Now much reduced in Lao PDR to a few centres of population, each probably with only about a dozen pairs at maximum.
Habitat	Rivers with good fringing forest. Photographs of the Nam Gniang look similar to some of the other streams inhabited by the species in Lao PDR, other streams of similar width, flow an flanking habitat seem to lack the species (e.g. the Nam Kading). Although in some areas this doubles because of persecution, this explanation is implausible for the Nam Kading within Nam Kading NPA. Without clearer understanding of the species's habitat use in Lao PDR it is not possible to predict the suitability of the Project area for the species.
Threats	Loss of riverine forest and persecution; the relative importance of the two is unclear. All remaining populations in Lao PDR are in relatively remote areas (really remote areas lack streams of sufficient width) in landscapes retaining a high proportion of forest.
Summary	With no information on the status in the Project area no firm decision can be made. Numbers, if any, in the Project area are probably too few for the area to constitute critical habitat; but if there are surprisingly large numbers there, then it possible would be critical habitat.
References	Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	Other possible species: *Aceros nipalensis*, **Rufous-necked hornbill** *Rheinardia ocellata*, **Crested argus** *Bubo nipalensis*, **Spot-bellied eagle owl** *Picus rabieri*, **Red-collared woodpecker** *Upupa epops*, **Hoopoe**
Candidate Criteria	Criterion 1 – These species have an elevated protection status nationally and are listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* None
	Indirect Based on habitat and geographical location, these bird species surely (Hoopoe), may well (Red-collared woodpecker, Spot-bellied eagle owl) or might (Crested argus) occur in the Project area, or might have done so (Rufous-necked hornbill).
Distribution	Various. None is endemic to Lao PDR. In Lao PDR, Crested argus is naturally restricted to eastern parts, but the others are or (Rufous-necked hornbill) were widespread.
Population	Various. Rufous-necked hornbill is now localised and rare; the breeding Hoopoe population is now localised and scarce; the others remain common within suitable habitat.
Habitat	Various. Rufous-necked hornbill - occupies hill forest Red-collared woodpecker - occupies lowland forest Crested argus – occupies wet evergreen forest with marginal extension into adjacent areas. Suitable habitat for these three species is naturally restricted or possibly absent in the Project area. Spot-bellied eagle owl and hoopoe occupy a range of habitats.
Threats	Various. Hunting has severely reduced Lao PDR populations of Rufous-necked hornbill, the breeding Hoopoe population and, probably to some extent, Spot-bellied eagle owl. Crested argus may also have been locally affected, especially where suitable habitat is naturally or anthropogenically fragmented. Suitable habitat remains extensive for all species, although ongoing conversion of lowland forest to plantations is probably much reducing suitable habitat for Red-collared woodpecker. Migrant populations of Hoopoe are probably not threatened in Lao PDR, although many individuals are probably killed.
Summary	Although some, perhaps all of these species are likely to inhabit the Project area, it forms only an insignificant part of the habitat in Lao PDR for all of them and it is **implausible it could be critical habitat** for any of them.
References	Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Broghammerus reticulatus*, Reticulated python
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper and lower Nam Ngiep, resettlement site and upper and lower Nam Xan however did not recognise its presence in Huay Ngua. Stakeholder village surveys in 2013 recognised the species as very common in Ban Pou, Ban Xomxuen and Ban Pakyong of the Nam Ngiep River as well as Ban Pakheuang and Ban Don of the Nam Xan River. Ban Kanyong of the Nam Xan River noted the species as common.
Distribution	The species occurs in Indonesia, Timor-Leste, Bangladesh, Brunei Darussalam, Cambodia, India, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.
Population	The species is considered to be widespread in Lao PDR, and populations are considered to be of low global significance.
Habitat	Duckworth et al (1999) noted the species is expected to occur in most forest types though it is also documented to inhabit humid forests and is typically found in riparian areas (Raffles Museum of Biodiversity Research 2013). It also occurs in agricultural areas, scrubland, mangroves and urban areas (Raffles Museum of Biodiversity Research 2013).
Threats	It is threatened by commercial exploitations for the skin trade.
Summary	Given that the Lao PDR population is not considered to be of global significance and that is it widespread it is **unlikely that the Project area sustains greater than 10 per cent of the global population or is one of 10 discrete management sites globally for the species (C1 Tier 1).** The baseline information **does not provide an indication that the habitat is of significant importance, or that records are part of an important concentration (C1 Tier 2).**
References	Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management. Raffles Museum of Biodiversity Research. 2013. *Broghammerus reticulatus* (Schneider, 1801). In: The DNA of Singapore. < http://rmbr.nus.edu.sg/dna/> Downloaded on 08 November 2013. Uetz, P & Hallerman, J. 2013. *Broghammerus reticulatus* (Schneider, 1801). In: The Reptile Database. Zoological Museum Hamburg. < http://reptile-database.reptarium.cz/>. Downloaded on 08 November 2013.

Species	*Indotestudo elongate*, Elongate tortoise
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List Included at request
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect -
Distribution	The species is found in Asia from Nepal to Malaysia.
Population	Limited population information available. Duckworth et al. reported in 1999 that the species is widespread in Lao PDR and that the population is of low global significance. In 2006 the IEWMP reported that the species is found widely in Lao PDR and although has not been recorded in Bolikhamxay Province should occur.
Habitat	A damp forest species although is also found in dry habitats. The species diet consist of fruits, leafy greens, worms, slugs and carrion.
Threats	The species is commonly encountered ni Asian food markets and the most common tortoise shipped to the Chinese food markets from Vietnam.
Summary	Given that the Lao PDR population is not considered to be of global significance and that is it widespread it is **unlikely that the Project area sustains greater than 10 per cent of the global population or is one of 10 discrete management sites globally for the species (C1 Tier 1).** The baseline information **does not provide an indication that the habitat is of significant importance, or that records are part of an important concentration (C1 Tier 2).**
References	Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management. Senneke, D. 2003. *Indotestudo elongaae* The Elongated Tortoise. World Chelodian Trust. http://www.chelonia.org/articles/elongatacare.htm Accessed 14 January 2014. IEWMP. 2006. Significant Wildlife and Wildlife Habitats of Bolikhamxay Province. Bolikhamxay Provincial Agriculture and Forestry Office and Wildlife Conservation Society. Vientiane Lao PDR.

Species	*Ophiophagus hannah*, King cobra
Candidate Criteria	Criteria 1 – The species is listed as Vulnerable on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect -
Distribution	Widely distributed in south and southeast Asia from Nepal and India, across outhern China, southward to the Philippines and Indonesia east to Bali, as well as parts of Malaysia.
Population	The species is common in good habitat in Thailand however is not frequently encountered in other areas of the wide range. Duckworth et al. reported in 1999 that the species is widespread in Lao PDR and that the population is of low global significance. In 2006 the IEWMP reported that the species probably occurs throughout Bolikhamxay Province.
Habitat	Found in most forest types, including bamboo.
Threats	The species is sought for wildlife trade to Vietnam and China where it is believed to have medicinal value.
Summary	Given that the Lao PDR population is not considered to be of global significance and that its haitat is widespread it is **unlikely that the Project area sustains greater than 10 per cent of the global population or is one of 10 discrete management sites globally for the species (C1 Tier 1).** The baseline information **does not provide an indication that the habitat is of significant importance, or that records are part of an important concentration (C1 Tier 2).**
References	Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management. IEWMP. 2006. Significant Wildlife and Wildlife Habitats of Bolikhamxay Province. Bolikhamxay Provincial Agriculture and Forestry Office and Wildlife Conservation Society. Vientiane Lao PDR.

Species	*Platysternon megacephalum*, **Big-headed turtle**
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper Nam Ngiep and upper Nam Xan.
Distribution	The species is native to China, Lao PDR, Myanmar, Thailand and Viet Nam. The species has been reported to occur in PKK to the west of the Project area as well as other records in Annamite mountains and southern Lao PDR in 1999 (Duckworth et al 1999).
Population	There is limited information regarding the size of the population of the species. In 1999 Duckworth et al. reported that Lao PDR populations are considered to be of moderate global significance with the species being widespread. In 2006 IEWMP reported the species probably occurs widely in the Bolikhamxay Province with known records from the Ban Nape area, Nam Nouang and NNT.
Habitat	The species inhabits fast flowing, cool, rocky mountain brooks and streams, usually narrower than 1 m and less than 10 cm deep. There are a number of low order streams that the Project area intersects. The species is thought to be nocturnal when it forages along the stream bottom and stream edge. It is a carnivorous species.
Threats	A key threat wil the species will be improved access to the area for illegal wildlife collectors, either via the reservoir itself, or via project access roads
Summary	The key threat to the species is hunting and although current information does not confirm critical habitat, the precautionary approach should be considered and the threats to the species should be managed throughout the Project construction and operation and within any Biodiversity Offset Design.
References	Asian Turtle Trade Working Group. 2000. *Platysternon megacephalum*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 12 June 2013. Kirkpatrick, D.T. 1995. The Big-headed Turtle, *Platysternon megacephalum*. Originally published in Reptile and Amphibian Magazine, November/December 1995, pages 40-47. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management. IEWMP. 2006. Significant Wildlife and Wildlife Habitats of Bolikhamxay Province. Bolikhamxay Provincial Agriculture and Forestry Office and Wildlife Conservation Society. Vientiane Lao PDR.

Species	*Catlocarpio siamensis*, Giant barb
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List Criterion 3 – The species is migratory
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area.
Distribution	The species is native to Cambodia, Lao PDR, Thailand and Viet Nam.
Population	The size of the population is reported to have declined rapidly since 1990. The species is very rare in Thai and Lao Mekong and associated tributaries.
Habitat	The species inhabits floodplain and main river habitats feeding on algae, phytoplankton, vegetation and small fish. Spawning areas are unknown and little is known about spawning behaviour. The Mekong River Commission notes juveniles are mainly seen in floodplain habitats and small tributaries, and that mature fish are only found in large streams. Large mature fish have not been observed in floodplain habitats and it is more likely the species spawns in certain habitats within the main river channel where juveniles can reach rearing habitats on the floodplain. The species is reports to undertake short-distance migrations however further research is needed on the migratory patterns of the species.
Threats	Main threats to the species include over-harvest and habitat fragmentation.
Summary	Specialist input identified that there is very little survey data from the Nam Ngiep catchment (pers. comm. Dr Maurice Kottelat 7/11/2013). The species is threatened throughout its range and any area where the species reproduces would be considered critical habitat (pers. comm. Dr Maurice Kottelat 7/11/2013). Species profile information suggests that the species spawning occurs in main or larger river channels and identifies the importance of floodplain areas. If the species is present downstream of the reservoir, the modification of the topography of its habitat and alteration of the flow pattern (especially disruption of daily and annual cycle) are expected to have an impact of the spawning sites and the reproduction of the species. Given the declining global population and the fragmentation of its distribution range, any spawning site would be a critical habitat and as such additional investigation specific to the species is being collected in the Project area.
References	Hogan, Z. 2011. *Catlocarpio siamensis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 12 September 2013. MRC. 2005a. Key Mekong fish species – migration paths. *Catlocarpio siamensis*. http://ns1.mrcmekong.org/programmes/fisheries/mig_catlocarpio.htm. Accessed 20 November 2013.

Species	*Laubuca caeruleostigmata,* **Flying minnow**
Candidate Criteria	Criteria 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey recorded this species in surveyed of the upper Nam Ngiep and lower Nam Xan sites. *Indirect*
Distribution	The species has been recorded from Thailand in the Mae Khlong and Chao Phraya basins, and from the Mekong in Cambodia, Lao PDR and Thailand.
Population	There is limited information on the population size of the species. In Thailand 60% of populations extirpated in 10 years due to loss of habitat. It is likely that the species is rare in Lao PDR.
Habitat	Found in large rivers in the main stream.
Threats	
Summary	Further targeted survey is scheduled in the Nam Ngiep for this species.
References	Vidthayanon, C. 2011. *Laubuca caeruleostigmata*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org Downloaded on 16 January 2014.

Species	*Pangasianodon hypophthalmus*, Striped catfish
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List Criterion 3 – The species is migratory
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area.
Distribution	There is limited information regarding the size of the population of the species however the species remains common and popular aquaculture species. It is used in aquaculture.
Population	The species is native to Cambodia, Lao PDR, Thailand and Viet Nam.
Habitat	It inhabits main channels and floodplains, moving off-channel for feeding and nursing. The species feeds mainly on algae, plants, zooplankton, insects, fruits, crustaceans and fish. The species is reported to move seasonally from main channels floodplains of large rivers to floodplains and marshland for feeding and nursing. The species is capable of migration in excess of 300 km.
Threats	Major threats to the species globally include overexploitation, habitat degradation, and changes in water quality and flow. Plans to dam the Mekong may disrupt the species life cycle as the migratory requirements appear to rely on flow or water quality to facilitate migration, cue spawning, and aid dispersal of young.
Summary	Species profile information suggests that the species utilises main or larger river channels and floodplain areas and undertakes long distance migrations and as such more confirmation of presence of the species is required. In the event there is spawning area downstream of the dam, the area may be considered critical habitat. Further targeted village interviews are scheduled to identify the locations where the species has been noted in the Nam Ngiep and neighbouring catchments.
References	Vidthayanon, C. and Hogan, Z. 2011. *Pangasianodon hypophthalmus*. In IUCN 2012. IUCN Red Lost of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 12 September 2013.

Species	*Poropuntius deauratus*, Yellow tail brook barb
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey recorded this species in all sites surveyed of Nam Ngiep, Huay Ngua and Nam Xan. At Huay Ngua 13 individuals were detected in comparison to much larger counts in Nam Ngiep (up to 139 individuals).
	Indirect -
Distribution	The species is listed as native to Viet Nam from coast river drainages. Records in Cambodia, China, La PDR, Malaysia and Thailand are noted to be misidentification.
Population	
Habitat	Species habitat is listed as coastal river drainages in Central Viet Nam (Hukstorf and Freyof, 2011) and it is considered that the survey record is a misidentification.
Threats	Overfishing and habitat degradation.
Summary	Species profile and specialist input (pers. comm. Dr Maurice Kottelat 11/11/2013) suggest that the species record is a misidentification and as such further confirmation on the record is currently being sought in order to identify critical habitat status. Potential candidates for the identification include (but not limited to) *P. carinatus* (LC), *P. angustus* (DD) or *P. normani* (LC). Additional waterway surveys are being undertaken.
References	Huckstorf, V. and Freyof, J. 2011. *Poropuntius deauratius*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org. Downloaded 20 November 2013.

Species	*Probarbus labeamajor*, **Thick lipped barb**
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List Criterion 2 – The species is endemic to the Mekong Criterion 3 – The species is migratory
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area.
Distribution	The species is endemic to the Mekong and reported only from the Mekong mainstream from Nakorn Phanom Province (Thailand) and Sambor District, Kratie District (Cambodia). It has also been found in Sesan, Sekong and Srepok tributaries of the Mekong.
Population	Population size is not well understood though it is noted to be decreasing and a population decline of at least 50% is inferred across the global population.
Habitat	The species inhabits the deep, slow reaches of the main channel of large rivers with a sand or gravel substrate and abundant mollusc population. It is known to undertake short distance migrations for spawning in November and January. The species feeds on aquatic plants, insects and shelled molluscs. The species is reported to undertake short distance migrations for spawning in November and January.
Threats	Threats to the species include overfishing, habitat destruction and large dams.
Summary	Specialist input (Dr Maurice Kottelat pers comm 11/11/2013) indicated that the species is not known to occur in the Project area part of the catchment and the record would require verification. The species is very distinctive and identification is generally unproblematic, as such the record is likely valid. Species profile information suggests that the species utilises main or larger river channels. Should the record be correct, the habitat in the lower reaches of the Nam Ngiep River may be susceptible to indirect impacts from the propose dam, however the area is unlikely to represent >10% of the habitat within the Mekong. **The Project area is not considered to be critical habitat for the species.**
References	Baird, I. 2011a. *Probarbus labeamajor*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 12 September 2013.

Species	*Yasuhikotakia splendida*, **Jaguar loach**
Candidate Criteria	Criterion 2 – The species may be endemic to Lao PDR
Record	*Direct* TISTR 2013 biodiversity survey recorded the species at Huay Ngua (4 individuals) and lower Nam Ngiep (1 individuals). No individuals were recorded from Nam Xan or upper Nam Ngiep.
	Indirect -
Distribution	No information available
Population	No information available
Habitat	Species habitat is listed as rocky rapids in large streams and rivers. The distribution of the species is reported from the Sekong River, Mekong (as Savannakhet) and the Mun River, Thailand.
Threats	No information available
Summary	Specialist input (Dr Maurice Kottelat pers comm 11/11/2013) indicated, consistent with other sources, the species is only known from the Xekong drainage in southern Lao and may be a mis-identification. If an accurate species identification the Nam Ngiep should be considered critical habitat and as such verification of the record would be required. Photographic record of the survey captures are currently being confirmed and the individuals may be *Y. lecontei* or Y. *caudipunctata* which are listed as least concern on the IUCN Red List.
References	Baird, I. 2011b. *Yasuhikotakia splendida*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.ord. Downloaded on 20 November 2013.

Species	*Wallago leeri*
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area.
Distribution	The distribution of the species reaches from the Mekong delta to northern Lao PDR and Thailand. Other sources note that reports of the species from the Mekong River basin are mis-identifications of *Wallago micropogon*. *W. leeri* is restricted to western Indonesia and Malay Peninsula where in the Mekong River *W. micropogon* occurs.
Population	No information available
Habitat	*W. micropogon* is found in rivers and smaller streams. It moves to flooded forests during high water levels and migrates from rivers to smaller srteams to spawn.
Threats	Threats to *W. micropogon* are likely related to loss of riverine forest and possibly changes to flow regimes.
Summary	*Wallago micropogon* is listed as data deficient on the IUCN Red list, it has been previously misidentified as *W. leeri* in the Mekong. **As such the species is not a candidate for critical habitat.**
References	Allen, D. 2011. *Wallago micropogon*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.ord. Downloaded on 20 November 2013.

Species	Migratory Fish Species
Candidate Criteria	Criterion 3 – These species are migratory
Record	*Direct* TISTR 2013 biodiversity survey recorded each of the species listed below.
General	• *Acantopsis choirorhynchos* (Horseface loach) – potamodromous, occurs in swift, clear streams with sand or gravelly substrate, also large rivers. IUCN distribution does not include Lao PDR (Ng 2012a). • *Barbonymus gonionotus* (Java barb) – potamodromous, occurs in rivers, streams, floodplains and occasionally reservoirs. Prefers standing water habitats. Local migrant from the Mekong to small streams and flooded areas (Thinh et al 2012). The species is widely distributed and cultivated. • *Henicorhynchus lineatus* – occurs mainly in medium to large-sized rivers and enters flodded fields (Allen 2011). • *Henicorhynchus ornatipinnis* • *Hypsibarbus venayi* • *Luciosoma bleekeri* (Shark minnow) – occurs in rivers and tributaries, moving to floodplains in the rainy season (Vidthayanon 2012a). • *Mystacoleucus atridorsalis* – occurs in lowland rivers and submontane streams and tributaries (Vidthayanon 2012c). • *Oxyeleotris marmorata* (Marbled goby) – occurs in wetlands, rivers, ponds, reservoirs, canals, swamps and flooded forest. Prefers little to no water movement (Allen 2011b). • *Scaphognathops bandanensis* • *Sikukia gudgeri* (Sikuk barb) – common throughout its range, potamodromous, migrates from Cambodia to southern Lao PDR and northeastern Cambodia between November and February (Baird 2012).
Summary	For species where the aquatic habitats up and downstream of the access road crossings may play a role in migration pathways, the area may be considered critical habitat. Further investigation into the migratory species relevant to the Project area is scheduled. Environmental flows release from the proposed dam will be required to consider the requirements of migratory species.
References	Ng, H.H. 2012a. *Acantopsis choirorhynchos*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013. Thinh, D.V., Van, N.S. and Nguyen, T.H.T. 2012. *Barbonymus gonionotus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013. Allen, D. 2011a. *Clarias batrachus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013. Allen, D. 2011. *Gymnostomus lineatus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 16 January 2014. Vidthayanon, C. 2012. *Luciosoma bleekeri*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013. Rayamajhi, A., Jha, B.R. and Sharma, C. 2010. *Mastacembelus armatus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2.

Species	Migratory Fish Species
	www.iucnredlist.org. Downloaded on 26 November 2013.
	Vidthayanon, C. 2012b. *Mastacembelus favus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Vidthayanon, C. 2012c. *Mystacoleucus atridorsalis*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Ng, H.H. 2012b. *Mystus singaringan*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Allen, D. 2011b. *Oxyeleotris marmorata*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Ng, H.H. 2012c. *Pseudomystus siamensis*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Baird, I. 2012. *Sikukia gudgeri*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Dey, S.C. 2010. *Xenentodon cancila*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Annex I

Socio-economic Survey Results

I.1 PROPOSED OFFSET AREA SOCIO-ECONOMIC AND CULTURAL RESULTS

I.1.1 Introduction

ERM undertook an assessment of the ecosystem services to supplement the biodiversity assessment completed for the NNPI project. The aim is to provide a social context to the establishment of biodiversity offsets.

The assessment included two field visits to collect relevant social data. The first visit involved engagement with key stakeholders (e.g. government officials) and village and market surveys to understand utilisation of ecosystem services by project affected people (PAP). The results of the first visit are presented in the *Inception Report*, prepared by ERM in July 2013.

The following sections present the results from the second field visit, which was undertaken 24 to 29 July 2013 in Bolikham District, Lao PDR. The focus of the second field was twofold:

(1) *An assessment of provisioning and cultural ecosystem services in the proposed offset area*. The field team mapped natural resources and cultural site locations as well as undertook a significance ranking exercise to prioritize natural and cultural resources. The focus was on prioritizing the species and resources to be conserved.

(2) *Stakeholder engagement to determine the level of community acceptance of offset measures in the area*. The field team conducted focus group discussions and in-depth interviews with hunters and gatherers from six villages (both male and female representatives) along Nam Ngiep River and Nam Xan River. The aim was to generate inputs to the *Biodiversity Offset Report*. The list of villages is provided in *Table 1.2*.

The villagers interviewed were largely lowland Lao, which differ from highland Laos in a number of ways. The Lao government classify the population by their location of residence for this reason Lao people can be categorized into three main groups - lowland Laos, highland Laos and upland Lao. The lowland Lao refer to groups of Lao people who reside in the lower part of mountains or on the flat areas. The lowland Laos practice Buddhism and engage in agricultural farming as a way of sustaining their livelihood. The majority of Lao population is the lowland Lao.

The highland Lao refer to those who reside in the mountainous region of the country. The highland Laos consist of different tribal groups, such as the Hmong, Kamoon and Yaoo. The highland Laos speak their own dialects and practice animism. In this report, no upland Laos were identified.

I.1.2 Stakeholder Engagement Outcomes

Based on the focus group discussions, villagers are aware that the Project is being constructed and may adversely impact their livelihood.

During the focus groups, villagers were asked about the concept of 'biodiversity offset'. Villagers appear to understand the concept as a conservation area that is like or similar to the one that is being used impacted (by the Project). The villagers are aware that areas located around their residence may be utilized as biodiversity offset areas.

In addition, villagers were informed, and appeared to be accepting, that the biodiversity offset proposal, is still in its initial stages of development by the NNP1PC. Villagers were aware that biodiversity offset will not be established without consent from villagers.

Villagers were aware that biodiversity offset areas, once established, may restrict their use of natural resources as well as access to significant cultural or spiritual sites that are frequently used or owned by the villagers.

Although villagers expressed concerns regarding the implementation of biodiversity offset areas, no villagers were openly opposed to the establishment of the biodiversity offset area. Instead most villagers interviewed appeared to have a neutral position. This may be due to the fact that villagers do not perceive the biodiversity offsets as a threat to their livelihood.

Much of the understanding within local villages comes from existing experience. According to the villagers in the Thatom district, including Ban Pou and Ban Pakyong, they were already conserving community forest in nearby areas through the Village Forest Committee. This was a result of a duty allocated by the Thatom District in which the villages are asked to manage and oversee their community forests and natural resources. Therefore, potential impacts from the implementation of biodiversity offset were understood by the villagers from Ban Pou and Ban Pakyong.

Similar to Ban Pou and Ban Pakyong, the lower villages including Ban Kanyong, Ban Pakheaung, Ban Don and Ban Xomxeun have also developed village police groups to oversee both legal and illegal doings, such as hunting and gathering related to the Provincial Protective Forests.

Based on their experience with conservation, villagers indicated that if their forests are used as conservation areas there should be other areas established where key activities can continue to occur, such as hunting and gathering. In this manner, villagers can continue to sustain their subsistence living and/ or livelihood without altering their way of life. This was the preferred to financial compensation.

The villagers indicated that the existing village forest committees could help manage the biodiversity areas. The committees, which have been set-up to oversee forest use, consist of village headmen, respected older male representatives from the Lao youth committee, and female representatives from the women's union.

Furthermore, the villagers suggested that the Lao government should be an actor in deciding which areas will be conserved. In addition, villagers indicated that they (and others) would be more willing to comply with the decision (e.g. prohibition on hunting in a conservation area) if the Lao government was the decision-maker.

I.1.3 Results Of Market Surveys

Two markets were surveyed (see Table I.1). This included the Bolikham and Thabok markets. The market surveys at Ban Pou and Pakxan markets indicated no signs of wildlife sales. The Bolikham and Thabok markets were selected to widen the pool in order better understand the potential sale of wildlife species.

The Bolikham market is located between Ban Don and Xom Xeun and includes a stop for Laos's public transportation. From visual observations, there are approximately 50 stalls of fresh vegetables, 20 stalls of fresh meats (e.g. chicken and pork), and 60 general commodity stores, such as manufactured household products and clothes. Several of the stalls sell NTFP, including mushrooms and bamboo shoots.

The Thabok market is located in the Thapabrad district, next to the Pou Khao Kouay National Protective Area. Based on observations, there are approximately 60 stalls of fresh produce and 20 stalls for general household merchandises, such as manufactured food and clothes. Some of the fresh produce stalls also sold wild species such as wild boar, wild chicken, and frogs. However, not always were the species on site, instead the species are stored at the vendor's residence and can be ordered.

Mr. Fongsalee Chaiyasarn, a government official from the Agriculture and Forestry Department, informed the survey team that vendors in local village markets were highly unlikely to be selling endangered species sourced from protected areas as it is prohibited in Loa. The field team observations align with the officer's comments as no endangered species were observed at the vendors' stalls at the Bolikham market. This may be because the market is located near the district's central administration office and government officers visit the market frequently.

Table I.1 Market Surveys

Market	Notable species observed
Bolikham	No notable species observed
Thabok	Wild boar, wild chicken, frogs

Figure I.1 Stalls at Bolikham Market

Stalls at Bolikham market

Fresh produce stall

Fresh produce stall

Selling of small frogs

Figure I.2 ***Stalls at Thabok Market***

Commodity stalls at Thabok market

Fresh produce stall

Wrapped wild chicken

Sale of endangered species
(A leg of wild boar was stored in the blue storage)

I.1.4 Results of the Village Surveys

In addition to stakeholder engagement and market surveys, focus groups were run with village representatives (*Table I.2.)*.

Table I.2 Villages Surveyed

Location	Focus groups and In-depth interviews
Ban Pou	25th July 2013
Ban Pakyong	25th July 2013
Ban Kanyong	26th July 2013
Ban Pakheaung	26th July 2013
Ban Don	27th July 2013
Ban Xomxeun	27th July 2013

Villagers were aware of a number of proposed developments for the local area, including Nam Ngiep 1, Nam Ngiep 2 and the Nam Xan project. (The Nam Xan project is a proposed weir, which will serve to generate electricity for village consumption.) Villagers at Ban Kanyong mentioned construction of Keang Tong and Keang Dao dam, which will generate electricity. The villagers did not identify any proposed mining projects.

Villagers also commented on unexploded ordnance (UXO) contamination. In most villages ordinances have been cleared. The exception is Ban Kanyong, where a small number of remaining UXOs exist. Government officers regularly visit the village to terminate UXOs.

I.1.5 Provisioning Services

Fauna

A flipbook was used during the focus groups to guide the discussion and generate dialogue. The flipbook included photographs of species that have been reported to exist in the Project area by the Environmental Research Institute Chulalongkorn University (ERIC) in 2011. Detailed information about the species found by villagers is contained in *Table I.3*, including species name and sight frequency.

Table I.3 Sight frequency of reported species

No.	Common Name	Scientific Name	IUCN Status	Sight Frequency					
				Nam Ngiep River			Nam Xan River		
	English (Lao) Name			Ban Pou	Ban Xomxuen	Ban Pakyong	Ban Kanyong	Ban Pakheuang	Ban Don
Mammals									
1	Red-shanked Douc Langur (Khadeng)	*Pygathrix nemaeus*	EN	N	N	N	N	N	N
2	Asian Wild Dog (Ma Nai)	*Cuon alpinus*	EN	A	A	A	N	N	A
3	Phayre's Langur	*Trachypithecus phayrei*	EN	A	C	N	C	N	N
4	Asiatic Elephant (Xang)	*Elephas maximus*	EN	N	N	LC	N	N	N
5	Fishing cat (Seua Pa)	*Prionailurus viverrinus*	EN	LC	N	LC	C	N	C
6	Tiger (Seua Khong)	*Panthera tigris*	EN	LC	N	N	N	N	N
7	Pangolin (Liin)	*Manis javanica*	EN	C	LC	LC	LC	C	A
8	Gaur (Meuey)	*Bos gaurus*	VU	N	N	N	N	N	N
9	Stump-Tailed Macaque (Ling Kung)	*Macaca arctoides*	VU	A	A	A	A	LC	A
10	Sambar Deer (Kouang)	*Rusa unicolor*	VU	A	LC	C	A	A	C
11	Marbled Cat (Seua Maeo)	*Pardofelis marmorata*	VU	C	A	A	A	A	C
12	Asian Slow Loris (Ling Lom)	*Nycticebus bengalensis*	VU	A	A	A	A	A	A
13	Pygmy Loris	*Nycticebus pygmaeus*	VU	A	A	A	A	A	A
14	Malayan Sun Bear (Mee Born)	*Helarctos malayanus*	VU	LC	LC	N	A	C	N
15	Asian Black Bear (Meuey)	*Ursus thibetanus*	VU	LC	LC	LC	C	C	N
16	Three-Striped Palm Civet	*Viverra zibetha*	NT	A	C	A	A	LC	A
17	Binturong (Ngen Hang Kho)	*Arctictis binturong*	VU	C	LC	A	A	N	C
18	White cheeked crested gibbon (Thany)	*Hoolock leuconedys*	VU	C	N	A	C	N	N
19	Chinese Serow (Nheuang)	*Capricornis milneedwardsi*	NT	N	A	C	N	N	N

No.	Common Name	Scientific Name	IUCN Status	Sight Frequency					
				Nam Ngiep River			Nam Xan River		
	English (Lao) Name			Ban Pou	Ban Xomxuen	Ban Pakyong	Ban Kanyong	Ban Pakheuang	Ban Don
20	Siamese Macaque (Ling Sehn)	*Macaca assamensis*	NT	LC	N	C	A	N	N
21	Asian Golden Cat (Seua Fai (Seua Daeng))	*Pardofelis temminckii*	NT	N	N	N	C	N	N
22	Hog Badger (Mu Leung)	*Arctonyx collaris*	NT	A	C	C	C	A	C
23	Common Otter (Nahk)	*Lutra lutra*	NT	A	A	A	N	N	N
24	Asiatic Jackal (Ma Jork)	*Canis aureus*	LC	N	A	N	A	A	N
25	Barking Deer (Fan)	*Muntiacus muntjak*	LC	A	A,LC	A	A	C	A
26	Colugo (Malayan Flying Lemur) (Bahng Hog (Bahng Nai))	*Galeopterus variegatus*	LC	A	C	N	C	N	N
27	Wildcat/Leopard cat (Seua Meo)	*Prionailurus bengalensis*	LC	N	C	N	C	A	A
28	Greater Short-Nosed Fruit Bat	*Cynopterus sphinx*	LC	C	A	C	C	A	A
29	Geoffrey's Rousettle	*Rousettus amplexicaudatus*	LC	A	A	C	C	A	A
30	Back Striped Weasel (Phung Porn)	*Mustela strigidorsa*	LC	A	A	A	A	A	A
31	Hoary Bamboo Rat (Onn Khaem)	*Rhizomys pruinosus*	LC	A	A	A	A	A	A
32	Large Bamboo Rat (Onn Hok)	*Rhizomys sumatrensis*	LC	LC	A	A	C	C	A
33	Asiatic Brush-tailed Porcupine (Hone)	*Atherurus macrourus*	LC	LC	A	LC	C	A	C
34	Variable Squirrel (Ka Hok Lark Sy)	*Callosciurus finlaysonii*	LC	A	A	A	C	A	A
35	Red-Cheeked Squirrel	*Dremomys rufigenis*	LC	LC	A	A	C	A	A
36	Phayre's Flying Squirrel	*Hylopetes phayrei*	LC	A	A	N	C	N	A
37	Lesser Giant Flying Squirrel (Bahng Lua)	*Petaurista elegans*	LC	A	C	N	C	N	C
38	Red Giant Flying Squirrel (Bahng Lua)	*Petaurista petaurista*	LC	A	N	N	N	N	N

No.	Common Name	Scientific Name	IUCN Status	Sight Frequency					
				Nam Ngiep River			Nam Xan River		
	English (Lao) Name			Ban Pou	Ban Xomxuen	Ban Pakyong	Ban Kanyong	Ban Pakheuang	Ban Don
39	Wild boar (Mou Paa)	*Sus scrofa*	LC	A	A	A	A	A	A
40	Kloss's Mole (Teung)	*Euroscaptor klossi*	LC	N	N	N	N	N	N
41	Three Striped Palm Civet (Ngen Omm Na Daen)	*Arctogalidia trivirgata*	LC	LC	N	A	C	N	N
42	Javan Mongoose (Phung Porn)	*Herpestes javanicus*	LC	A	C	N	C	N	A
43	Masked Palm Civet (Ngen Kheua Khow)	*Paguma iarvata*	LC	A	A	A	C	C	A
44	Common Palm Civet (Ngen Omm Tin Tam)	*Paradoxurus hermaphrodites*	LC	A	C	LC	C	N	C
45	Northern Treeshrew (Ka Tae)	*Tupaia belangeri*	LC	A	A	N	C	A	A
46	Small Indian Civet	*Viverricula indica*	LC	N	N	C	N	N	C
47	Porcupine	*Hystrix brachyuran*	LC	A	A	A	C	C	C
48	Lesser Mouse Deer (Kaay)	*Tragulus javanicus*	DD	A	A	A	A	A	A
49	Large-toothed Ferret-Badger (Ma Leung)	*Melogale personata*	DD	N	C	N	C	N	N
50	Grey-Bellied Squirrel	*Callosciurus caniceps caniceps*	unknown	A	A	A	A	A	A
51	Rhesus Macaque	*Mecaca mulatta*	unknown	N	A	A	N	C	C
52	Flying squirrel (Baang)	Subfamily Sciurinae, Tribe Pteromyini	unknown	A	C	A	LC	C	C
Reptiles and Amphibians									
53	(Khiet Lai/Hin)	*Amolops cremnobatus*	NT	A	A	A	A	A	A
54	(Khiet Ta Pat Leuang)	*Rhacophorus calcaneus*	NT	A	C	A	A	A	A
55	(Khiet Ta Pat Tong)	*Rhacophorus reinwardtii*	NT	N	LC	A	A	N	N
56	Indochinese Sand Snake (Ngou Xeuak Phat)	*Psammophis condanarrus*	unknown	A	A	A	A	A	A
57	Asian Water Dragon (Kathang)	*Physignathus cocincinus*	unknown	N	A	A	C	A	A
58	Common Ratsnake (Ngou Sing)	*Ptyas mucosus*	unknown	A	A	A	A	A	A

No.	Common Name	Scientific Name	IUCN Status	Sight Frequency					
				Nam Ngiep River			Nam Xan River		
	English (Lao) Name			Ban Pou	Ban Xomxuen	Ban Pakyong	Ban Kanyong	Ban Pakheuang	Ban Don
59	Black Rat Snake	*Ptyas carinatus*	unknown	A	A	A	A	A	A
60	Red-Necked Keelback Snake	*Rhabdopsis subminiatus*	unknown	A	A	A	A	A	A
61	King Cobra	*Ophiophagus hanah*	unknown	A	C	A	C	A	A
62	Monocled cobra (Ngou Haou)	*Naja kaouthia*	unknown	A	A	C	C	A	A
63	Reticulated Python (Gnou Leuam)	*Python reticulates*	unknown	A	A	A	C	A	A
64	Green Snake (Ngou Khieo)	-	unknown	A	A	A	A	A	A
65	Sun Skink	*Mabuya multifasciata*	unknown	A	A	A	A	A	A
66	Tortoises (Tau)	*Testudo* spp.	unknown	A	C	A	A	A	A
67	Water monitor (Hiaa)	*Varanus salvattor*	unknown	A	A	A	A	A	C
68	Jellow Tree Monitor (Len)	*Varanus bengalensis*	unknown	A	A	A	A	A	A
69	Kob Dong	*Annandia delacouri*	DD	A	C	A	A	A	N
70	Kiet Keoung	*Microhyra berdmorei*	LC	N	A	N	A	A	A
Avian Species									
71	White backed vulture (Heng Khorkham)	*Gyps bengalensis*	CR	N	N	N	N	N	N
72	White winged duck (Nok Pet Nam)	*Cairina scutulata*	EN	N	C	C	C	A	C
73	Imperial Eagle (Leo)	*Aquila heliacal*	VU	N	N	N	N	N	A
74	Rufous-necked Hornbill (Nokkok kho-kham)	*Aceros nipalensis*	VU	N	N	C	C	N	N
75	Oriental Darter (Nok Khor Gnou)	*Anhinga melanogaster*	NT	N	A	N	A	N	C
76	Red Crowned Barbet	*Megalaima rafflesii*	NT	LC	A	C	A	A	A
77	Helmeted Hornbill(Nok kok)	*Rhinoplax vigil*	NT	N	N	C	C	N	N
78	Blue Winged Leaf Bird	*Chloropsis cyanopogon*	NT	A	A	A	C	A	A

No.	Common Name	Scientific Name	IUCN Status	Sight Frequency					
				Nam Ngiep River			Nam Xan River		
	English (Lao) Name			Ban Pou	Ban Xomxuen	Ban Pakyong	Ban Kanyong	Ban Pakheuang	Ban Don
79	Scaly-breasted Partridge (Nok Kho)	*Arborophila charltonii*	NT	N	LC	A	C	A	A
80	Siamese Fireback (Kay Khoua)	*Lophura diardi*	NT	A	A	C	A	A	A
81	Puff Backed Bulbul	*Pycnonotus eutilotus*	NT	A	C	A	A	A	A
82	Scarlet Rumped Trogon	*Harpactes duvaucelii*	NT	A	C	C	C	A	N

Remark: A: very common C: common, LC: less common, N: never
IUCN Red list Category: CR: Critically Endangered EN: Endangered VU: Vulnerable species NT: Near Threaten LC: Low concern DD: Data Deficient

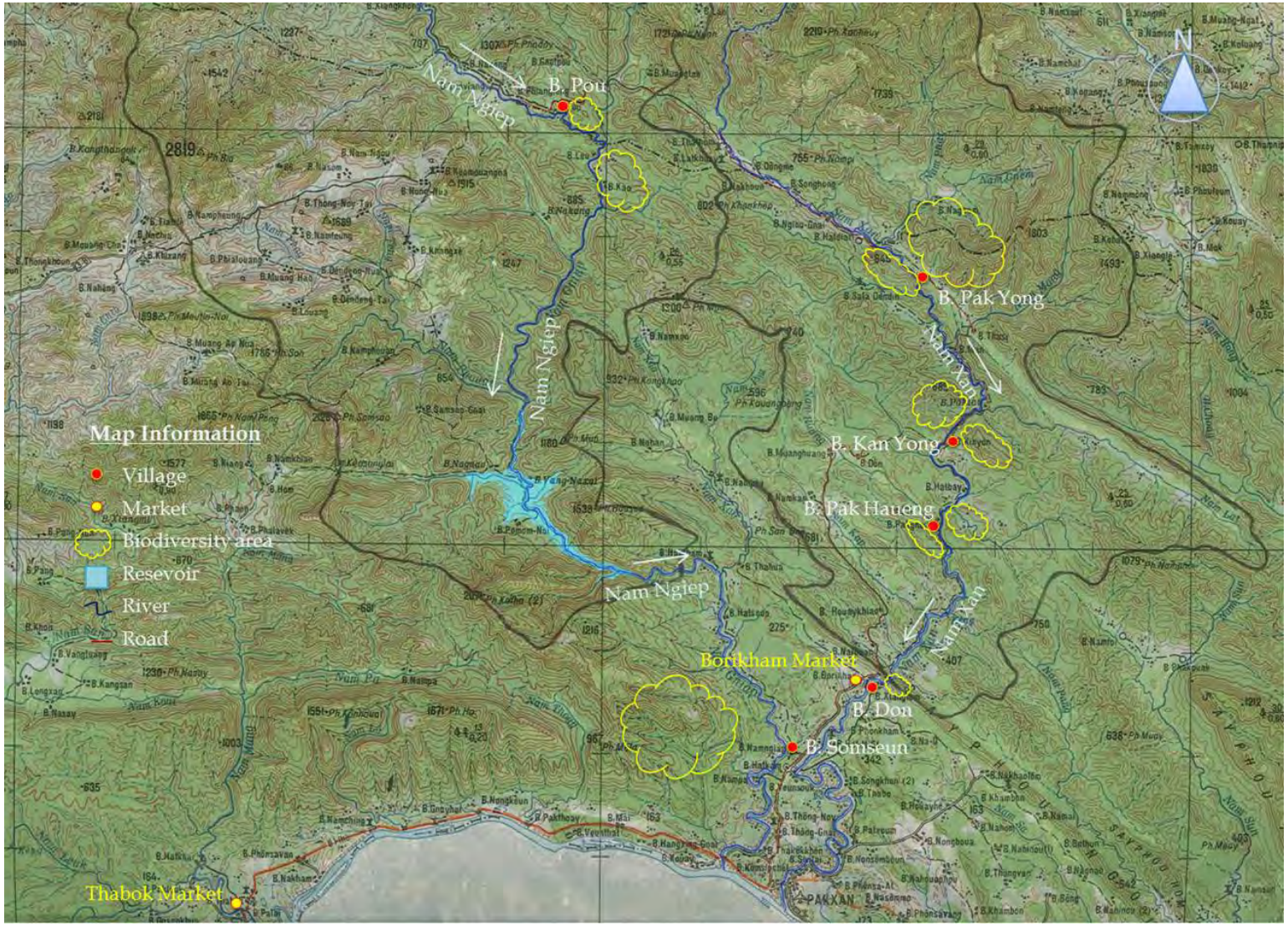
Most of the villagers identified the areas where the above-mentioned species are seen in and around their village and along Nam Ngiep and Nam Xan Rivers (*Table I.4*). In a number of instances, the reported locations align with the community forests, which are located adjacent to the villages.

Table I.4 Biodiversity areas reported by each village

No.	Village name	Community forest	Other reported areas
1.	Ban Pou	Houy Tarin, Poo Kor hai	-
2.	Ban Pakyong	Poo Padeang, Poo Namxan	-
3.	Ban Kanyong	-	Poo Padeang, Poo Nam Xan, Ban Ngua
4.	Ban Pakheaung		Nam Heaung, Pa Meaung cave
5.	Ban Don		Ban Nong, Pak Beuang, Houy sai, Lak Xao, Poo Mor, Poo Tuen, Pa dong, Pa Hea, Pa Sod and along Nam Xan River, Nam Ngiep River
6.	Ban Xomxeun		Keang Kai, Huay Ngua, Napeun, Houy Kee Yeuak, Poo Hong, Pa Dan Takytan, , Nam Pa, Lak xao, Nam Houy, Nam Dong and along Nam Ngiep River

The locations identified in *Table I.4* have been mapped in *Figure I.3*.

Figure I.3 Map with identified biodiversity areas



During the focus group discussions a significance ranking exercise was conducted. Results of this activity led to a prioritized list of significant species which hold relative importance to the villagers.

For the mammal species, the villagers viewed big animals as the most important species due to their tracks (i.e. footprints). The villagers reasoned that the tracks, when hunting, lead them to areas rich in biodiversity. When asked to prioritize species that should be conserved, the villagers ranked large mammals in the following order Asian Elephant, Southern Red Muntjak, Tiger, Gaur, Bears, Pangolin and Red-shanked Douc Langur.

As for reptiles and amphibian species, the villagers did not identify any of the flipbook species as significant (i.e. that need to be conserved). However, they mentioned a soft-shelled turtle (*Trionyx cartilageneus*) as a valuable amphibian species. Since the soft-shelled turtle draws a high price at market, which means that if caught it will be sold for income. Apart from market value, the soft-shelled turtle does not hold other significant values to villagers.

For avian species, the Hornbill, including the Rufous-necked Hornbill and Helmeted Hornbill, were identified as important species that should be conserved. The villagers indicated that these species have gradually disappeared from the areas around the villages, which means that they are now rare. In order to conserve the Hornbills, the villagers suggested maintaining and growing Hornbill habitat (e.g. areas where Hornbills nest).

Generally, villagers agreed that endangered species, and if possible, all species should be conserved for future generations (e.g. to see and consume).

In terms of locations, the species are typically found around the villages as well as in the provincial protective forests. The village areas are owned by the villagers.

The provincial protective forests are owned by the Lao government. The forests are divided into reserved and productive areas. Villagers are allowed to access the productive areas, while access to the reserved lands is strictly prohibited. The productive areas are allocated on an annual basis to villagers to ensure that the land is used on a rotation basis. The boundaries are delineated by poles placed around the productive areas by government and announced by the village headman to ensure compliance.

As for private areas, or areas which are privately owned by individual villagers the lands are normally utilized by planting crops. The villagers then know that these areas have ownership and they are not allowed to hunt in such areas.

Terrestrial

Male: Male hunters generally hunt species primarily for household consumption; any surplus is sold to intermediaries. Approximately, 10% to 50% of species are sold to the market. The money generated by this activity is spent on household expenses such as buying food from markets, clothes and education.

Male hunters normally go hunting individually, unless big animals such as cow or deer are needed for events, such as weddings. Male hunters then go hunting in groups of four to five to hunt big animals. They typically hunt in the designated productive forest areas.

Hunting frequency ranges from two to three times per week to once a month in most villages. However, male hunters from Ban Don mentioned that they have not hunted for the past six years, which is when hunting became illegal. Enforcement has been strictly implemented around Ban Don

A variety of weapons are used. This includes gun, knife, rubber band, traps and nets were also impounded by the district officials.

Typically, male hunters tend to catch what they see, rather than a pre-determined species. Frequently caught species include small species such as squirrels, birds and lesser mouse deer; however, once in a while big animals such as Rusa Unicolor, Southern Red Muntjak and Pangolin are caught. The villagers explained that small species, if caught, will be consumed in the household. Big species, on the other hand, are sold to intermediaries. According to male hunters, the most prized mammals species is the Pangolin, the price for which ranges from 100,000 KIP (13 USD) to 1 million KIP (130 USD) per kilogram. (The price correlates to the availability of the species – e.g. in areas where the species is more readily available the price is lower.) This is because of its rarity and medicinal purpose – it is believed to have sexual stimulation powers and is preferred alive.

In terms of cultural importance, male hunters did not identify any species which possess culture or spiritual value.

Hunters reported that the availability of resources has been declining since around 2000. The villagers believed that the cause of such decline is the increasing number of new settlers who have migrated to the village areas and started accessing the existing natural resources.

Female: Similar to males, female villagers also hunt; however, females hunt smaller species such as squirrels, bamboo rats, reptiles, and birds. These species are hunted primarily for household consumption; any surplus is sold to intermediaries.

Female hunters usually go hunting in groups of four to five. Female hunters are less likely to go to forests alone.

Hunting frequency ranges from daily to once a once a month. The frequency largely depends on the season and the villager's desires for dinner.

In the same manner with the male hunters, female hunters when they go hunting, they do not have specific species in mind. They claimed to catch whatever species they see. In terms of location, female hunters hunt in the government's designated productive forest areas.

Similar to male hunters, female hunters mentioned that the availability of the existing resources has been declining since 2000. This was attributed to the increasing numbers of people coming into the area to hunt.

In context of cultural importance, female villagers did not identify any animal or plant species which hold significant values to them.

Aquatic

Villagers indicated that fishing is mainly the role of females rather than males. Female hunters claimed to go fishing in groups of three to four at a frequency of daily to two to three times per week (depending on, again, on what they want for dinner).

Females indicated that they go fishing more often during the rainy season. This is largely because species that dwell in Mekong River flow downstream to the Nam Ngiep and Nam Xan rivers during the rainy season.

Fishing primarily occurs along the Nam Ngiep and Nam Xam rivers (and their tributaries). Female hunters use nets, baits and traps to fish year round (*Figure I.4*).

Figure I.4 Female fishing method

Female fishing

Catch of the day

Female fishing with net

Female fishing

The majority of fish caught are consumed within household. Only surplus or the prized species are sold to intermediaries. Hence, family income derived from selling fish is relatively low - ranging from 20% to zero.

In terms of species, female hunters typically catch cat fish and scale fish. Scale fish are reported to be the most prized species – it can attract up to 130,000 KIP (17 USD) per kilogram at market.

Regarding availability of fish, female hunters mentioned that such resources have been declining due to the increasing number of people fishing. In addition, villagers noted many of these people are fishing for commercial purposes, not household consumption.

The villagers noted that the fish catch are unlikely to be found only in the Project area. Instead, the fish can be caught elsewhere.

Flora

Information regarding flora species was also investigated during the focus groups. Females are responsible for gathering flora species and usually operate in groups of three to four in the productive forest areas. They typically use knifes and basket when collecting species.

Female gatherers reported that they visit forests more often at the start of the rainy season (i.e. May) given that the bamboo shoots and ground vegetation are abundant and ripe at this type of year.

No specific flora species were identified during the focus group discussions. This included no specific plant species for medicinal or ceremonial purposes. This aligns with the information obtained about cultural practices – i.e. villagers do not hold any particular important ceremonies.

In terms of non-timber forest products (NTFPs), a number of species are collected, including mushrooms and bamboo shoots, which are gathered at different times of the year, depending on the species' growing season.

Flora species were, again, primarily used for household consumption and only surplus is sold to intermediaries. However, from time to time, specific species will be request by intermediaries, such as Nor boon (1,000 KIP (15 cent) per piece) and Nor Xang (50,000 KIP (7 USD) per kilogram). These are the most prized plants due to their taste.

Female gatherers tend to engage in other activities, such as planting rice or textile production, in order to provide family income (instead of gathering flora species for income).

In terms of availability of existing resources, similar to fauna species, it was reported that flora species have been declining due to the increasing number people settling in the area.

I.1.6 Cultural Services

During the village surveys, information was collected on histories and migration stories. Most of the villages have common stories that involve involuntary migration as the result of the Laotian Civil War (1953-1975).

Ban Pou was settled in 1975 after the Civil War for strategic reasons. The villagers mainly migrated from the Xaysomboon province. At present, the villager consists of 70 percent Hmong people, while the remaining 30 percent is lowland Laos.

Ban Pakyong was founded in 1987 with the old name of Ban Nayae. The villagers moved back and forth between Thatom and Bolikham to avoid the Civil War before finally settling in the current location in 1987. The village consists of equal numbers of lowland Laos and Kamoo tribe people.

Villagers in Ban Kanyong, similar to other villages, moved back and forth due to the Civil War. The village was officially founded in 1989. The composition of the villagers is 100 percent lowland Lao.

The villagers in Ban Pakheaung migrated back and forth along the Nam Xan River as required by the Lao government before finally settling the village in 1977. The composition of the villagers is 100 percent lowland Lao.

Ban Don was founded in 1975. Prior to settlement, villagers migrated from Kumkerd, which was located Bolikhamxay province but no longer exists, and the Xiangkwang province. The village proportionally consists of both highland and lowland Laos.

Ban Xomxeun is believed to be over 100 years old with the former name of Ban Meung Mai. The composition of the villagers is 100 percent lowland Lao.

I.1.7 Tangible Cultural Heritage

In terms of tangible cultural heritage, most of the villages identified two specific cultural sites deemed important to their way of life - village temples and cremation sites. The cultural sites are typically located in close proximity to each of the villages, but are communally owned by the village.

For example, Ban Don reported to have village temple named Ban Don Chaiyaram, which is located at the centre of the village. Religious ceremonies are held at the site from time to time. The villagers reported conduct religious activities, such as release fish, turtles at the temple.

Ban Xomxeun identified *Tad Jaokumheaung*, a place where Buddhist relics are located. Villagers go to the location to pay respects to the remains of Ban Xomxeun's founder or Jao Kam Heaung. Another cultural site identified is Buddha's footprint was located between Nam Xan and Nam Ngiep River since 1974.

When asked, the villagers indicated that the sites can be moved elsewhere or destroyed and rebuilt elsewhere. In order for this to occur, compensation in the form of land or money is required. The only exception was the Ban Hat Seung Tom, a historic cultural site where artefacts are buried, in Ban Pakheaung. The site was established prior to the founding of the village itself.

Figure I.5 Cultural sites at Ban Xomxeum

Tad Jaokumheaung at Xomxeun

Buddha's footprint at Xomxeun

Pagoda next to Buddha's footprint

Historical description

Intangible Cultural Heritage

As for intangible cultural heritage, no significant sites were identified. This is partly due to the fact that the village residences were largely lowland Laos who are Buddhist. Accordingly, religious ceremonies are conducted in village temples. Another possible underlying factor is that the villagers have migrated many times prior to settling after the Laotian Civil War. Hence, concerns of originality and native lands are of low importance.

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