CHAPTER - 4

WATER QUALITY ANALYSIS

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4. WATER QUALITY ANALYSIS

4.1 INTRODUCTION.

This report covers the results of water analysis of the first set of the water samples collected in January 1999. There are two more water samplings to be undertaken in 1999, once every three months. In this report, a table summarizing water quality of some rivers in the Lao PDR and the water standard for drinking water and fishery commonly used are also presented. Although it is impossible to compare the result of two samplings with the those of a long duration monitoring of other rivers, it is however expected that such kind of information might be useful to get the first impression of the water quality collected.

4.2 SELECTION OF SAMPLING STATIONS.

As part of the Environmental Assessment Survey, a water quality survey has to be carried out 4 times during the study (on the average, once every 3 months), each time at four sampling stations, thus providing an information representative of an annual hydrologic cycle. Two sampling stations are located upstream of the Nam Ngiep-I dam site and the two remaining stations at the downstream reach.

UPSTREAM STATIONS:

- Nam Ngiep at Tha Vieng, within the Upper Reservoir and at about 57.5 Kms upstream of the dam site. The Nam Ngiep-I catchment area at Tha Vieng is sbout 1,875 Km2.
- Nam Siap at Ban Xiengkhong, the major tributary that is located upstreamof the dam site having a catchment area of 582 km2.

DOWNSTREAM STATIONS:

- Ban Hat Kham gauging station recently equipped with a water level recorder installed by the Mekong River Commission Secretariat. Discharge at Hat Kham has been measured since 1991 but with long period of interruption. The station is about 5 Kms from the damsite. The catchment area at this station is estimated at 3,720km2.
- Muang Mai gauging station, also recently equipped with a water level recorder installed by. the Mekong River Commission Secretariat. Discharge at Muang May has been measured since 1987 .The catchment area at Muang May is estimated at4,803 km2.

The actual location of the downstream stations could be easily identified as they are at existing gauging stations. In order to facilitate in identifying those in the upstream part, visual mark has been made at sampling sites (see photo).

4.3 ANALYSIS.

In accordance with the TOR, analysis of samples should be carried out not later than 1 week after sampling, with appropriate preservation measure for samples. For the purpose of coherence with other existing data on water quality, it is suggested that the Consultant use analytical procedures of the Water Quality Laboratory of Vientiane, already in charge of the Mekong Water Quality Monitoring in the Lao PDR.

In line with the above, the Vientiane laboratory was engaged in training the surveyor on measures to be taken in water sample collection and handling. Analysis was carried out at the above-mentioned laboratory.

Samples were taken at upstream stations were collected on 8 January and 16 March 1999 and handed over to the laboratory two days after the sampling. Samples in the downstream stations were collected 12 January and 19 March 1999. Those at the downstream were collected and handed over to the laboratory on the same day. PH and conductivity were measured on site. The mothod for analysis is shown in the following table1.

TableI: The Analytical Method

Parameter	Method
Ca, Mg and Hardness	Complexometry(EDTA)
Alkalinity	Potentiometric method (end point titration)
SO_4	Mackereth method
Cl	Mercury nitrate method
PO_4-P	Spectrophotometric method
NO_3-N	Reduction with Cd and diazotation
Si	Spectrophotometric, molybdo silicate method
Total-Fe	Spectrophometric, phenantroline method after digestion
COD_{Mn}	Permanganate oxidation
PH	PH meter
Conductivity	Conductivity meter
TSS	Total nonfitrable residue dried at 103-105 °C
Faecal coliform test	Membrane filter technic

(note: The water quality laboratory in Vientiane is not able to provide analysis for Sodium and Potassium)

4.4 RESULTS

The results of chemical analysis are presented in Table II and III. The water quality of other rivers is given in Table IV.

Table II: Results of the Water Quality Analysis of Upstream Stations

Parameter	Unit	Ban Sopsiep				Ban Thavieng				Drinking Water Standard
Date		8/1/99	16/3/99	22/6/99	24/8/99	8/1/99	16/3/99	22/6/99	25/8/99	
Temp.	°C	NA	23.1	27	25	NA	22.9	30	24	
PH		8.10	7.39	7.79	8.18	7.61	7.91	7.58	7.68	5.8-8.5
TDS	Mg/l	NA	39	44	40	NA	63	33	40	
DO	Mg/l	NA	7.8	7.56	6.75	NA	8.0	7.5	6.84	
Conduct	ms/m	13.5	7.2	8.03	8.07	9.8	11.2	6.3	8.02	-
Ca	Mg/l	15.16	7.76	0.592	14.4	11.28	13.96	0.421	11.6	-
Mg	Mg/l	8.78	2.00	0.22	3.89	3.91	4.09	0.206	2.7	-
Na	Mg/l	NA	0.03	0.074	1.4	NA	0.035	0.049	2.6	
K	Mg/l	NA	0.01	0.036	0.312	Na	0.009	0.031	0.273	
Cl	Mg/l	0.42	2.00	0.007	0.014	0.28	0.70	0.018	0.011	<250mg/l
SO_4	Mg/l	1.92	3.74	0.074	0.011	1.06	6.00	0.064	0.019	<400mg/l
NO_3-N	Mg/l	0.001	0.002	0.127	0.068	0.001	0.001	0.126	0.086	<10mg/l
PO_4-P	Mg/l	0.014	0.020	0.088	0.011	0.011	0.008	0.059	0.019	-
Hardness	Mg/l	64.9	27.8	40.60	52.2	44.5	52.0	31.35	40.4	<300mg/l
$CaCO_3$	Mg/l	67.9	34.4	37.6	43.4	48.2	53.6	27.1	16.3	<350mg/l
TSS	Mg/l	1	87	658	38	1	20	486	53	-
Tot-Fe	Mg/l	0.152	0.68*	0.256	0.143	0.146	0.36*	0.359*	0.499*	<0.3mg/l
Si	Mg/l	7.3	9.0	4	4	8.8	8	2	5	-
COD_{Mn}	Mg/l	0.458	3.8	3.2	0.589	0.866	1.2	5.55	0.568	-
Faecal Coliform	100ml	NA	3	2	2		5	0	1	0

(Note: NA= Not available)

* = Except the samples taken on 16/3/99 at Ban Sopsiep , the sample taken on 16/3/99 , 22/6/99 and 25/8/99 at Ban Dong

Table III: Results of the Water Quality Analysis of Downstream Stations

Parameter	Unit	Ban HatKham				Ban Moung Mai				Drinking Water Standard
Date		12/1/99	19/3/99	24/699	10/9/99	12/1/99	19/3/99	24/6/99	10/9/99	
Temp.	°C	NA	27.4	24.6	26.8	NA	27.1	25	26.2	
PH		7.84	8.56	7.75	5.56	7.81	8.26	7.52	5.93	5.8-8.5
TDS	Mg/l	NA	56	36	28	NA	57	36	27	
DO	Mg/l	NA	7.3	7.98	7	NA	8.0	7.62	6.8	
Conduct	ms/m	9.9	9.87	6.64	5.9	9.4	10.2	6.64	5.8	-
Ca	Mg/l	11.60	12.18	0.446	7.2	13.94	12.54	0.455	7.1	-

Mg	Mg/l	5.56	3.12	0.193	1.56	4.88	2.98	0.202	1.5	-
Na	Mg/l	NA	0.042	0.052	1.288	NA	0.043	0.077	1.265	
K	Mg/l	NA	0.012	0.045	0.468	NA	0.012	0.033	0.468	
Cl	Mg/l	0.35	1.54	0.016	1.820	1.19	0.84	0.018	1.75	<250mg/l
SO_4	Mg/l	2.88	2.40	0.078	3.504	2.40	2.98	0.066	3.36	<400mg/l
NO_3-N	Mg/l	0.023	0.018	0.147	0.14	0.314	0.110	0.134	0.138	<10mg/l
PO_4-P	Mg/l	0.01	0.003	0.018	0.015	0.009	0.003	0.019	0.015	-
Hardness	Mg/l	42.9	43.5	31.95	24.5	47.1	43.9	32.85	24	<300mg/l
$CaCO_3$	Mg/l	43.1	42.6	28.9	19.4	44	44.0	28.2	19.45	<350mg/l
TSS	Mg/l	2	12	140	196	1	14	88	180	-
Tot-Fe	Mg/l	0.171	0.45*	0.307 *	0.338 *	0.244	0.39*	0.606 *	0.346 *	<0.3mg/l
Si	Mg/l	8.9	8.0	6	6	8.6	8.0	6	6	-
COD_{Mn}	Mg/l	0.517	1.2	0.95	1	0.521	0.9	0.78	1.2	-
Faecal Coliform	100ml	46	25	5	6	10	40	12	2	0

(Note: NA=Not available)

* = Except the samples taken on 19/3/99, 24/6/99,10/9/99at Ban Hatkham , the sample taken on 19/3/99 , 24/6/99 and 10/9/99 at Ban Muangmai

The discharges of Nam Ngiap are available only at Ban Mai. The discharges at Thavieng Sop Siep and Ban Hatkham are estimated by assuming the discharges at different stations are in proportion with the catchments.

The results of discharge computation are given below:

Date of Water Sampling	DISCHARGE (M3/sec)			
	Ban Sop Siep	Ban Thavieng	Ban Hat Kham	Ban Mai
08/1/1999	4.4	14.2	29.2	36.4
12/1/1999	4.3	14.1	27.8	36.1
16/3//1999	2.4	7.9	15.6	20.2
19/3/1999	2.3	7.4	14.6	18.9

The results of the water analysis show that:

- The pH seems to be stable both at the upstream and downstream stations. The water is slightly basic but remains within the standard for drinking water. The values of pH of upstream stations vary from 7.39 to 8.10 and from 7.81 to 8.56 at the downstream stations. Except the Sop Siep station, the value of pH at other stations increases from January to March.
- The concentration of total salts using conductivity as indicator of all sites is low which is similar to other rivers in the country. The values of conductivity found in the Nam Ngiep, are about haft of the median value of the Mekong and much less than several tributaries flowing across the limestone area.
- The ionic composition of the river in Lao PDR is highly dominated by calcium bicarbonate. The ionic content in the river is usually high during the dry season and low during the wet season, because of dilution with rainwater. The ion content in Nam Ngiap measured in January and March 1999 is also low.
- Nutrients and organic matter, the nutrients mainly nitrogen and phosphorus compound, as well as organic substances are lost from land and reach the water. The concentration of NO_3-N and PO_4-P are representatives of nutrients, are relatively low at the all stations. The yield of organic matter indicated by COD is relatively low. The Silica is an indicator of the level of chemical

weathering of the soils. The concentration ranges between 7.3 to 8.9 mg/L. The iron is an essential element to man and has a relatively low toxicity, the concentration found in Nam Ngiep and its tributary is between 0.146 to 0.244 mg/. These values are within the standard of 0.3 mg/L

- Faecal coliform is the indicator bacterial pollution in water. The bacteria is found in all human beings and indicates feacal pollution. Microbial contamination reduces the water quality with respect to usage as water source for human consumption. We found 46 colonies per 100 milliliter of water sample at Ban Hatkham station and Moung Mai station 10 colonies per 100 milliliter in January and respectively 25 and 40 colonies per 100 milliliter in March 1999. These numbers are in the range of the guidelines proposed (less than 300 colonies per 100 milliliter of water sample). The two upstream station no sample for test.

Table III: Water Quality of some rivers in the Lao PDR

Median vahus					
N. Ngum Thangone (1)	Sebangfai (2)	Mekong, Luangprabang (3)	Mekong Vientiane (4)	Mekong Pakse (5)	Nam Xan Thamdin (6)
1985-97	1985-97	1985-97	1985-97	1985-97	30/1/99
7.40	7.80	7.80	7.90	7.80	7.30
11.8	27.60	22.60	22.40	19.30	6.0
15.58	37.96	28.76	28.84	22.56	6.34
2.90	6.35	5.52	5.08	4.02	0.48
2.24	1.16	2.36	5.71	7.42	1.08
7.63	9.26	19.78	19.39	15.02	2.54
0.074	0.124	0.168	0.176	0.119	0.005
0.007	0.011	0.032	0.035	0.030	0.008
51.05	121.30	94.90	93.25	73.15	26.85
48.15	118.20	84.20	85.30	66.45	29.50
16	31	180	252	127	6.00
0.12	0.09	0.12	0.143	0.16	0.306
5.80	4.00	6.30	6.20	5.90	.3.90
0.90	0.90	1.10	1.20	1.10	-
80	-	-	410	-	-

(1): Lat. 1808,1 N; Long. 10237,3 E; Catchment area 16,500 km^2
(2) Lat. 1704,3 N; Long. 10459,1 E; Catchment area 8,560 km^2
(3) Lat. 1953,5 N; Long. 10108,2 E: Catchment area 268,000 km^2
(4) Lat. 1755,7 N; Long. 10234,2 E; Catchmen area 299,000 km^2
(5) Lat. 1507,0 N; Long. 10548,0 E; Catchmen area 545,000 km^2
(6) Lat. 1832,1 N; Long. 10256,3 E; Catchmen area....
Water supply autority (Lao PDR)

4.5 CONCLUSIONS.

According to the data, water of the Nam Ngiep and its tributary has relatively

low concentration of a major constituents, nutrients and organic matters. The pH values are normal.

The analyses carried out so far showed that the quality of water along Nam Ngiep is quite good and not significantly affected by human activities yet.

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CHAPTER - 5

WILDLIFE, HABITATS, VEGETATION BIOMASS AND FORESTRY

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LIST OF FIGURES

LIST OF ABBREVIATIONS

cu.m	Cubic metres
dbh	Diameter breast height
FSL	Full Supply Level
HPO	Hydropower Office
HZ	Innundation Impact Zone
IR	Infra-red
km	Kilometres
LS	Land System
m	Metres
MOL	Minimum Operating Level
NBCA	National Biodiversity Conservation Area
NGD	National Geographic Department
NGO	Non-Governmental Organisation
NOFIP	National Office of Forest Inventory and Planning
RMR	Resource Management and Research
sq. km	Square Kilometeres
sq. m	Square metres
STS	STS Consultants

5.1 Introduction

Resource Management & Research (RMR) were engaged by STS Consultants to carry out a wildlife/habitat/vegetation biomass/forestry and land use survey of the proposed Nam Ngiep Hydropower Project. The Terms of Reference described 15 important tasks, namely:

- Basic descriptions of habitat types and distributions within the proposed inundation area
- Assessments of the conditions of these habitat types
- Possible mitigation measures for any serious loss of significant habitats
- Preliminary assessment of commercial timber volumes and vegetation biomass within the Inundation Impact Zone (IIZ).
- Recommendations regarding logging and biomass clearance and approximate costs of such measures.
- A list of all tree species encountered during the survey which occur in the identified habitat types
- Identification of habitats or areas of particular importance for wildlife
- A list of terrestrial vertebrate species which occur in the identified habitat types
- A determination of the status of species of conservation concern
- Any possible migration routes will be identified
- Assessments of project impacts (logging, clearing & inundation) on the terrestrial vertebrate species
- Proposals for mitigating measures for the loss or damage to wildlife populations and approximate costs
- The entire Project Area will be classified into different land use types and the areas of each will be tabulated according to various elevations proposed at full supply levels for the reservoir alternative and for each of the distinct impact zones
- A preliminary land use map will be prepared
- Recommendations for further studies and/or surveys

This final report describes the results of the habitat, floral and faunal, biomass, forestry and land use surveys.

The period 1 January to 21 January was spent analysing river, longitudinal and latitudinal relief profiles using 1:50,000 and 1:100,000 scale maps, Preliminary stratification of the Nam Ngiep catchment was also performed using 1:50,000 and 1:100,000 scale maps.

The field work was carried between 22 January to 20 February and 1 April to 12 April by RMR teams comprising:

Dr. R. M. Watson	Zoologist/Ecologist and Project Manager
Dr. S. P. Watson	Biologist and Site Manager
Mr. A. Watson	Biologist and Deputy Site Manager
Mr. A. Dennis	Field Assistant
Mr. J. Searle	Field Assistant and Tree Expert
Mr. Thongdy Paklay	Local Naturalist & Tree Naming Expert
Mr. Somneuk Vithagna	Interpreter
Mr. Changmai	Interpreter

5.2 Field Work Activities

The first period of field work started on the 22 January and finished on 20 February. The areas traversed are shown in Figure 1.

Day 1
22 January: Met with military escort and Mr Kampseum (HPO representative) in Long Xane. Drove to Ban Palavek and met with District officials. Drove to Ban Sopyouk and arranged accommodation.

Day 2
23 January: Drove to Ban Sopphoun making observations on wildlife, habitats and land use. Daylight boat traverse to Ban Huoaypamon through Land System [LS] 14. Interviewed villagers of Ban Huoaypamon on wildlife, hunting and land-use.

Day 3
24 January: Interviewed villagers of Ban Huoaypamon on wildlife, hunting and land-use. Examined animal specimens gathered by villagers. Separated into two teams. Team one performed a daylight traverse on foot through LS's 14 and 10. Team two surveyed flora in LS 14. Prepared a live bait trap.

Day 4
25 January: Checked live bait trap. Examined animal specimens gathered by villagers. Team one performed a daylight traverse on foot through LS's 14 and 20. Team two surveyed flora in LS 14 and 20.

Day 5
26 January: Examined animal specimens gathered by villagers. Team One performed a daylight boat traverse in LS14. Team Two surveyed biomass and timber volume in LS14.

Day 6
27 January: Examined animal specimens gathered by villagers. Daylight boat traverse to Ban Sopphoun in LS14. Team one performed a daylight traverse on foot to Ban Sopyouk through LS14 and LS5. Team two interviewed villagers of Ban Sopphoun on wildlife, hunting and land-use.

Day 7

28 January: Ban Sopyouk; Team one examined animal specimens gathered by villagers. Interviewed villagers on wildlife, hunting and land-use. Daylight boat traverse downstream of Ban Sopyouk in LS5. Ban Sopphoun; Team two examined animal specimens gathered by villagers. Team two surveyed flora in LS14. Team was collected in the evening and driven to Sopyouk.

Day 8
29 January: Examined animal specimens gathered by villagers of Ban Sopyouk. Daylight traverse on foot through LS5 and LS3 to a point 8km south of Ban Sopyouk. Established field camp 1. One member of the RMR team stayed in Sopyouk to purchase bait. Prepared a dead bait (shot deer carcass) IR (Infra Red) trap near an animal watering hole.

Day 9
30 January: Examined animal specimens gathered by local guides. Checked dead bait IR trap and moved IR trap next to a watering hole. Team two surveyed flora in LS2 and LS3. Team one performed a daylight traverse on foot through LS2 and LS3. Team one performed a night traverse on foot through LS2 and LS3. Night surveillance of an animal watering hole in LS2.

Day 10
31 January: Examined animal specimens gathered by local guides. Checked IR trap and prepared another dead bait IR trap. Team two surveyed flora in LS2 and LS3. Team one performed a daylight traverse on foot through LS2 and LS3. Team one performed a night traverse on foot through LS2 and LS3. Night surveillance of an animal watering hole in LS2.

Day 11
01 January: Examined animal specimens gathered by local guides. Checked dead bait IR trap. Decamped and walked to Ban Sopphoun, making observations on wildlife, habitats and land-use.

Day 12
02 January: Awaited delivery of fuel for boats in Ban Sopphoun. Night traverse by boat to Ban Houaypamon in LS14.

Day 13
03 January: Daylight traverse by boat to the Nam Mang confluence through LS14 and LS21 Daylight traverse on foot from the Nam Mang confluence to Ban Nakang through LS21.

Day 14
04 January: Interviewed villagers on wildlife, hunting and land-use. Team one performed a daylight traverse on foot through LS21. Team one prepared two live bait IR traps. Team two surveyed flora in LS21 and LS34.

Day 15
05 January: Checked two live bait IR traps. Team one performed a daylight traverse on foot through LS21. Team two surveyed biomass and timber volume in LS21.

Day 16
06 January: Checked two live bait IR traps. Daylight traverse on foot through LS21. Daylight traverse by boat north and south of the Nam Mang confluence (LS21 and LS14). Returned to Ban Sopphoun.

Day 17
07 January: Team one performed a daylight traverse on foot through LS14 and LS16. Team two surveyed biomass and timber volume in LS14.

Day 18
08 January: Daylight traverse on foot to Ban Namyouk through LS14 and LS5. Interviewed villagers on wildlife, hunting and land-use. Daylight traverse on foot up the Nam Toum Valley (LS5). Established field camp 2. Prepared one dead bait IR trap and one watering hole IR trap in LS3. Night traverse on foot through LS3. Examined animal specimens gathered by local guides.

Day 19
09 January: Examined animal specimens gathered by local guides. Team one performed a daylight traverse on foot through LS3 and LS5. Team two surveyed flora in LS3.

Day 20
10 January: Checked two IR traps. Daylight traverse on foot to Ban Sopyouk. Examined animal specimens gathered by villagers.

Day 21
11 January: Daylight traverse by boat, bamboo raft and on foot down the Nam Ngiep valley in LS5. Established field camp 3. Interviewed local guides on wildlife, hunting and land-use. Examined animal specimens gathered by local guides.

Day 22
12 January: Examined animal specimens gathered by local guides. Daylight traverse on foot further down the Nam Ngiep valley in LS5. Established field camp 4.

Day 23
13 January: Daylight traverse on foot further down the Nam Ngiep valley to Ban HuayXayKam through LS5 and LS1. Interviewed villagers of to Ban HuayXayKam on wildlife, hunting and land-use.

Day 24
14 January: Daylight traverse on foot up the Houay Soup Noy in LS2. Established field camp 5 at the top of the valley. Prepared one IR trap on an animal trail.

Day 25
15 January: Examined animal specimens gathered by local guides. Team one performed a daylight traverse through LS2. Team one set up two dead bait IR traps. Team two surveyed flora in LS2.

Day 26
16 January: Examined animal specimens gathered by local guides. Checked two IR traps. Team one performed a daylight traverse through LS2. Team two surveyed flora in LS2.

Day 27
17 January: Examined animal specimens gathered by local guides. Checked two IR traps. Daylight traverse on foot to Ban HuayXayKam through LS2 Daylight traverse by boat to Ban HatYeun in LS1.

Day 28
18 January: Traveled by motorcar to Ban Muang Bo. Team two interviewed villagers on wildlife, hunting and land-use. Team one performed a daylight traverse on foot through LS10 and LS7.

Day 29
19 January: Team one performed a daylight traverse on foot through LS10 and LS7. Two IR traps were set up next to a watering hole. Team one also surveyed flora in LS10. Team Two surveyed land use in LS7 and interviewed villagers and contractors working on the Ban Muang Bo resettlement/irrigation development scheme.

Day 30
20 January: Examined and collected specimens gathered by villagers. Daylight traverse by tractor and on foot to Ban Tahua through LS7, LS6 and LS1. Daylight traverse by boat to Ban Muang Mai in LS1. Returned to Vientiane by bus from Pakxan.

The period 21 January to 3 March was spent in analysis and identification of data and specimens collected. In addition an interim report was written.

The second period of field work started on the 1 April and finished on 12 April. The areas traversed are shown in Figure 2.

Day 31
1 April: Drove to Pakxan. Met with HPO and STS representatives. Drove to Ban Muang Mai - and met village chief. Arranged for guides and a militia escort.

Day 32
2 April: Upstream daylight boat traverse to Houay Ngua in LS1. Established field camp 6. Team 1 performed a daylight foot traverse up the Houay Ngua tributary and along elephant trails. Team 2 surveyed flora in LS1. Set up IR camera traps along animal paths.

Day 33
3 April: Checked IR camera traps. Examined animal specimens gathered by local guides. Team 1 performed a day foot traverse down to the Nam Ngiep via Houay Dtawn Don and Bong at Houay Pern along elephant trails. Team 1 then performed a daylight boat traverse up the Nam Ngiep to camp 6. Team 2 surveyed flora in LS1. Set up IR camera traps along animal paths.

Day 34
4 April: Checked IR camera traps. Examined animal specimens gathered by local guides. Day boat traverse down to the Nam Ngiep and up the Houay Khingneuk tributary. Day foot traverse up the Houay Khingneuk to camp 7. Team 2 surveyed flora in

LS2. Established field camp 7. Team 1 performed an evening foot traverse up the Houay Khingneuk. Set up IR camera traps along animal paths.

Day 35
5 April: Checked IR camera traps. Examined animal specimens gathered by local guides. Team 1 performed a daylight foot traverse in LS2. Team 2 surveyed flora in LS2. Established field camp 8 near to an elephant watering hole. Set up IR camera traps along animal paths.

Day 36
6 April: Checked IR camera traps. Examined animal specimens gathered by local guides. Team one observed the elephant watering hole (0500-1000) in LS2. Interviewed villagers from Bam Muang Mai. Team one explored a system of caves close to field camp 8. Team 2 surveyed flora in LS2. Set up IR camera traps along animal paths.

Day 37
7 April: Daylight foot traverse down to the Nam Ngiap. Daylight boat traverse upstream to Ban Hatyeun. Met with village chief and arranged new guides and militia escort.

Day 38
8 April: Daylight foot traverse to field camp 9. Established field camp 9. Team 1 performed a daylight and evening foot traverse in LS1. Team 2 surveyed flora in LS1 and LS6. Set up IR camera traps along animal paths.

Day 39
9 April: Checked IR camera traps. Examined animal specimens gathered by local guides. Team 1 performed a daylight foot traverse in LS1. Team 2 surveyed flora in LS1. Set up IR camera traps along animal paths.

Day 40
10 April: Checked IR camera traps. Examined animal specimens gathered by local guides. Daylight foot traverse to Ban Hatyeun. Interviewed Ban Hatyeun villagers.

Day 41
11 April: Daylight foot traverse to Ban Thahua. Interviewed Ban Thahua villagers. Team 1 performed a daylight foot traverse to through LS1, LS6 and LS7. Team 2 surveyed flora in LS1 and LS6. Daylight boat traverse downstream to Ban Muang Mai.

Dat 42
12 April: Returned to Vientiane

5.3 METHODOLOGIES

5.3.1 WILDLIFE/HABITAT SURVEY

Field methods used were more of less standard observational techniques employed in vertebrate and habitat surveys. These are:

Slow and quiet daylight movement on foot along tracks, across open glades and down rivers, making visual identifications using binoculars and aural identification at frequent stopping points.

Slow and quiet night movement on foot along tracks, across open glades and down rivers, making visual identifications using binoculars combined with head-mounted spotlights, and aural identification at frequent stopping points.

Baiting and the laying of scent trails. Baits used were dead pigs and other mammal carcasses, live and dead chickens. These were placed in a range of locations. Baits were visited once per day. IR Camera traps were set up next to dead bait. IR Camera traps were also set up on animal tracks and beside watering holes.

Collection and identification of bones and teeth.

Identification of all animal faeces encountered

Searches of sand, mud and other suitable surfaces for animals spore

Examination of tracks for signs of animal use

Examination of trees, particularly those in fruit, for signs of climbing animals

Interviews with hunters, villagers and farmers, and examination of animal remains in villages.

Commissioning local hunters to collect small vertebrates

Opportunistic collections of small animals by all staff.
The short time available and the need to cover a large area made it inappropriate to mount a systematic trapping programme.

Systematic observation of geology, geomorphology, soil, drainage, erosion processes, vegetation (species, size, demography, "patterns", use & condition) land-use and potential on all traverses made.

Frequent photography of habitats to provide illustrative material.

5.3.2 VEGETATION BIOMASS AND COMMERCIAL TIMBER VOLUMES

It was not possible stratify vegetation in the inundation zone prior to performing the survey because clearance could not be obtained for an overflight.

Two different methods were used to estimate commercial timber volumes and vegetation biomass. Three sampling sites have been surveyed to date (Figure 1).

5.3.2.1 Commercial Timber Volumes

For each sampling site, selected a bearing (0-359°) was determined using random numbers. The survey team then marked out 100m on the appropriate bearing. All trees within 20m either side of the transect line were surveyed. Each sampling site surveyed an area of approximately 400m^2.

For each tree the scientific and local name was recorded. A hand held clinometer was positioned at least 25m from the tree and, if possible, at a point slightly above the horizontal plane of the base. A narrow path was then cut through the low vegetation to afford a clear view of the trees trunk from the clinometer position. Readings of inclination were taken from:

- the base of the trunk
- 1.0m diameter breast height points
- the top cutting position as indicated by the expert tree feller

A standard diameter tape was used to measure diameters at heights of 1.0m. In addition any comments about the expected timber quality were recorded.

5.3.2.2 Vegetation Biomass

A stake was placed at each randomly selected sampling site. This has become the Southwest corner of quadrate 1 for each sample. From this stake using compass and tape, a 5×5m square was laid out with North/South and East/West sides.

For each 5x5m square all the vegetation biomass was classified, measured and recorded in distinct categories; litter, low vegetation, dead branches, dead logs, live bamboo, dead bamboo, small trees (dbh >3cm and <20cm), large trees (dbh >20cm), lianas and vines.

5.3.3 LAND USE SURVEY

It had been intended to use low level aerial methods to make a proper land use survey of the Nam Gniep catchment. It proved impossible to get the necessary overflight clearances. The use of helicopters was not considered as they would have cost in excess of $25,000 to make the overflight pattern needed for the survey (as against $3,750 using RMR's survey aircraft). Cheaper military helicopters were not considered as they were not acceptable to the consultants insurers.

As a way of replacing the up-to-date synoptic view which the overflights would have provided, the consultants hoped to use recently made maps. This strategy was confounded

by two problems. The 1:250,000 scale maps made by the Lao-Swedish Forestry Project using satellite imagery (Handsat) have produced inconsistent and erroneous distinction of woodland and forest categories, mainly because bamboo "crowns" have been frequently classified as tree crowns (RMR 1994[*]). The ground-truthing carried out by RMR in 1994 and 1995, which led to the conclusion that the Forestry Departments 1:50,000 scale land use and vegetation maps were inadequate for planning purposes has recently been confirmed by the GTZ Forestry Mapping Team.

Christoph Feldkötter (pers comm.) has confirmed that these 1993-1994 Forestry Department land use and vegetation maps are not accurate or consistent. Ironically the GTZ land use maps, also produced from handsat imagery, but in this case systematically ground truthed using two "layers" of further information from 1:25,000 scale monochrome stereo aerial photography, and from on the ground visits, are completed, but are not available. They apparently differ too much from the previous maps, (specifically by solving part of the problem of differentiating between bamboo and tree crowns).

As the way has been barred from to acquiring up-to-date and synoptic information the consultants have:

1. Assembled the 1:50,000 scale topographic maps produced by the US army mapping service, based on 1965 and 1966 aerial photography. (Unfortunately the Lao national archive for these maps at the NGD no longer has original map sheets for the whole of the catchment. Some missing maps are available as monochrome copies. These are impossible to use for the vegetation and land use analysis which has to be made. Colour originals could be obtained from the US, UK or France, but this process takes some time.)
2. Super-imposed of the boundaries of the of the L.S's on these maps and used a modified line-intersect sampling method to determine the following characteristics for each of the 40 L.S. Units (LSU's):
   - Area under dense forest. This is actually classified as being land over which there is more than 75% of dense vegetation foliage cover. The photo interpreters clearly recognised that they could not determine the nature of the vegetation.
   - Area under open forest. This is classified as being land over which there is 25% to 75% in even and discontinuous cover of vegetation foliage.

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[*] In 1994 in a report titled "Report on an investigation of Timber Resources of SF6, SF8, Muangkhi and Adjoining Areas", the consultants wrote:
"1- It appears that the forest cover classifications of the forestry departments map are between 1 and 2 classes higher in their cover estimates than those estimated from the aircraft. The lower storey young regenerating trees and bushes, bamboo and plantain cover has probably not been differentiated from the crown cover in the spot image interpretation"
"2 - The distribution pattern of trees is too hetrogenous on too small a scale for a mapping at 1:100,000 scale to be useful. Even at 1:50,00 scale the interpretation made from a spot image largely ignores the issue of the actual distribution of the trees. The interpretation has been made essentially at two scales or levels: a high level precise interpretation of land use, in which for example father small rice fields have been identified and mapped (areas as small as 5ha have been marked on the 1:50,000 maps), and a low level less precise interpretation of the vegetation in which areas of 5000ha and much greater have been assigned to a single vegetation classifications. The 1:50,000 Forestry Department maps are useful only at the most preliminary stages of planning forestry development, although they may be more useful for studies of land use"

- Area under plantation. It is unclear on the 1961 map key if this term includes timber plantations and fruit tree orchards.
- Area under paddy (poldered) rice cultivation.
- Area under "brushwood". This has been tabulated as scrubland. It probably refers to all the stages of woody regeneration on land previously cleared for hill rice.
- Area as marsh or swamp.
- Area where bamboo is the dominant vegetation cover.
- Area as river water.
- Area built up in villages and towns
- Area as roads and tracks
- Area as permanent or seasonal water body
- Area subject to seasonal flooding

3. Systematically searched each LSU area on the maps to count and record:
   - Number of villages
   - Number of houses in named villages
   - Number of houses (isolated or in clusters) not in named villages
4. Tabulated the above information in Table X.
5. Assembled the 1:100,000 scale topographic maps prepared by the NGD with Soviet assistance based on 1981 aerial photography.
6. Superimposed the LSU boundaries, and used the method described in paragraph 2 above to determine the following characteristics for each LSU.
   - Area under dense forest (No criteria have been specified by the cartographer)
   - Area under open forest (No criteria have been specified by the cartographer)
   - Area under cleared forest
   - Area under fruit and vegetable gardens
   - Area under paddy (poldered) rice
   - Area under other rice (This may not be a consistent identification of hill rice - some hill rice seems to have been interpreted as grassland)
   - Area as grassland
   - Area as marsh / seasonal or permanent swamp
   - Area where bamboo is the dominant vegetation cover
   - Area as river water
   - Area built up with villages and towns
   - Area as roads and tracks
   - Area as permanent or seasonal water body
7. Systematically searched each LSU area on the maps to count and record:
   - Number of villages
   - Number of houses in named villages
   - Number of houses not in named villages
   - Number of abandoned villages
8. Tabulated the above information in Table X.
9. Analysed the two sets of data which represent the land use situation 18 and 34 years ago and compared it with the limited information collected in 1999 to develop a preliminary picture of contemporary land use in the catchment

5.4 Results

5.4.1 Study of Habitats

5.4.1.1Catchment analysis

The catchment was analyzed using 1:50,000 and 1:100,000 scale maps and divided into 40 land systems which are shown in Figure 2. A further catchment analysis has been made to describe the sub-catchments of the Nam Ngiep river. The results are presented in Table 1. A reconnaissance level description of each land system unit has been made from all sources available to the consultants and is set out in Table 2. Riverine habitats encountered during the survey are listed in Table 3.

TABLE 2: LAND SYSTEMS OF THE NAM NGIEP CATCHMENT

Land System Number	Land System Name	Area In sq. Km.	Mean Altit-ude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
1	Nam Ngiep Valley Terrace	236	170	Quaternary deposits of sand. silt & clay.	Flat to gently undulating valley terrace with silty soils 2-3m deep.	Extensively used for paddy & hill rice, and livestock. Heavy use for forest products.	Grasslands, secondary woodlands & low bushlands, with seasonally flooded swamplands near Mekong River	Many areas can be irrigated using regulated river. Intensive arable use to be expected.
2	Phu Katha Eroded Plateau	320	850	Jurassic & Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone.	Very deeply incised valleys cutting plateau remnants. Soils shallow silts, with some rock pavements.	Flatter plateau tops have been cultivated in the past; now apparently abandoned.	Low secondary woodland including Pines, Dipterocarps & evergreens. Grassy glades & clearings.	Highest potential comes from recreational use as a site for scenic & wildlife lodges.
3	Nam Gnok Noi Valley	68	520	Jurassic & Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone	Moderately sloping slightly incised valleys with soils 1-2m deep.	Previously extensively cultivated and evidence of increased cropping now.	Low bamboo & secondary woodland; some recently cleared land supporting pasture.	Perennial tree crops and pasture in agro-forestry production system.
4	Phu Nam Gnok Noi Plateau Remnant	20	1000	Jurassic & Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone.	Very deeply incised valleys cutting plateau remnants now reduced to hilltops. Soils very shallow silts, with many exposed cliffs.	Previously cultivated on limited areas with less steep slopes; now apparently abandoned.	Low secondary woodland including Pines, Dipterocarps & evergreens. Grassy glades & clearings.	Highest potential comes from recreational use as a site for scenic & wildlife lodges.
Land System Number	Land System Name	Area In sq. Km.	Mean Altit-ude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
5	Lower Reservoir	48	310	Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone	Flat to gently undulating valley terrace with silty-clay soils 2-3m deep.	Previously extensively cultivated and evidence of increased cropping now.	Low secondary woodland and bamboo thickets. Pasture lands and clearings. Most of the area is current or fallow cropland.	A rich arable area, with considerable potential for irrigation development.
6	Say Phou Spur	44	400	Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone	Very steeply sloping elongated whale-backs with medium to shallow soils.	Previously cultivated on limited areas with less steep slopes; now apparently abandoned.	Low secondary woodland and bamboo thickets.	Limited potential for forestry & grazing.
7	Nam Xao Valley Terrace	72	200	Jurassic & Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone.	Flat to gently undulating valley terrace with silty-clay soils 2-3m deep.	Previously extensively cultivated and evidence of increased cropping now, with small scale irrigation.	Low secondary woodland and bamboo thickets. Pasture lands and clearings.	A rich arable area, with considerable potential for irrigation development if water can be brought. In.
8	Nam Pou Valley Terrace	40	250	Late Triassic granite intrusives; Permian limestones with intermediate effusives; Upper Ordovician – Silurian limestone, conglomerate & schist	Gently to moderately sloping terrace with silty soils of 1-2m depth.	Previously extensively cultivated, and evidence of an increase in cropping now.	Low secondary woodland and bamboo thickets. Pas-ture lands and clearings.	Perennial tree crops and pasture in agro-forestry production system, with some irrigable areas, for which additional water will be required.
Land System Number	Land System Name	Area In sq. Km.	Mean Altit-ude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
9	Phu Huasua Mountain	92	820	Jurassic & Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone.	Very steeply and steeply sloping plateau relict with silty generally shallow soils.	Previously cultivated on east facing less steep slopes; now apparently abandoned.	Low secondary woodland and bamboo thickets. Some small stands of older trees.	Limited potential for forestry & grazing.

10	Phu Mun/Kong-kao Mtns.	142	560	Triassic sandstone, siltstone, shale, marl & coal seams.	Deeply dissected plateau remants with shallow soils. Cliffs and sandstone outcroppings occur.	Previously cultivated on east facing less steep slopes; now apparently abandoned.	Low secondary woodland and bamboo thickets. Some more extensive stands of older trees.	Moderate potential for forestry & grazing in the west. Perennial tree crops and pasture in agroforestry production systems on the low eastern hills.
11	Nam Ma Valley Terrace	20	410	Late Triassic Intrusives with Triassic sandstone, siltstone, shale, marl & coal seams.	Flat to gently undulating valley terrace with silty-clay soils 2-3m deep.	Previously very extensively cultivated. Some apparent increase in cropping now.	Low secondary woodland, bamboo thickets and some stands of older trees. A few pasture lands and clearings.	A rich arable area, with considerable potential for irrigation development if water can be brought. In.
12	Upper Phu Moun Mountain	26	1030	Late Triassic Intrusives.	Moderately sloping mountain top with weakly incised drainages. Soils 1-3m deep with high clay content.	Previously very extensively cultivated. Said still to support some cropping.	Low secondary woodlands and bushed grasslands with bamboo thickets.	Moderate potential for livestock & forestry use. Specialised tree crops could be established. Water is main constraint.
Land System Number	Land System Name	Area In sq. Km.	Mean Altit-ude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
13	Lower Phu Moun Mountain	148	490	Permian limestones with intermediate effusives.	Moderately sloping low hills & lower mountain slopes.	Previously supported a few areas of hill rice; now apparently not used.	Low secondary woodland and bamboo thickets. Some more extensive stands of older trees.	A few areas could be developed for perennial tree crops and pasture in agroforestry production systems. Reasonable forestry & livestock potential

14	Middle Reservoir	32	330	Late Triassic Intrusives.	Flat to gently undulating valley terrace with some low hills. Silty-clay soils 2-3m deep.	Previously moderately cropped. Now extensively cultivated on all terrace land.	A very few old trees. Mostly pasture and cropland (current and fallow)	A rich arable area, with considerable potential for irrigation development.
15	Upper Phu Samsao Mtn.	96	1140	Antecarboniferous granites.	Moderately sloping mountain top with weakly incised drainages. Soils 1-3m deep with high clay content.	Previously very extensively cultivated. Lower slopes still support hill rice, maize and cassava cropping & livestock.	Medium secondary woodlands, bushed grasslands and open grassland/shrubland. Isolated trees & some bamboo thickets.	Moderate potential for livestock & forestry use. Specialised tree crops could be established. Water is main constraint.

Land System Number	Land System Name	Area In sq. Km.	Mean Altit-ude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
16	Lower Phu Samsao Mtn.	124	850	Antecarboniferous granites.	Moderately and steeply sloping mountain lower slopes with moderately incised drainages. Soils 1-2m deep with high clay content.	Previously supported a few areas of hill rice; present use not known except near Nam Gniep River, where there is increased cropping.	Medium secondary woodland and extensive bamboo thickets. Some more extensive stands of older trees.	Areas adjacent to the Nam Gniep & Nam Phoun could be developed for perennial tree crops and pasture in agroforestry production systems. Reasonable forestry & livestock potential.

17	North Nam Phouan Valley Side	32	980	Antecarboniferous granites.	Moderately sloping mountain side with weakly incised drainages. Soils 1-3m deep with high clay content.	Previously very extensively cultivated. Present use not known.	Medium secondary wood-lands, bushed grasslands and open grassland/ shrubland. Isolated trees & some bamboo thickets.	Moderate potential for livestock & forestry use. Specialised tree crops could be established. Water is main constraint.
18	Phadoy Upland Plains	72	980	Devonian-Carboniferous shale, sandstone, lime-stone, rhyolite, tuffs & Silurian-Lower Devonian shale, sandstone limestone, andesite & tuffs.	Flat to moderately sloping infilled terraces with fairly deep soils.	Recently and still heavily used for paddy rice, hill rice, wet season maize & pasture. Many villages and gardens. Apparent expansion of use in progress.	Current and fallow cropland and grasslands.	An area with considerable potential for irrigation development if water use can be managed.
Land System Number	Land System Name	Area In sq. Km.	Mean Altit-ude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
19	Phadoy Uplands	236	1355	Devonian-Carboniferous shale, sandstone, lime-stone, rhyolite, tuffs ; Silurian-Lower Devonian shale, sandstone lime-stone, andesite & tuffs; Triassic siltstone, marl, shale, rhyolite, tuffs.	Complex mountain area with moderate to steep slopes & incised drainages. Some karst areas with limestone cliffs & outcroppings. Soils vary from deep to shallow, generally silty.	Recently & still heavily cropped & used for livestock.	Low shrubland with scattered low trees; bamboo thickets on lower slopes. Current and fallow cropland	Areas adjacent to the Phadoy Upland Plains could be developed for perennial tree crops and pasture in agroforestry production systems. Reasonable forestry & livestock potential.

20	Samlian Eastern Slopes	76	860	Antecarboniferous granites; Triassic siltstone, marl, shale, rhyolite, tuffs.	Moderate to steep slopes and weakly incised drainages. Soils about 2m. with some clay.	Recently extensively used. Use now confined to lower slopes close to Nam Gniep valley.	Medium secondary woodland and extensive bamboo thickets. Some more extensive stands of older trees.	Areas adjacent to the Nam Gniep could be developed for perennial tree crops and pasture in agroforestry production systems. Reasonable forestry & livestock potential.

Land System Number	Land System Name	Area In sq. Km.	Mean Altit-ude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
21	Upper Reservoir	80	950	Permian limestones with intermediate effusives & Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone.	Flat to gently undulating valley terrace with some low hills. Silty-clay soils 2-3m deep.	Recently and still heavily used for paddy rice, hill rice, wet season maize & pasture. Many villages and gardens. Apparent rapid expansion of use in progress, with irrigation projects.	Current and fallow cropland and grasslands. Some low secondary woodland, bamboo thickets and seasonal swamps on lower Nam Mang and a few section of Nam Gniep.	A rich arable area, with considerable potential for irrigation development and crop intensification.

22	Nong Houd Hills	28	600	Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone.	Low hills with moderate to steep slopes and moderately incised drainages. Soils 2m deep & silty.	Recently extensively used for hill rice production. Current use not known.	Medium secondary woodland and extensive bamboo thickets. Some small stands of older trees.	Areas adjacent to the Nam Gniep valley could be developed for perennial tree crops and pasture in agroforestry production systems. Reasonable forestry & livestock potential.
23	Lower Nam Chian Valley	60	610	Upper Ordovician – Silurian limestone, conglomerate & schist; Antecarboniferous granites.	Narrow valley terrace weakly incised between moderately steep low hills. Soil depths probably medium.	Recently extensively used for hill rice production. Current use not known.	Medium secondary woodland and bamboo thickets. Some stands of older trees. Current & fallow cropland.	Areas adjacent to the Nam Chian valley could be developed for perennial tree crops and pasture in agroforestry production systems. Reasonable forestry & livestock potential.
Land System Number	**Land System Name**	**Area In sq. Km.**	**Mean Altitude in m.**	**Geology**	**Geomorphology & Soils**	**Recent Land-Use**	**Vegetation**	**Land Potential**
24	Phu Nang Phoun Mountain	52	1160	Antecarboniferous granites.	Mountain with steep slopes and moderately to weakly incised drainages. Shallow soils.	Recently partly cropped but now abandoned.	Medium secondary woodland and bamboo thickets. Some stands of older trees.	Limited potential for forestry & livestock.

25	Phu Xao Mtn. Clearings	52	1310	Antecarboniferous granites; Upper Ordovician –Silurian limestone, conglomerate & schists; Permian limestones with intermediate effusives.	Moderate sloping mountain top with weakly incised drainages.	Recently and still extensively cropped. Many livestock	Open shrub grassland and low bushland, with bamboo thickets and stands of older trees. Current and fallow cropland.	Limited potential for forestry & livestock.
26	Phu Kabo Phu Xao Mtn.	316	1390	Antecarboniferous granites; (Some Upper Ordovician –Silurian limestone, conglomerate & schists; Permian limestones with intermediate effusives).	Mountain sides with moderate to steep slopes, Severely eroded with moderately to weakly incised drainages. Shallow soils.	Recently and still partly cropped, and used for livestock production.	Medium height dense secondary woodland and bamboo thickets. Some extensive stands of older trees.	Limited potential for livestock; probably suitable for commercial forestry uses.

Land System Number	**Land System Name**	**Area In sq. Km.**	**Mean Altitude in m.**	**Geology**	**Geomorphology & Soils**	**Recent Land-Use**	**Vegetation**	**Land Potential**
27	Upper Nam Ngiep Valley	9	755	Antecarboniferous granites.	Narrow flat valley terrace with variable depth of soils.	Recently growing paddy rice at northern and southern ends. Some expansion of cropping taking place.	Medium secondary woodland and bamboo thickets. Open grasslands and current and fallow croplands.	An area with some potential for irrigation development and crop intensification.

28	Phu Houat Uplands	347	1380	Antecarboniferous granites; (Some Permian limestoaes with intermediate effusives).	Mountain tops with moderate and a few steep slopes, Severely eroded with weakly and some moderately incised drainages. Medium depth silty-clay soils.	Recently and currently intensively farmed for hill rice, maize and cassava. Considerable livestock populations. Narrow valley terraces are poldered for paddy rice production.	Open shrub grassland and low bushland, with bamboo thickets and stands of older trees. Current & fallow cropland.	Moderate to high potential for livestock & forestry use. Specialised tree crops could be established, and incorporated into agro-forestry production systems. Water is main constraint.

Land System Number	Land System Name	Area In sq. Km.	Mean Altit-ude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
29	Upper Nam Chian Valley	108	1250	Antecarboniferous granites; Permian limestones with intermediate effusives.	A moderate to gently sloping watershed terrace with weakly or non-incised drainages. Soils medium to deep.	Recently and currently intensively farmed for hill rice, maize and cassava. Considerable livestock populations. Most valley terraces are poldered for paddy rice production. Substantial increases in cropping taking place	Open shrub grassland and low bushland. A few bamboo stands, with bamboo thickets and large stands of older trees. Current & fallow cropland.	High potential for livestock & forestry use. Specialised tree crops could be established, and incorporated into agro-forestry production systems. Water is main constraint.
30	Phu Tin Eastern Slopes	120	875	Late Triassic granite intrusives; Triassic sandstone, siltstone, shale, marl & coal seams.	Very steep mountain slopes with moderately incised drainages. Soils shallow to medium.	A few less steep slopes have been cropped in the past; now apparently abandoned.	Medium height dense secondary woodland, with extensive areas of older trees. Bamboo thickets and some glades on old fields.	Low potential for forestry use.

Land System Number	Land System Name	Area In sq. Km.	Mean Altitude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
31	Phu Bia Mountain	100	2430	Permian limestones with intermediate effusives; Devonian siltstone, shale, & limestone.	Very steep mountain slopes with weakly to moderately incised drainages. Soils shallow to medium.	One or two small areas on hilltops have been cropped in the past; now apparently abandoned.	Medium and tall dense secondary woodland and forest, with extensive areas of older trees, including Conifers. Bamboo thickets and some glades on old fields.	Medium potential for forestry use.
32	Nam Siam Upper Valley	184	975	Devonian siltstone, shale, & limestone; (Some Permian limestones with intermediate effusives & late Triassic granite intrusives.)	Steep and moderate mountain slopes with moderately incised drainages. Soils shallow to medium.	Recently very intensively used for cropping: now apparently little used.	Open shrub grassland, low bushland & low secondary woodland. A few bamboo thickets. Current & fallow cropland.	Medium potential for livestock and forestry in the west of the unit. Specialised tree crops could be established, and incorporated into agro-forestry production systems.
33	Phu Xao Noi Hill	44	580	Permian limestones with intermediate effusives.	Moderately sloping low hills & lower mountain slopes.	Previously supported a few areas of hill rice; now apparently not used.	Dense low secondary woodland and forest with extensive bamboo thickets. Some stands of older trees.	Reasonable forestry & livestock potential.

Land System Number	Land System Name	Area In sq. Km.	Mean Altitude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
34	Nam Pang Valley	52	480	Late Triassic granite intrusives; Triassic sandstone, siltstone, shale, marl & coal seams; Jurassic-Cretaceous red conglomerate, sandstone, siltstone & claystone.	Flat to gently undulating valley terrace with some low hills. Silty-clay soils 2-3m deep.	Recently partly used for growing hill rice, maize & cassava, and for livestock. Now more extensively used for cropping and livestock.	Open shrub grassland, low bushland & low secondary woodland. A few bamboo thickets. Current & fallow cropland.	High potential for livestock & forestry use. Specialised tree crops could be established, and incorporated into agro-forestry production systems.
35	Nam Siam Nam Pot Lower Valleys	240	1075	Devonian siltstone, shale, & limestone; Permian limestones with intermediate effusives; late Triassic granite intrusives; Ante-carboniferous granites; Carboniferous-Permian limestone.	Mountain sides with moderate to steep slopes. Severely eroded with moderately to weakly incised drainages. Shallow soils.	Recently and still partly cropped, and used for livestock production.	Medium height dense secondary woodland and bamboo thickets. Some extensive stands of older trees.	Limited potential for livestock; probably suitable for commercial forestry uses.

Land System Number	Land System Name	Area In sq. Km.	Mean Altitude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
36	Nam Pot Valley Floor	28	1120	Carboniferous-Permian limestone, Carboniferous shale, chert, siltstone, limestone, coal seams.	Narrow flat valley terrace with variable depth of soils.	Recently and currently intensively cultivated for paddy rice on poldered fields. Some expansion of cropping taking place. Heavily used by livestock	Open grasslands and current and fallow croplands.	An area with some potential for irrigation development and crop intensification.
37	Phonsavan Plain	88	1120	Permian limestones with intermediate effusives; Silurian-Lower Devonian shale, sandstone, limestone, andesite & tuffs; Carboniferous-Permian limestone; (Some Quaternary deposits of sand, silt & clay.	Flat to gently undulating plain, with weakly to very weakly incised drainages.	Recently and currently very heavily used for cultivating rice, maize, vegetable, etc., with large numbers of livestock. Valley floors are frequently poldered. Many villages and gardens. Small scale irrigation schemes widespread.	Open grasslands and current and fallow croplands. Stands of young Pines widespread.	A rich arable area, with considerable potential for irrigation development, and crop/livestock intensification.

Land System Number	Land System Name	Area In sq. Km.	Mean Altitude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
38	Plai Khe Uplands	544	1250	Devonian siltstone, shale, & limestone; Permian limestones with intermed-iate effusives; late Triassic granite intrusives; Ante-carboniferous granites; Carboniferous shale, chert, siltstone, limestone, coal seams; Devonian-Carboniferous shale, sandstone, limestone, rhyolite, tuffs; Silurian-Lower Devonian shale, sandstone, limestone, andesite & tuffs;	Mountain with moderate and a few steep slopes, Severely eroded with weakly and some moderately incised drainages. Medium depth silty-clay soils. Some areas of karst formations, featuring cliffs and rock outcroppings.	Recently and currently intensively farmed for hill rice, maize and cassava. Considerable livestock populations. Narrow valley terraces are poldered for paddy rice production, with irrigation based on diverted stream flows.	Open shrub grassland and low bushland, with bamboo thickets and stands of older trees, including Pines. Current & fallow cropland.	Moderate to high potential for livestock & forestry use. Specialised tree crops could be established, and incorporated into agro-forestry production systems, particularly where the unit borders the Phonsavan Plain. Water is main constraint.

Land System Number	Land System Name	Area In sq. Km.	Mean Altitude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
39	Nam Ngiou Valley Floor	42	1130	Permian limestones with intermediate effusives; Carboniferous-Permian limestone.	A wide flat valley terrace terrace with weakly or non-incised drainages and a few low hills. Soils medium to deep.	Recently and currently intensively farmed for hill rice, maize and cassava. Many villages and gardens. Considerable livestock populations. Most valley terraces are poldered for paddy rice production. Substantial increases in cropping taking place	Open grassland and low bushland. A few bamboo stands. Current & fallow cropland, and groves of fruit trees. Some stands of Pine on side valleys.	High potential for livestock & forestry use. Specialised tree crops could be established, and incorporated into agro-forestry production systems. Water is main constraint.

Land System Number	Land System Name	Area In sq. Km.	Mean Altitude in m.	Geology	Geomorphology & Soils	Recent Land-Use	Vegetation	Land Potential
40	Phu Gnouan Southern Slopes	124	1430	Silurian-Lower Devonian shale, sandstone, limestone, andesite & tuffs; Carboniferous shale, chert, siltstone, limestone, coal seams; Devonian red sandstone, shale, conglomerate; Devonian sandstone, shale & limestone; (Some Permian limestones with intermediate effusives).	Very eroded, moderately to steeply sloping hills, with deeply incised drainages. Soils medium to shallow.	Recently extensively cropped. Now little cropping taking place, but heavily used by livestock	Dense secondary woodlands and forests with Pines and Ketelaria spp.. A few stands of older trees. Some grassy glades.	High potential for livestock & forestry use. Specialised tree crops could be established, and incorporated into agro-forestry production systems. Water is main constraint.
All		4510						

TABLE 3: RIVERINE HABITATS

Habitat Area	Speed of Flow	Riverbed description	Vegetation	Landscape	Fish Species Observed in Habitat Type
LARGE SCALE HABITAT					
1.	Moderate with a few turns. Moderate gradient	Sandbanks and stretches of shallows running over stony beds often emerging as river islands, which are flooded for between a few days to 6 months by fast flowing water to depths which vary from a few cm to several metres,	Islands support a highly specialised hydrophyte flora of low bushes and shrubs including several Capparidaceae spp. Each species is dominant to the point of being the only plant represented in the different linearly arranged zones of submergence depths, paralleling the situation seen in mangrove swamps. Where the current is lower there are considerable filamentous algal growths anchored to stones	River flows over a flood plain.	*Luciocyprinus striolalius* *Bagarius cf. Yasrelli* (Caught by hand in pebbly shallows)
2.	Fast, river runs straight. High gradient	Rocky islands, some very large boulders, and many deep pools.	Less vegetation is generally observed on the rocky islands and sand bars. Again these support a highly specialised hydrophyte flora of low bushes and shrubs including several *Capparidaceae spp.*	Steeply incised gorge/ valley	*Scaphiodonichthys acanthopterus* *Poropuntius deauratus* *Labeo behri* *Pa Lai* *Garra pingi* *Pa Langoh*
SMALL SCALE HABITAT					
3.	Fast flowing tributary. Very high gradient. (e.g. Houay Soup)	Areas of limestone rock pavement with microsteps and water "sculpting". Water chutes and rock pools.	These fast flowing but permanent streams which are submerged for only short periods support a typical rheophytic flora of Bryophytes, ferns, Aroids, *Pininga spp.* palms and Rubiaceae shrubs	Steeply climbing valley.	*Clarias butrachas* *Cirrhinus molitorella* *Scaphiodonichthys acanthopterus* *Channa cf. Marulia*
4.	Slow. Low gradient. River widens from	The river is very deep. (over 30m)	Fringed by secondary woodland.	The river exits a gorge and onto the	Local guides indicated that crocodile were known to inhabit

	15m across to over 50m for approximately 400m.			Nam Ngiep Valley Terrace.	this pool up until 20 years ago. Dynamite fishing is said to have killed off the population
5.	Slow flowing tributary. Low gradient	Backwaters, where river gradients are slight and the reduced flows have created local very small sediment basins.	Relatively unspecialised vegetation such as water lilies, Aroids, and *Nymphoides sp.*	Stream flows over flood plain	Large school of Poropuntius deauratus moving from the main river into a tributary.

Note: The mapping of these habitats would require 1:10,000 scale aerial photography to be available.

5.4.1.2 Vegetation

The area surveyed was rather limited when taking into account the size of the catchment. Forty land system types were identified from analysis of 1:50,000 scale maps of which only 12 (LS 1, 2, 3, 5, 6, 7, 9, 10, 14, 16, 20, 21 and 34) have been traversed. Due to problems of insecurity, it was not possible for the survey team to traverse any more LS's. This survey will therefore present only a very fragmented view of the Nam Ngiep catchment.

The lower reservoir has small areas of secondary woodland (LS5) all seriously degraded, with extensive areas of land cleared, cultivated and logged. The middle and upper reservoir (LS14 and LS21) though less degraded (least degraded between Ban Houaypamon and the Nam Mang confluence) is still mainly covered with secondary woodland (with large areas of woodland) interspersed with areas of hill rice cultivation. In the upper reservoir the Nam Mang (tributary upon which Ban Nakang is located) most of the valley floor has been cleared for paddy rice cultivation in the last few years. Small scale logging operations are currently working in the lower, middle, and upper reservoir.

In the small areas of LS2, LS3, LS9, LS10, LS16, and LS20 surveyed the steepest slopes and ridge tops tended to have the oldest and most diverse stands of trees. Particular patches of LS2 and LS3 had the most mature stands of trees observed. The riverbanks of the Nam Ngiep in LS1 are heavily cultivated (mainly sugar cane and rainfed rice) and further from the river large areas have been subject to swidden agriculture, logging and the impacts of small to moderate numbers of elephant. Interestingly most of the bamboo flowered and seeded more or less simultaneously in LS1 and LS2 four years ago. The large quantities of dead bamboo which built up then burned in a series of severe forest fires that burnt through the areas in the following two years. Hence the degraded secondary woodland in LS1 and LS2 is characterised by a grassy rather than bamboo understorey.

The northern end of the Nam Xao Valley (LS7) has recently been almost totally cleared for a large irrigation/resettlement development project. The southern end has a mosaic of young secondary woodland interspersed with late stage regeneration on crop fields. Two old

village sites were present in the southern end of the valley. In addition logging over the past 6 years has extracted all of the valuable trees in the valley and on adjacent slopes. The hills overlooking the Nam Xao Valley have all been used by shifting cultivators in the past 10-20 years, and are covered by large areas of bamboo.

The identifications of the trees observed by Mr. Thongdee, an extremely experienced and skilled tree-namer, indicate that the areas of catchment surveyed have low species diversity in comparison to other woodlands surveyed in Lao PDR (surveys in Xaignabouli (SFE6), Vientiane (SFE9) and Attapu (Xe Kaman basin). The level of diversity is comparable to the degraded woodlands of the Nam Leuk catchment. However the forests of the Nam Ngiep catchment surveyed are however generally older than those found in the Nam Leuk Catchment.

The severity and age of degradation of the land systems is presented in Table 4 and a list of trees identified in the respective habitat types is shown in Table 5.

TABLE 4: LEVEL OF DEGRADATION OF SELECTED LAND SYSTEMS

LAND SYSTEM	TYPE OF DEGRADATION	SEVERITY OF DEGRADATION	AGE OF DEGRADATION
LS1	Shifting and paddy cultivation	Very Severe	50 - 100 years to present
	Elephant induced	Severe	50 years to present
	Fire Catastrophe	Severe	3 years ago
	Logging	Very Severe	?
LS2	Shifting cultivation	Moderate	20 years to present
	Elephant induced	Severe	50 years to present
	Fire Catastrophe	Severe	2 years ago
	Logging	Moderate	20 years to present
LS3	Shifting cultivation	Severe	40 years to present
	Logging	Severe	20 years to present
LS5	Shifting and paddy cultivation	Very Severe	20 years to present
	Logging	Very Severe	20 years to present
LS7	Shifting and paddy cultivation	Very Severe	20 years to present
	Logging	Very Severe	6 years to present
LS9	Shifting cultivation	Severe	20 years to present
	Logging?	Severe	?
LS10	Shifting cultivation	Severe	20 years to present
	Logging	Moderate	6 years to present
LS14	Shifting cultivation	Very Severe	10 years to present
	Logging	Severe	10 years to present
LS16	Shifting cultivation	Severe	20 years to present
	Logging	Severe	4 years to present
LS20	Shifting cultivation	Severe	40 years to present
	Logging	Moderate	?
LS21	Shifting and paddy cultivation	Very Severe	20 years to present
	Logging	Severe	?

All land systems experience (and have experienced in the past) hunter-gatherer degradation pressures, which can be significant. All ecotypes have probably suffered moderate to severe degradation pressures from large populations of wild elephant until about 60 years ago.

TABLE 5: TREES IN THE NAM NGIEP CATCHMENT

	Lao Name	Observed in Land System	Abundance
Anacardiaceae			
Allospondias lakonensis	Ho	1,2,3,10	COMMON
Bouea burmanica	Phang	1	RARE
Choerospondias axillaris	Meu	14,	RARE
Mangifera spp.	Muang pa	2,3,5,9	RARE

	Lao Name	Observed in Land System	Abundance
Melanorrhoea spp.	Na:m kiang daeng	2,3	
Spondius cytherea	Kok	3,10,21,34	RARE
Annonaceae			
Cananga latifolia	Ka: saeng	2	RARE
Polyalthia memoralis	Haek	1,2,3,5,9,14	COMMON
Polyalthia simiarum	Nyang de:n	2,3,5,9,10	COMMON
Apocynaceae			
Alstonia scholaris	Tin pe:t	1,2,3,14	RARE
Wrightia tomentosa var. cochinchinensis	Mu:k muk	1,2,3	RARE
Betulaceae			
Carpinus poilanei	Kiu	1	COMMON
Bignoniaceae			
Millingtonia hortensis	Kang khong	2	RARE
Stereospermum chelnoides	Khae say	2,3	RARE
Stereospermum fimbriatum	Khae foy	2	RARE
Burseraceae			
Canarium kerii	Leuam	2,21,34	
Canarium spp.	Nyang kai:	2,3	COMMON
Protium Serratum	Faen	1	RARE
Combretaceae			
Terminalia belerica	Haen	2,3	RARE
Terminalia catappa	Hu kwang	10	RARE
Terminalia chebula	So:m mo	2,3	RARE
Terminalia chebula var. citrana	So:m mo	1,2,3,5,9	RARE
Terminalia gracilior	Si kha:m	2	
Terminalia myriocarpa	Khaew neua	14	RARE
Coniferae Araucariaceae			
Cunninghamia sinensis	Long leng	2,3	VERY RARE
Datiscaceae			
Tetrameles nudiflora	Sa: phu:ng	1,2,3,10,14	ABUNDANT
Dilleniaceae			
Dillenia kerrii	San khaeng	2,3,21,34	RARE
Dillenia spp.	San phao	14	RARE
Dipterocarpaceae			
Anisoptera cochinchinensis	Bak	3,2	COMMON
Anisoptera costata	Bak	1,2	COMMON
Anisoptera costata (?)	Bak leuang	1,2	COMMON
Anisoptera robusta	Bak	2,10	COMMON
Dipterocarpus alatus	Nyang	2,10	COMMON
Dipterocarpus costatus	Nyang daeng	2	COMMON
Dipterocarpus intricatus	Nyang sa baeng	2,3	RARE
Dipterocarpus sp.	Nyang si	2	COMMON
Dipterocarpus tuberculatus	Kung	2,3,14	RARE
Dipterocarpus turbinatus	Nyang daeng	2	COMMON

	Lao Name	Observed in Land System	Abundance
Hopea ferrea	Khaen hin	2,3,5,9,10	COMMON
Shorea cochinchinensis	Khaen kha: nyom	1	COMMON
Shorea dealbata	Khaen heua	1,2	COMMON
Shorea floribunda	Khaen kha: nyom	2	COMMON
Shorea harmandii	Khaen kha: nyom	2	RARE
Shorea hypochra	Khaen khai:	1,2	COMMON
Vatica cinerea	Si	1,2,3,5,9,10	COMMON
Vatica dyeri	Si kan daeng	1,2	RARE
Ebenaceae			
Diospryos mollis	Keua	2	RARE
Diospyros decandra	Cha:n	2	RARE
Diospyros ehretioides	Heaun kwang	2	RARE
Diospyros embryopteris	Na:ng haeo	2,3	RARE
Diospyros mum	Na:ng da:m	2,3	RARE
Diospyros rubra	La:ng da:m	2,3,5,9,10	RARE
Elaeocarpaceae			
Elaeocarpus floribundis	Mu:n	1	RARE
Elaeocarpus integripetalus	Kok don	14	RARE
Elaeocarpus robusta	Bi mi	3,10,14	COMMON
Elaeocarpus siamensis	Mu:n	1,3	RARE
Elaeocarpus spp.	Pi tong	1,2,3	RARE
Elaeocarpus spp.	Som pher:ng	1	RARE
Euphorbiaceae			
Aporosa sphaerosperma	Meuat nyai:	2	RARE
Aporosa spp.	Meuat do:ng	1,2,3	RARE
Aporosa villosa	Meuat	1	RARE
Baccaurea oxycarpa	Fai:	1,2,3	COMMON
Bischoffia javanica	Kho:m fat	2,3,5,9	RARE
Chaetocarpus castanocarpus	Bo:k khay	1,2,14	RARE
Croton joufra	Pao:	2,3	RARE
Hura crepitans	Pho tha: le	1,2,3,5,9,14	ABUNDANT
Mallotus cocinchinensis	Lat kua	2,21,34	COMMON
Mallotus phiippinensis	Khi mon	2	RARE
Microdesmis casaeriaefolia	Du:k khai	1,2,14	COMMON
Microdesmis spp. (?)	Du:k khao	2,3,5,9	ABUNDANT
Phyllanthus emblica	Kham pom	1,2,3	RARE
Trewia midiflora	Pop	1,10,14	COMMON
Fagaceae			
Castanopsis fleuryi	Ko mong	21,34	RARE
Castanopsis hystrix	Ko deng	2,3	COMMON
Castanopsis laotica	Ko daek	5,9	COMMON
Lithocarpus annamensis	Ko fa	1	RARE
Lithocarpus trimcatus	Ko deauy	2	COMMON
Flacourtiaceae			
Hydnocarpus anthelmintica	Ka bao:	2,3,10,14	COMMON

	Lao Name	Observed in Land System	Abundance
Gramineae			
Bambusa nana	Dan khwa:n	1	RARE
Dendrocalamus brandisii	Ho:k	21,34	ABUNDANT
Schizostachyum zollingeri	Hia	2,3,14,21,34	ABUNDANT
Thyrsostachys spp.	Hae	14,21,34	ABUNDANT
UNIDENTIFIED	Haen	2	RARE
UNIDENTIFIED	Kong pi	2,3	RARE
UNIDENTIFIED	Luang khao: khway	2	RARE
Guttiferae			
Calophyllum spp.	Nyang so:ng	1,2,3,5,9,10,14	COMMON
Garcinia ferrea	Kua:k	2	RARE
Garcinia multiflora	Phong	2,3,14	RARE
Hypericaceae			
Cratoxlylon polyanthum	Tiu leuang	1,2	COMMON
Cratoxlylon prunifolium	Tiu daeng	1,2,3	COMMON
Lauraceae			
Chisocheton spp.	Kuang	1,14	RARE
Cinnamomum iners	Si khai: to:n	1,3	COMMON
Cinnamomum litsaefolium	Chuang	2	COMMON
Lauraceae spp.	Kuang daeng	14	RARE
Litsea glutinosa	Mi tho	2,3	COMMON
Litsea polyantha	Mi do:ng	2,3	RARE
Litsea sebifera	Mi tho	1	COMMON
Litsea spp.	Mi me:n	1,2,14	RARE
Machilus odoratissima	Ka: bo	1	RARE
Nothaphoebe umbelliflora	Ya bong	2	RARE
Lecythidaceae			
Careya sphaerica	Ka: don	1	RARE
Leguminosae			
Adenanthera microsperma	La:m ta khway	1,2,3	COMMON
Adenanthera pavonina	La:m	5,9	RARE
Adenanthera spp.	La:m ta kai:	2,3,5,9	RARE
Albizzia lebbekoides	Khang hu:ng	1,14	RARE
Albizzia lucida	Sa: khae:	3,10,14	
Dalbergia cambodiana	Du laeng	1,2	RARE
Dalbergia cochinchinensis	Kha: nyu:ng	1,2,10	RARE
Dalbergia cultrata	Ka: bo	2	COMMON
Dalbergia kerrii	Ket	2,3,5,9	RARE
Dalbergia lanceolaria	Ka: bo	1,2	COMMON
Dalbergia nigrescens	Pa: do:ng khao	2,3	RARE
Desmodium gyrans (?)	Du:k khiat	2	RARE
Erythrina ovalifolia	Thong lang	2,3,21,34	COMMON
Leucaena spp.	Ka:nthin	2,5,9,14	COMMON

	Lao Name	Observed in Land System	Abundance
Ormosia cambodiana	Kha khi mu	2,3,5,9,14	ABUNDANT
Parkia streptocarpa	Hua lo:n	21,34	COMMON
Peltophorum dasyrachis	Sa pha:ng	1	RARE
Pithecellobium clypearia	Sa: thon	1,2	RARE
Pterocarpus macrocarpus	Du	1,5,9	RARE
Sindora cochinchinensis	Tae ho	1,2,3	COMMON
Lythraceae			
Lagerstroemia angustifolia	Peuay dok khao	2,3,14	COMMON
Lagerstroemia anisoptera	Khaew neua	2	RARE
Lagerstroemia balancae	Peuay lan	1,5,9,10,14,21,34	COMMON
Lagerstroemia calyculata	Peuay dok khao	14	COMMON
Lagerstroemia floribunda	Peuay na:m	14	RARE
Lagerstroemia spp.	Peuay en	1,2,3,14	RARE
Magnoliaceae			
Michelia alba	Cham pi	1,2,3,14,21,34	RARE
Mavaceae			
Bombax albidum	Ngiu pa	2,3	RARE
Hibiscus macrofilus (?)	Po khao	1,2	RARE
Meliaceae			
Aglaia euphoriodes	Daeng do:ng	1,2	COMMON
Aglaia merostela	Kong	5,9,14	RARE
Aphanamyxis cochinchinensis	Kong ta seua	1,2,14,21,34	COMMON
Aphanamyxis polystachya	Ta seua	5,9	RARE
Chukrassia tabularis	Nyo:m khao	1,2	RARE
Melia azedarach	Ka: dao sang	2,3	RARE
Sandoricum indicum	Tong	1	
Toona febrifuga	Nyo:m hom	2,3,10	RARE
Toona sinensis	Nyom fot	1,2,3,10,14	RARE
Moraceae			
Antiaris toxicaria	Nong	1,2,3,10,14	RARE
Artocarpus asperula	Hat	1,2,3,14,21,34	COMMON
Artocarpus lakoocha	Hat mi	3	RARE
Artocarpus spp.	Hat lai:	2,3	COMMON
Broussonetia papyrifera	Po sa	21,34	RARE
Euphoria sp.	Nya:m nyai: don	1,2	RARE
Ficus callosa	Mi pa	1	RARE
Ficus gibbosa	Hai:	2,5,9	ABUNDANT
Ficus hispada	Deua pong	10	RARE
Ficus racemosa	Deua kiang		RARE
Ficus spp.	Hai: kham	2,3,10,14	ABUNDANT
Streblus asper	So:m pho	14,21,34	RARE
Myrtacae			

	Lao Name	Observed in Land System	Abundance
Eugenia jambos	Chiang	2	RARE
Tristania merguensis	Du khang	1	RARE
Eucalyptus spp.	Si khai: to:n	2	COMMON
Eugenia compongensis	Va khi no:k	1,2	RARE
Eugenia jambolana	Va so:m phu	2,3	COMMON
Eugenia logiflora	Va choy	1,2	RARE
Eugenia spp.	Va kaew	2,3	RARE
Eugenia/syzygium spp.	Va	2	ABUNDANT
Psidium guyava	Si da	1	RARE
Syzygium cumini	Va so:m phu	2	COMMON
Palmae			
Arenga sacchariferа	Tao tat	2,3	RARE
Caryota mitis	Tao hang	21,34	RARE
Wallichia gracillis	Tao	2,3	RARE
Platanaceae			
Platanus kerrii	Peuay na:m	14	RARE
Proteaceae			
Helicia balanse	Meuat fay	1	RARE
Rhizophoraceae			
Carallia brachiata	Bo:ng na:ng	2,3,5,9,14,21, 34	RARE
Carallia lucida	Bo:ng na:ng	2	RARE
Rubiaceae			
Anthocephalus chinensis	Sa: ko	1,14,21,34	COMMON
Gardenia erythroclada	Muy daeng	1,2	RARE
Gardenia philastrei	Khai: nao:	2	COMMON
Hymenodictyon excelsum	So:m ko:p	1	RARE
Malus doumeri	Leaung	1,2	RARE
Nauclea orientalis	Kan leuang	2	COMMON
Sarcocephalus cordatus	Kan leuang	1,2,5,9	ABUNDANT
Rutaceae			
Zanthoxylum spp.	Khaen kheua	2	RARE
Sapindaceae			
Dimocarpus longan	La:m nyai:	1	RARE
Pometia eximia	Kuang	1,2,3,10,14	RARE
Pometia pinnata	Ko	2,3,10	COMMON
Sapindus rarak	Sa:k pa	1	RARE
Xerospermum laoticum	Kho laen	2,3	RARE
Sapotaceae			
Achras sapota	Mak la:mut	14	RARE
Palaquium spp.	Yang ńiao	2	RARE
Simarubaceae			
Ailanthus malabarica	Nyo:m pa	1,2,3,5,9	RARE
Ivingia harmandia	Bo:k	1,2,10	RARE
Ivingia malayana	Bo:k	2	RARE

	Lao Name	Observed in Land System	Abundance
Sonneratiaceae			
Duabanga grandiflora	Te:n	1,2,3,10,14,21,34	COMMON
Duabanga sonneratioides	Ling ngo	3,14	RARE
Sterculiaceae			
Heritiera javanica	Hao	1,2,3,21,34	COMMON
Pterocymbium dussaudii	Po dan	1,2,14	RARE
Sterculia alata	Po daeng	2,3	RARE
Sterculia spp.	Po tae	2,5,9,14	COMMON
Sterculia thorelii	Po daeng	1,2,3,14	RARE
Ternstroemiaceae			
Anneslea fragrans	Kaem o:n	2,3	COMMON
Schima wallichii	Mi	21,34	RARE
Tiliaceae			
Grewia paniculata	Khom so:m	2,3	RARE
Grewia spp. (?)	Po ka: hok	1,2	RARE
Pentacme burmanica	Si siat	3	RARE
Pentacme siamensis	Phao:	2	RARE
Ulmaceae			
Celtis sp.	Kiu do:ng	14	RARE
Verbenaceae			
Gmelina arborea	So	1,21,34	RARE
Vitex peduncularis	Tin no:k	1,21,34	RARE
Vitex pubescens	Tin no:k	2	RARE
Xanthophyllaceae			
Xanthoxyllum glaucum	So:m saeng	2	RARE
UNIDENTIFIED			
	A Lang	2	RARE
	Bon	1,2	RARE
	Bak kay	2	RARE
	Deau kai	1,2	RARE
	Du:k	2,3,10	COMMON
	Duk ngua	1,2,3	COMMON
	Duk sang	2,3	COMMON
	Fa:k kha:m	2,3	ABUNDANT
	Haet	14	RARE
	Ham Xanghong	2,3	RARE
	Ka bao nok	2	COMMON
	Ka bok nam	2	COMMON
	Ka tong	2	RARE
	Khae	2,3,10	COMMON
	Khae daeng	3	COMMON
	Khae nang	3	COMMON
	Khaeng nong	1,2	COMMON
	Kham paep	1,2,3,5,9,10,1	COMMON

	Lao Name	Observed in Land System	Abundance
		4	
	Kho leuang	3	RARE
	Ko huat	1	COMMON
	Kon beung	2	RARE
	Kuang si	1	RARE
	Leaung	3,21,34	RARE
	Lin khway	1,10,14,21,34	RARE
	Man meuy	14,21,34	COMMON
	Meaut khay	2	RARE
	Meuat ae:	2	RARE
	Mu:n Dong	1,2	RARE
	Nuat Seua	2	RARE
	Nyang tui	2	RARE
	Pang	14	ABUNDANT
	Phak hai ton	2,3	RARE
	Phut Pa	2	RARE
	Po hu	1,10,21,34	ABUNDANT
	Po Mong	1,21,34	ABUNDANT
	Sa: kham	1,3	RARE
	Saed	2	RARE
	Sang nga	2,3,14	RARE
	Si da pa	2	RARE
	Si kan da:m	2	RARE
	So da:m	1,2,3,14	RARE
	So yuark	2,3	RARE
	So:m sua	21,34	RARE
	Ta khay	5,9,10	RARE
	Tang nok	2,3	RARE
	Tao mui	3,21,34	RARE
	Thong fan	1,2,10,14	RARE
	Thong pa	2,3	RARE
	Tin cham	2,14	RARE
	Va Na:o Nai	2	RARE

5.4.1.3 RECOMMENDATIONS

MITIGATIONS FOR THE LOSS OR DAMAGE TO VALUABLE HABITATS

Riverine Habitats

The dam will flood approximately 156 sq.km and will result in a gross change in riverine habitat, from a running water environment to a predominantly lacustrine system. The riverine habitats downstream of the dam will also be damaged due to the reduction in flows during the long filling period (21 months), the probable release of anoxic water from the dam after filling, and rapid flow changes which occur during expected power generation periods. For these reasons:

1. It is recommended that a future study should investigate the level of riparian release required to mitigate the damage to riverine habitats downstream during the long filling period. The riparian release arrangement will need a variable level intake to avoid releasing anoxic water. Attention should be paid to the experiences of Nam Theun Hinboun where the riparian release appears to have been inadequate to prevent significant damage to the downstream fishery.

2. It is recommended that a study be undertaken to determine whether it is feasible either: to install a variable level intake, so as to ensure that water is not drawn from below the thermocline, resulting in releases of anoxic water downstream or: install other devices (such as oxygen injectors or surface pumps) to insure the power conduits do not discharge anoxic water.

3. It is recommended that a proper evaluation of the possibilities of improving water quality in the reservoir be made including

- Biomass reduction
- Silt Control
- Oxygen injection and surface pumps

4. It is recommended that a study be undertaken to determine if it is feasible to construct a re-regulating dam of sufficient size to re-regulate flows.

Alternative River Basin Conservation

The creation of the reservoir will result in a large number of people (6000) having to be resettled in the general vicinity of the reservoir. The project will also result in a significant increase of in-migration into the area. The inevitable development pressures that follow will result in extremely severe degradation of the surrounding terrestrial habitats in addition to a gross change in riverine habitat. For these reasons it is probably impractical to try and conserve the majority of the terrestrial habitats in the vicinity of the reservoir.

The mitigation strategy recommended here is to first identify a river basin with equivalent species and habitat diversity, and conservation significance, approximately 2000 sq. km in size and not too close to the reservoir and work sites. Once identified an environmental management plan should be prepared for the new area in coordination with the relevant government ministries. The approximate cost to identify a suitable area and prepare a environmental management plan would be in the region of $100,000.

It is recommended that the environmental management plan should outline effective and practical control measures which would have to be put in place. These would include highly motivated and well paid park rangers, checkpoints, access roads, fencing, firebreaks, a tourism development plan and a villager participation programme. The villager participation programme would be designed to mitigate for the loss of use of the forest (hunting and collection of forest products), and to demonstrate the benefits of maintaining the reserve (for example wage earning jobs in the park and tourist industries) The annual budget to protect such an area would be in the region of $100,000 per annum.

If this approach is effective, the negative impact of damaging an already degraded habitat would be more than balanced by the substantial positive impact of the new reserve.

5.4.2 Timber volumes and vegetation biomass

It has to be noted that it was not possible to stratify the vegetation in the inundation zone prior to performing the survey because clearance could not be obtained for an overflight.

5.4.2.1 Commercial Timber Volumes

Three sampling sites to assess timber volumes have been surveyed to date in the inundation zone (Figure 1). The preliminary results are detailed in the Table 6.

TABLE 6: COMMERCIAL TIMBER VOLUMES

Sample Site Number	Land System	Area in sq. km	Total Number of stems per hectare	Number of commercial stems per hectare	Average Stem Diameter Breast Height at 1m	Cu.m Hectare (commercial timber volume)
1	14	32	15	3	33.7	9.7
2	14	32	178	83	54.5	396.3
3	21	80	43	8	51.1	35.0
Mean			79	31	46.4	147.0
Standard Deviation			71	37	9.1	176.6
Mean (excluding 2)			**29**	**6**	**42.4**	**22.4**
Standard Deviation (excluding 2)			**14**	**3**	**8.7**	**12.7**

Findings

Sample site 2 was in a particularly dense patch of forest. Only about 5% of the inundation zone surveyed is covered by forest of this density. The reservoir-wide density of commercial timber will be between 15 and 35 cu.m/ha.

It has to be cautioned that these results are from a very small number of sampling sites in a limited area of the inundation zone. In addition the lower reservoir LS5 has yet to be surveyed. From visual inspections it seems to have much lower timber volumes due to the large areas under cultivation.

The results to date (excluding sample plot 2) suggest that there could be approximately 40 stems per ha to be extracted with a maximum of 35 cu.m per ha to be removed. This implies a maximum of 6,420,000 stems could be cut and a maximum of 5,460,000 cu.m of timber could be moved out of the inundation zone. Again it has to be stated that the more densely populated areas of the upper and lower reservoir have yet to be surveyed. The defects found in the timber in Lao forests, the lack of a differentiated timber market and the nature of

logging (i.e. untrained subcontractor felling, old equipment etc), make it unlikely that more than 20% of the potentially commercial timber would be extracted from the reservoir area (= c. 1 million cu.m of timber), of which about 500,000 cu.m could reach commercial saw mills.

Logging operations in Laos are unmechanised and not apparently very profitable. The relatively low timber volume density in the reservoir presents almost no opportunities for real profit. In addition small scale logging operations have probably already extracted the most valuable stems from the upper and lower reservoir over the past 3 to 4 years.

Logging could only become a commercially viable as part of a comprehensive biomass clearance programme, if modern management and modern equipment were to be deployed.

Experience with other reservoirs shows that poorly managed logging carries the risk of generating adverse international publicity (NT2, Nam Leuk). The issue will require careful co-ordination of the numerous interest groups which control different facets of logging in the Lao PDR.

Recommendations

It is recommended that additional field work be carried out to establish with more precise magnitude the commercial timber volume in the inundation zone, especially in the upper reservoir in the Tavieng area as a more sound estimate has to be established. In deciding how to carry out a commercial timber volume inventory it is recommended that proper attention is paid to the Nam Leuk experience. The National Office of Forest Inventory and Planning (NOFIP) over-estimated the volume of commercial timber by a factor of 3 and marked up numerous trees which were outside the reservoir area. If NOFIP were commissioned to carry out inventory work, close supervision of there work would be needed. The cost of a professional reservoir timber inventory and a logging plan which integrates with the biomass clearance programme would cost about $150,000.

It is further recommended that this more precise data be used to formulate an integrated biomass clearance and logging plan which also identifies how the process can be managed to prevent adverse international reactions.

5.4.2.2 Vegetation Biomass

Three sampling sites to assess vegetation biomass have been surveyed to date in the inundation zone (Figure 1). The results for each sample plot are shown below in Table 7 Each biomass component has been converted to a density of tonnes per hectare undried biomass. Tree stems are shown as numbers per hectare in the large (dbh >20cm) and small (3cm<dbh<20cm) categories. The individual sampling plots have then been combined to produce the density of undried biomass for the different biomass components and the number of trees per hectare for all the sample plots.

In Table 8 the biomass density information has been combined and analyzed to show undried biomass densities in tonnes per hectare for different decomposition types of biomass, and their total weights for the inundation zone.

TABLE 7: DENSITY OF BIOMASS COMPONENTS

Sample Site	LS	Quadrate	Litter tonnes /ha	Low Veg tonnes /ha	Dead Wood tonnes /ha	Live Bamboo tonnes /ha	Dead Bamboo tonnes /ha	Lianas tonnes /ha	Tree Stems (*) tonnes /ha	Tree Foliage (*) tonnes /ha	No. Large Trees	No. Small Trees
1	14	1	6.2	4	0	40.6	14.6	0	21.3	9.3	0	2000
2	14	1	7.0	2.1	0	3.6	4.3	0	334.8	12.8	400	800
3	21	1	5.8	1.8	8.2	0	0	13.2	334.9	11.5	400	400
Mean			6.3	2.6	2.7	14.7	6.3	4.4	230.3	11.2	266.7	1066.7
Standard Deviation			0.5	1.0	3.9	18.3	6.1	6.2	147.8	1.4	188.6	249.4

TABLE 8: TOTAL DENSITY OF RAPID AND SLOWLY DEGRADABLE BIOMASS

Land System	Area (Ha)	Rapidly Decomposed Biomass		Slowly Decomposed Biomass		All Biomass	
		Density Tonnes per Ha	Total Weight 1000's Tonnes	Density Tonnes per Ha	Total Weight 1000's Tonnes	Density Tonnes per Ha	Total Weight 1000's Tonnes
ALL	15600 (FSL)	45.5	709.8	233	3634.8	278.5	4344.6

Findings

The overall undried above ground biomass density of 278.5 tonnes per hectare is comparable to findings of the Nam Leuk Biomass survey (289.8 undried above ground biomass density). It has to be cautioned that these results are from a very small number of samples in a limited area of the reservoir. In addition the lower reservoir LS5 has yet to be surveyed and from initial inspections may have a lower above ground biomass density, due to the large areas under cultivation. Of critical importance in terms of water quality is the rapidly degradable biomass of which there is approximately 45 tonnes per ha (above ground) and from studies performed in the Nam Leuk the fine

5.4.2 Wildlife Survey

5.4.3.1 Results of Terrestrial Veterbrate Survey

Findings

Due to the short time period of the survey it is difficult to draw definite conclusions about the relative abundance of individual species for different habitat types or ecotypes. In addition the area surveyed was rather limited when taking into account the size of the catchment. Forty land system units were identified from analysis of 1:50,000 scale maps of which only 13 (LS 1, 2, 3, 5, 6, 7, 9, 10, 14, 16, 20, 21 and 34) have been traversed. Mainly due to problems of insecurity, it was not possible for the survey team to traverse any more of the LS's. This survey will therefore present only a very fragmented view of the Nam Ngiep catchment.

The rate at which animal sounds and/or signs were encountered were much higher than was found in comparable surveys made in the Xe Kaman basin, in Xaignabouli (SFE6) Province, western Vientiane Province (SFE9) and in the Middle Nam Leuk Basin. The areas traversed outside the inundation zone appeared rich in terms of species diversity and high in terms of density and could be described as a "rich community". This "rich community" of fauna may be due in part to the unusual geology of this catchment (Figure 5). It has large areas of eroded intrusive rock from which a particularly fertile soil is weathered, which is probably able to support more abundant and diverse food chains.

A list of species either sighted or hunted by villagers is presented in Table 9. It gives indications of relative abundance of each species and the change in abundance over the last 5 years. A list of birds sighted in the catchment is listed in Table 10. A list of mammals and reptiles sighted in the catchment is presented in Table 11.

The two areas where "rich communities" of fauna are found are highlighted in Figure 4. North of Ban Sopphoun up to Ban Nakang is one area. The other area is directly south of Ban Sopyouk in LS2 and LS3 and east of the Nam Ngiep into LS1. LS1 and LS2 appeared particularly rich, with evidence of at least two separate herds of Asiatic Elephant of approximately 12 and 6 individuals respectively. The herd in LS2 (west of the Nam Ngiep river) migrate through the area during the rainy season and the herd in LS1 (East of the Nam Ngiep river) appears to stay in LS1 all year round. However the elephants habitat in LS1 is coming under severe pressure from logging and cultivation and their future prospects in this area do not look promising . The possible migration route of the herd in LS2 is displayed in Figure 4. Both these herds, and possibly others not yet located, would be adversely affected by the construction phase of the project, by the increases in economic activity, and by increased human populations, which the project is likely to induce.

TABLE 2: VILLAGER FAUNA OBSERVATIONS

Species Name	English Name	Lao Name	Village	Collection Site Opportunistic (OP); Known General Location (KGL); Specific Weather/ Time (SW/T); Known Identical Location (KIL); Seasonal (S); Known Habitat (KHT).	Annual amount collected (kg) for the entire village. PROTECT= Protected and therefore not hunted.	Closest site (hrs walk)	Furthest Site (hrs walk)	Equipment Used Gun (G); Knife (K); Trap (T); Digging Tool (D). Net (N), Catch by Hand (H), Mine Trap (mT)	Habitat Type S=HILLSIDES; H=HIGH ALT; L=LOW ALT; R=RIVERINE; F=DENSE FOREST; FL=FLOODLAND; N=NONG; C=CAVE; O=OPEN WOODLAND	Findability	Change over Last 5 years
MAMMALS											
Bovidae											
Bos gaurus	Gaur	Meuey	Ban Muang Bo	KGL	0	1.5	3	G	S,H,L,F	HARD	HARDER
			Ban Hatyeun	KHT	(in 1973) 800	2	3	G	S	HARD	HARDER
			Ban Muang Mai	KHT	(in 1975) 2500	1.5	2	G	H,L,F	EASY	HARDER
			Ban Sopphoun	OP, KGL	700	0.75	3	G, T	S,F	HARD	HARDER
Capricornis sumatraensis	Serow	Nyeuang	Ban Muang Bo	KGL	20	2	3	G	S,H	HARD	HARDER
			Ban Hatyeun	KGL	50	1	4	G	S,H,L	HARD	HARDER
			Ban Muang Mai	KIL	18	3		G	S,H	HARD	HARDER
			Ban Nakang	KGL	PROTECT	3	4	G	S,H,F	HARD	EASIER
			Ban Namyouk	OP,SW/T	PROTECT	1	4		H,R	EASY	
			Ban Sopphoun	KHT	150	2	4	G	S,H	HARD	HARDER
			Ban Sopyouk	OP	800	4	12	G	S	EASY	
Canidae											
Canis aureus	Asiatic Jackal	Ma Jork	Ban Muang Bo	OP, KGL	30	1	3	G,T	S,H,L,R,F	HARD	HARDER
			Ban Sopphoun	KGL	30	0.25	1	G	S,H,L,R,F	HARD	HARDER
			Ban Thahua	KGL	PROTECT						
Cuon alpinus	Asian Wild Dog	Ma Nai	Ban Hatyeun	KGL	PROTECT						
			Ban Muang Mai	KGL	13	0.25	1.5	G	S,H,L,R,F, Fl	MEDIUM	HARDER
			Ban Nakang	KGL	18	0.5	3	G	S,H,L,R,F	HARD	HARDER
			Ban Thahua	KGL	PROTECT						
Cercopithecidae											
Macaca arctoides	Stump-Tailed Macacque	Ling Kung	Ban Muang Bo	KGL	50	0.3	3	G	S,H,L,R,F, FL	HARD	HARDER

			Ban Houaypamom	NC					F,H	HARD	
			Ban Hatyeun	KGL	10	1	4	G	S,H,L,R,F, FL	HARD	HARDER
			Ban Muang Mai	KGL		1.5	3	G	S,H,L,R,F, FL	HARD	HARDER
			Ban Sopphoun	KGL	500	3	4	G	S,H,L,F	EASY	EASIER
			Ban Thahua	KGL	PROTECT						
Macaca assamensis	Asamese Macaque	Ling Sehn	Ban Hatyeun	KGL	20	1	4	G,T	S,H,L,R,F, FL	MEDIUM	HARDER
			Ban Muang Mai	KGL	30	1.5	3	G	S,H,L,R,F, FL	EASY	EASIER
			Ban Thahua	KGL	150	0.5	1	G	S,H,L,R,F, FL	MEDIUM	EASIER
Macaca mulata	Rhesus Macacque	Ling Vork	Ban Muang Bo	KGL	30	0.5	3	G	S,H,L,R,F, FL	EASY	EASIER
			Ban Nakang	KGL	6	0.5	1	G	S,H,L	MEDIUM	HARDER
			Ban Sopphoun	KGL	100	0.5	1	G	S,H,L,R,F	EASY	EASIER
Presbytis cristatus	Silvered Langur	Khang	Ban Hatyeun	KGL	20	1	4	G	S,H,L,R,F, FL	MEDIUM	HARDER
			Ban Muang Mai	KGL	5	1.5	3	G	S,H,L,R,F, FL	HARD	HARDER
			Ban Nakang	KGL	6	0.5	1	G	S,H,L	MEDIUM	HARDER
Presbytis melalophos	Banded Langur	Khang	Ban Muang Bo	KGL	180	2	3	G	S,H,F	HARD	HARDER
			Ban Sopphoun	KGL	100	1	3	G	S,H,L,F	EASY	HARDER
Sp.	Monkeys	Ling	Ban Namyouk	KGL	40	2	10	G	S,F	EASY	
			Ban Sopyouk	OP	70	1	3	G	S	MEDIUM	
Cervidae											
Cervus porcinus	Hog Deer	Gwang	Ban Muang Bo	OP, KGL	250	0.7	3	G	S,H,L,R,F	MEDIUM	HARDER
			Ban Nakang	KGL	PROTECT	1	2	G	S,H,L,R,F	HARD	EASIER
			Ban Namyouk	KIL,SW/T	PROTECT	0.5	2		F	MEDIUM	
			Ban Sopphoun	KGL,KHT	300	0.5	1	G	S,H,L,R,F	HARD	HARDER
			Ban Sopyouk	KHT	0	1	2	G	S	MEDIUM	EASIER
Cervus unicolor	Sambar	Gwang	Ban Hatyeun	KHT	300	0.5	3	G	S,H,L,R,F, FL	HARD	HARDER
			Ban Muang Mai	KGL	1200	0.25	0.5	G	S,H,L,R,F	EASY	HARDER
Muntiacus feae	Feas Barking Deer	Fahn Mo	Ban Houaypamom	OP	100	0.5		G	R,F	HARD	NO CHANGE
Muntiacus muntjak	Common Barking Deer	Fahn Tong	Ban Houaypamom	OP	100	0.5		G	R,F	HARD	NO CHANGE
			Ban Hatyeun	KHT	100	0.25	3	G	S,H,L,R,F, FL	EASY	HARDER
			Ban Muang Mai	KGL	700	0.25	0.5	G	S,H,L,R,F	EASY	EASIER
			Ban Sopphoun	KGL	300	0.25	2	G	S,H,L,R,F, FL	EASY	HARDER
			Ban Thahua	KGL	(in 1996) 20	0.5		T	S	EASY	EASIER
Muntiacus sp.	Barking Deer	Fahn	Ban Muang Bo	KGL	300	0.5	3	G	S,H,L,R,F	EASY	HARDER

			Ban Nakang	KGL	60	1	2	G	S,H,L,R,F	MEDI UM	HARDE R
			Ban Sopyouk	KGL	250	0.1	2.5	G	S	MEDI UM	EASIER
Cynocephalid ae											
Cynocephatus variegetus	Colugo(Malay an Flying Lemur)	Bahng Hok (Bahng Nai)	Ban Hatyeun	KGL	3	0.016	4	G	S H,L,R,F, FL	MEDI UM	EASIER
			Ban Muang Mai	KGL	5	0.016	3	G,C	S,H,L,R,F, FL	EASY	EASIER
			Ban Thahua	KGL	3	0.016	1	G	S,H,R,F,F L	EASY	EASIER
Elephantidae											
Elephas maximis	Asiatic Elephant	Xang	Ban Hatyeun	KHT	One elephant in 1969	0.5		G	R	HARD	HARDE R
			Ban Muang Mai	KHT	Two elephants in 1975	0.08	2	G	H,L,F	EASY	HARDE R
Felidae											
Felis temmincki	Asian Golden Cat	Seua Fai (Seua Daeng)	Ban Muang Bo	OP, KGL	0	0.5	3	G	S,H,L,R,F	HARD	HARDE R
			Ban Houaypamom	OP	0	30		G	F	HARD	
			Ban Hatyeun	OP	50	0.5	4	G	S,H,L,R,F, FL	HARD	HARDE R
			Ban Muang Mai	KGL	(in 1995) 30	3		G	S,H,L,R,F	HARD	HARDE R
			Ban Namyouk	KIL	30	0.1	10	G	S,F	HARD	
			Ban Sopphoun	KGL	50	0.25	0.75	G	H,L,F	HARD	HARDE R
			Ban Sopyouk	KGL	35	0.1	2	G	L	HARD	HARDE R
Felis viverrina	Fishing Cat	Seua Pa	Ban Houaypamom	KHT	10	0		G	L,R	HARD	
Filis marmorata	Marbled Cat	Seua Maeo	Ban Hatyeun	KGL	15	0.25	3	G	S,H,L,R,F, FL	HARD	HARDE R
			Ban Muang Mai	KGL	60	0.25	3	G	S,H,L,R,F, FL	MEDI UM	HARDE R
			Ban Thahua	KGL	5	0.3	1	G	S,H,L,R,F, FL	HARD	HARDE R
Panthera tigris	Tiger	Seua Khong	Ban Muang Bo	OP, KGL	0	1.5	2	G	S,H,L,F	HARD	HARDE R
			Ban Houaypamom						F	HARD	HARDE R
			Ban Hatyeun	KHT	(in 1975) 200	1.5		mT	R	HARD	HARDE R
			Ban Muang Mai	KGL	(in 1977) 200	1		G	S,h,L,R,F, FL	HARD	NO CHANG E
			Ban Sopphoun	OP,KGL	0	0.5	2	G	H,L,F	HARD	HARDE R
Hylobatidae											
Hylobates agilis	Agile Gibbon	Thanee Meu Damm	Ban Muang Bo	KGL	30	2	3	G	S,H,F	HARD	HARDE R
			Ban Hatyeun	KGL	10	1	4	G	S,H,L,R,F, FL	HARD	HARDE R
			Ban Muang Mai	KGL	8	1.5	3	G	S,H,L,R,F, FL	HARD	HARDE R
			Ban Sopphoun	KGL	50	2	3	G	S,H,L,R,F	HARD	HARDE R
Sp.	Gibbons	Thanee	Ban Namyouk	KGL	PROTEC T	3	12		S,F	EASY	
			Ban Sopyouk	KIL	PROTEC T	1	3		H	HARD	HARDE R

Hystricidae											
Atherurus macrourus	Bush Tailed Porcupine	Horn	Ban Houaypamom	KGL	50	1	4	G	S,F	HARD	HARDER
			Ban Hatyeun	KGL	50	1	3	G	S,H,L,R,F,FL	EASY	EASIER
			Ban Muang Mai	KGL	45	1.5	3	G,T	S,H,L,F	MEDIUM	EASIER
			Ban Nakang	KHT	10	2	3	G	S,H,L,F	HARD	HARDER
			Ban Namyouk	KGL	50	2	3	G	S,R	MEDIUM	HARDER
			Ban Sopphoun	KGL	20	0.5	1	G	S,H,L,R,F	MEDIUM	HARDER
Hystrix brachyura	Malayan Porcupine	Menh	Ban Muang Bo	OP, KGL	50	0.5	3	G	S,H,L,R,F	MEDIUM	HARDER
			Ban Houaypamom	KHT	1	0.5		G,D	F,S	HARD	
			Ban Hatyeun	KGL	30	0.5	3	G,T	S,L,R,F,FL	HARD	HARDER
			Ban Muang Mai	KGL	50	1.5	3	G,T	S,H,L,R,F,FL	MEDIUM	EASIER
			Ban Nakang	KGL	15	0.25	1	G	S,L,R,F	HARD	HARDER
			Ban Namyouk	KGL	40	1	3	G	S,F	MEDIUM	
			Ban Sopphoun	KGL	20	0.5	1	G	S,H,L,R,F	MEDIUM	HARDER
			Ban Thahua	KGL	25	0.5	1	T	S,H,L,R,F,FL	MEDIUM	HARDER
Lorisadea											
Nycticebus coucang	Slow Loris	Ling Lom	Ban Muang Bo	KGL	15	0.3	3	G	S,H,L,R,F,FL	EASY	EASIER
			Ban Sopphoun	KGL	15	0.5	3	G	S,H,L,F	EASY	EASIER
Manis javanica	Malayan Pangolin	Linh	Ban Muang Bo	KGL	200	0.25	3	D	L,R,F,FL	MEDIUM	HARDER
			Ban Houaypamom	KHT	16	0.3		D	F	HARD	HARDER
			Ban Hatyeun	KGL	30	0.16	5	C,T	S,H,L,R,F,FL	MEDIUM	HARDER
			Ban Muang Mai	KGL	100	0.25	2	C	S,H,L,R,F,FL	EASY	HARDER
			Ban Nakang	KGL	10	0.25	1	D	L,R,F,FL	HARD	HARDER
			Ban Sopphoun	KGL	20	0.5	2	D	L,R,F,FL	HARD	HARDER
			Ban Thahua	KGL	8	0.5	1	C,T	S,L,F	HARD	HARDER
Mustelidae											
Arctonyx collaris	Hog Badger	Mu Leung	Ban Muang Bo	KGL	60	2	3	G	R,FL	HARD	HARDER
			Ban Houaypamom	NC					F	HARD	
			Ban Hatyeun	KGL	15	1	3	G,T	S,H,L,R,F,FL	HARD	HARDER
Arctonyx collaris	Hog Badger	Mu Leung	Ban Muang Mai	KGL	(in 1993) 25	1		G	R,F,FL	HARD	HARDER
			Ban Namyouk	OP	20	1	8	G	S,L,F	HARD	
			Ban Sopphoun	KGL	20	0.5	1	G	S,H,L,R,F	HARD	HARDER
Lutra lutra	Common Otter	Nahk	Ban Hatyeun	KGL		0.08	3	G	R,FL	HARD	HARDER
			Ban Muang Mai	KGL	4	3	4	G	R,FL	HARD	HARDER
			Ban Nakang	KGL	5	0	3	G	R	HARD	HARDER

Melogale personata	Large-toothed Ferret-Badger	Ma Leung	Ban Hatyeun	KGL	8	1	3	G,T	S,H,L,R,F, FL	HARD	HARDER
			Ban Muang Mai	KGL	18	3	3	G	R,F,FL	HARD	HARDER
Mustela strigidorsa	Back Striped Weasel	Phung Pom	Ban Sopphoun	OP, KGL	2	0.5	1	G	S,H,L,R,F	MEDIUM	HARDER
Rhizomyidae											
Rhizomys pruinosus	Horay Bamboo Rat	Onn Khaem	Ban Houaypamom	KHT	72	0.1		D	S,F	EASY	
			Ban Hatyeun	KGL	10	0.16	4	D	S,H,L,R,F, FL	EASY	EASIER
			Ban Muang Mai	KGL	25	2	3	D	S,H,L,F	HARD	HARDER
			Ban Nakang	KGL	15	0.5	1	D	S,L,R,F,FL	MEDIUM	HARDER
			Ban Thahua	KGL	5	0.16	1	D	S,H,L,R,F, FL	EASY	EASIER
Rhizomys sumatrensis	Large Bamboo Rat	Onn Hok	Ban Houaypamom	KHT	72	0.1		D	S,F	EASY	
			Ban Hatyeun	KGL	20	0.16	4	D	S,H,L,R,F, FL	EASY	EASIER
			Ban Muang Mai	KGL	20	2	3	D	S,H,L,R,F, FL	HARD	HARDER
			Ban Nakang	KGL	15	0.25	1	D	S,L,R,F,FL	MEDIUM	HARDER
			Ban Sopphoun	KGL	20	0.25	1	D	S,H,L,R,F, FL	EASY	EASIER
			Ban Thahua	KGL	30	0.3	1	D	S,H,L,R,F, FL	EASY	EASIER
Rhizomys sp.	Bamboo Rat	Onn	Ban Namyouk	KGL, SW/T	35	0.5	8	D, G	S	EASY	
Sciuridae											
Callosciurus flavimanus pranis	Belly-banded Squirrel	Ka Hok Bao	Ban Hatyeun	KGL	30	0.3	4	G	S,H,L,R,F, FL	EASY	EASIER
			Ban Muang Mai	KGL	35	0.25	3	G	S,H,L,R,F, FL	EASY	EASIER
			Ban Thahua	KGL	15	0.16	1	G	S,H,L,R,F, FL	EASY	EASIER
Callosciurus finlaysoni	Variable Squirrel	Ka Hok Lark Sy	Ban Muang Mai	KGL	50	0.25	3	G	S,H,L,R,F, FL	EASY	EASIER
			Ban Nakang	KGL	90	0.25	1	G	S,H,L,R,F, FL	EASY	EASIER
			Ban Hatyeun	KGL	30	0,16	4	G	S,H,L,R,F, FL	EASY	EASIER
			Ban Thahua	KGL	15	0.16	1	G	S,H,L,R,F, FL	EASY	EASIER
Petaurista elegans	Lesser Giant Flying Squirrel	Bahng Lua	Ban Nakang	KGL	10	0.5	1	G	S,H,L,R,F	HARD	HARDER
Petaurista petaurista	Red Giant Flying Squirrel	Bahng Lua	Ban Muang Mai	KGL	10	2	3	G	S,H,L,F	MEDIUM	HARDER
			Ban Sopphoun	KGL	6	0.5	1	G	S,H,L,F,R	HARD	HARDER
			Ban Houaypamom	NC		2				VERY HARD	
			Ban Hatyeun	KGL	5	0.5	4	G	S,H,L,R,F, FL	HARD	HARDER
			Ban Thahua	KGL	5	0.3	1	G	S,H,R,F,FL	HARD	HARDER
Suidae											
Sus scrofa	Common Wild Pig	Mu Pa	Ban Muang Bo	KGL	800	0.3	3	G	H,L,R,F,FL	EASY	EASIER
			Ban Houaypamom	OP	150	0.1	1	G	H,L	EASY	

			Ban Hatyeun	KHT	100	0.3	4	G,T	S,H,L,R,F,FL	EASY	EASIER
			Ban Muang Mai	KGL	1500	0.16	0.3	G	S,H,L,R,F,FL	EASY	EASIER
			Ban Nakang	KGL	600	1	2	G	S,H,L,R,F,FL	EASY	EASIER
Sus scrofa	Common Wild Pig	Mu Pa	Ban Namyouk	KGL	900	0.5	10	G	S,L,R,F	MEDIUM	
			Ban Sopphoun	KGL	500	1	2	G	S,H,L,R,F,FL	EASY	EASIER
			Ban Sopyouk	KGL	640	0.5	1	G	F	MEDIUM	
			Ban Thahua	KGL	400	0.16	0.5	G	S,L,R,F,FL	EASY	EASIER
Talpidae											
Talpa micrura	Eastern Mole	Teung	Ban Sopphoun	OP	0	2	3	D	S,H	HARD	HARDER
Tragulus javanicus	Lesser Mouse Deer	Kai	Ban Muang Bo	KGL	50	0.3	3	G,T	S,H,L,R,F,FL	EASY	EASIER
			Ban Houaypamom	KHT	30	0.1		T	R	HARD	NO CHANGE
			Ban Hatyeun	KGL	40	0.5	4	G,T	S,H,L	MEDIUM	EASIER
			Ban Muang Mai	KGL	30	1	3	G,T	S,H,L,R,F,FL	MEDIUM	EASIER
			Ban Nakang	KGL	20	1	2	G,T	L,R,F,FL	MEDIUM	HARDER
			Ban Namyouk	OP	30	0.5	8	G	L,F	MEDIUM	
			Ban Sopphoun	KGL	20	0.5	1	G,T	S,H,L,R,F,FL	EASY	EASIER
			Ban Thahua	KGL	30	0.5	1	G,T	S,H,L,R,F,FL	EASY	EASIER
Tragulus sp.	Mouse Deer	Kai	Ban Sopyouk	OP	28	0.25	1	G	R	EASY	
Tupaiidae											
Tupaia glis	Common Treeshrew	Ka Tae	Ban Sopphoun	KGL	20	0.1	1	G,T	S,H,L,R,F,FL	EASY	EASIER
Tupaia minor	Pygmy Treeshrew	Ka Chorn	Ban Hatyeun	KGL	5	0.08	4	G,T	S,H,L,R,F,FL	EASY	EASIER
			Ban Muang Mai	KGL	10	0.08	3	G,T	S,H,L,R,F,FL	EASY	EASIER
			Ban Thahua	KGL	2	0.08	1	G,T	S,H,L,R,F,FL	EASY	EASIER
Ursidae											
Helarctos malayanus	Malayan Sun Bear	Mee Born	Ban Muang Bo	KGL	150	1	3	G	S,H,L,F	HARD	HARDER
			Ban Houaypamom	OP	25	0.5		G	F	HARD	HARDER
			Ban Hatyeun		PROTECT						
			Ban Muang Mai	KGL	26	3		G	S,H,L,R,F	HARD	HARDER
Helarctos malayanus	Malayan Sun Bear	Mee Born	Ban Sopphoun	KGL	150	0.5	1	G	S,H,L,R,F	HARD	HARDER
Selenarctos thibetanus	Asiatic Black Bear	Meuey	Ban Hatyeun	OP	(in 1988) 100	3		G	S,H,L,R,F	HARD	HARDER
			Ban Muang Mai	KGL	(in 1997) 90	3		G	S,H,L,R,F	HARD	HARDER
Sp.	Bear	Mee	Ban Namyouk	KGL	50	1	10	G	S,H	HARD	HARDER
			Ban Sopyouk	KIL	150	2	4	G	F,H	HARD	HARDER
Viverridae											
Arctictis binturong	Binturong	Ngen Hang Kho	Ban Muang Bo	KGL	160	2	3	G	S,H,R,F,FL	MEDIUM	HARDER

			Ban Houaypamom	KGL	5				F	HARD	
			Ban Hatyeun	KGL	20	0.5	3		S,H,L,R,F,FL	MEDIUM	HARDER
			Ban Muang Mai	KGL	70	1.5	3	G	S,H,L,R,F,FL	MEDIUM	EASIER
			Ban Nakang	KGL	100	1	4	G	S,H,L,R,F,FL	EASY	HARDER
			Ban Namyouk	KGL	40	0.5	10	G	F	MEDIUM	
			Ban Sopphoun	KGL	80	0.25	1	G	S,H,L	EASY	EASIER
			Ban Sopyouk	KGL	30	0	1	G	H	EASY	
			Ban Thahua	KGL	50	0.5	1	G	S,H,L,R,F,FL	MEDIUM	EASIER
Arctogalidia trivirgata	Three Striped Palm Civet	Ngen Omm Na Daen	Ban Houaypamom	KGL	40	0.1	3	G	F	EASY	NO CHANGE
Herpestes javanicus	Javan Mongoose	Phung Pom	Ban Houaypamom	KGL	1				F	HARD	
Paguma larvata	Masked Palm Civet	Ngen Kheua Khow	Ban Namyouk	OP	10	0.1	4	G	F	EASY	
			Ban Sopphoun	KGL	320	0.25	1	G	R,F	EASY	EASIER
			Ban Sopyouk	KGL	4	0.1	2	G	R	HARD	HARDER
Paradoxus hermaphroditus	Common Palm Civet	Ngen Omm Tin Tam	Ban Houaypamom	NC					F	HARD	
Viverra zibetha	Large Indian Civet	Ngen Omm Hang Kam	Ban Hatyeun	KGL	5	0.25	3	G	R,L,F,FL	HARD	HARDER
		Ngen Omm Hang Kam	Ban Muang Mai	KGL	60	0.5	1	G	R,L,F,FL	EASY	EASIER
		Ngen Omm Hang Kam	Ban Nakang	KGL	20	1	4	G	S,H,L,R,F,FL	MEDIUM	HARDER
		Ngen Omm Hang Kam	Ban Thahua	KGL	60	0,5	1	G	R,L,F,FL	EASY	EASIER
Viverricula malaccensis	Small Indian Civet	Ngen Faeng	Ban Houaypamom	KGL	10				F	HARD	
			Ban Hatyeun	KGL	15	0.25	3	G	S,H,L,R,F,FL	EASY	EASIER
			Ban Muang Mai	KGL	30	5	0.16	G	L,R,F,FL	MEDIUM	HARDER
			Ban Nakang	KGL	30	1	3	G	S,H,L,R,F,FL	EASY	HARDER
			Ban Thahua	KGL	6	0.08	1	G	R,L,F,FL	MEDIUM	EASIER
	Civet	Ngen Om	Ban Hatyeun	KGL	30	0.5	4	G	S,H,L,R,F,FL	EASY	EASIER
			Ban Muang Mai	KGL	30	0.3	3	G	S,H,L,R,F,FL	EASY	EASIER
			Ban Thahua	KGL	10	0.5	1	G	S,H,L,R,F,FL	EASY	EASIER
BIRDS											
Ardeidae											
Egretta intermedia	Plumed Egret	Nok Nyang	Ban Hatyeun	KGL	20	0.03	1	G,T	R,FL	EASY	EASIER
			Ban Thahua	KGL	5	0.08	1	G,T	R,FL	EASY	EASIER
Bucerotidae											
Anthracoceros albirostris	Indian Pied Hornbill	Nok Kaeng	Ban Hatyeun	KGL	10	1	4	G	S,H	EASY	HARDER
			Ban Muang Mai	KGL	2	1.5	3	G	S,H	HARD	HARDER
			Ban Sopphoun	KGL	150	0.25	3	G	S,H,L,F	EASY	EASIER
			Ban Thahua	KGL	5	1	2	G	S,H,F	HARD	HARDER
Rhinoplax vigil	Helmeted Hornbill	Nok Kok	Ban Hatyeun	KGL	4	1	4	G	S,H	HARD	HARDER

			Ban Muang Mai	KGL		2	3	G	S,H	HARD	HARDER
			Ban Sopphoun	KGL	6	1	2	G	S,H,L,F	EASY	EASIER
			Ban Thahua	KGL	5	1	2	G	S,H,F	HARD	HARDER
Rhinoplax spp	Hornbill	Nok	Ban Houaypamom			0.2		G		EASY	EASIER
Columbidae											
Ducula badia	Mountain Imperial Pigeon	Nok Moum	Ban Hatyeun	KHL	5	0.16	4	G	S,H,LR,F, FL	EASY	EASIER
			Ban Muang Mai	KHT	75	1.5	3	G,N,T	S,H,LR,F, FL	EASY	EASIER
			Ban Thahua	KHL	10	0.25	1	G,T	S,H,LR,F, FL	EASY	EASIER
Treron bicincta	Orange-breasted Pigeon	Nok Pao	Ban Hatyeun	KHL	5	0.16	4	G	S,H,L,R,F, FL	EASY	EASIER
			Ban Muang Mai	KHT	75	1.5	3	G,N,T	S,H,L,R,, FL	EASY	EASIER
			Ban Thahua	KHL	10	1.5	1	G,T	S,H,L,R,F, FL	EASY	EASIER
Phasianidae											
Arborophita charltonii	Scaly-breasted Parteidge	Nok Kho	Ban Hatyeun	KGL	20	0.16	4	G,T	S,H,L,R,F, FL	EASY	EASIER
			Ban Thahua	KGL	20	0.5	1	G,T	S,H,L,R,F, FL	EASY	EASIER
Gallus gallus	Red Junglefowl	Kai Pa	Ban Hatyeun	KGL	50	0.16	4	G,T	S,H,L,R,F, FL	EASY	EASIER
			Ban Muang Mai	KGL	150	0.25	3	G,T	S,H,L,R,F, FL	EASY	EASIER
			Ban Thahua	KGL	20	0.08	1	G,T	S,H,L,R,F, FL	MEDIUM	EASIER
Lophura diardi	Siamese Fireback	Nok Khua	Ban Hatyeun	KGL	20	0.16	4	G,T	S,H,L,R,F, FL	EASY	EASIER
			Ban Muang Mai	KGL	40	1.5	3	G,T	S,H,R	MEDIUM	EASIER
			Ban Sopphoun	KGL	60	2	4	G,T	S,H,L,F	EASY	EASIER
			Ban Thahua	KGL	10	0.5	1	G,T	S,H,L,R,F, FL	MEDIUM	EASIER
Lophura nycthemera	Silver Pheasant	Nok Khi Oh	Ban Hatyeun	KGL	10	0.16	4	G,T	S,H,LR,F, FL	EASY	EASIER
			Ban Thahua	KGL	3	0.25	1	G,T	S,H,LR,F, FL	MEDIUM	HARDER
Polyplectron bicalcaratum	Grey Peacock Pheasant	Nok Kong Kort	Ban Hatyeun	KGL	20	0.16	4	G,T	S,H,L,R,F, FL	EASY	EASIER
			Ban Muang Mai	KGL	40	1.5	3	G,T	S,H,R	MEDIUM	EASIER
			Ban Sopphoun	KGL	50	1	4	G,T	S,H,L,R,F	EASY	EASIER
			Ban Thahua	KGL	5	0.5	1	G,T	S,H,L,R,F, FL	MEDIUM	EASIER
Rallidae											
Amaurornis phoenicurus	White-breasted Waterhen	Nok Kai Nah	Ban Hatyeun	KGL	10	0.16	1	G,T	R,FL	EASY	EASIER
			Ban Thahua	KGL	2	0.08	1	G,T	R,FL	MEDIUM	HARDER
REPTILES											
Agamidae											
Physignathus cocincinus	Asian Water Dragon	Kathahng	Ban Hatyeun	KGL	10	0.3	4	G,C,T	R,FL	EASY	EASIER

			Ban Muang Mai	KGL	15	0.25	3	T,C	R,FL	EASY	EASIER
			Ban Thahua	KGL	5	0.08	1	G,C	R,FL	EASY	EASIER
Boidae											
Python sp.	Python	Ngoo Leuam	Ban Muang Bo	OP	200	2	3	G,K	L,R,F,FL	EASY	HARDER
			Ban Sopphoun	KGL	150	0.15	3	G	S,H,L,F,R, FL	HARD	HARDER
			Ban Hatyeun	KGL	20	0.16	4	G,C,T	S,H,L,R,F, FL	MEDIUM	HARDER
			Ban Muang Mai	KGL	30	0.25	3	G	S,H,L,R,F, FL	MEDIUM	HARDER
			Ban Thahua	KGL	20	0.3	1	C	S,H,L,R,F, FL	HARD	HARDER
Testudinidae											
Testudo spp.	Tortoise	Tao	Ban Hatyeun	KGL	10	0.3	4	C,T	S,H,L,R,F, FL	EASY	EASIER
			Ban Muang Mai	KGL	45	1	3	C	R,FL	EASY	EASIER
			Ban Thahua	KGL	5	0.3	1	C	R,FL	HARD	HARDER
Varanidae											
Varanus bengalensis	Yellow Tree Monitor	Laen	Ban Hatyeun	KGL	30	0.3	4	G,C,T	S,H,L,R,F, FL	EASY	EASIER
			Ban Muang Mai	KGL	100	0.25	3	G,C,T	S,H,L,R,F, FL	EASY	EASIER
			Ban Thahua	KGL	150	0.25	1	G,C	S,H,L,R,F, FL	EASY	EASIER
Varanus salvato	Water Monitor	Hea	Ban Hatyeun	KGL	20	0.3	4	G,C,T	R,FL	EASY	EASIER
			Ban Muang Mai	KGL	60	0.25	3	G,C,T	R,FL	MEDIUM	HARDER
			Ban Thahua	KGL	20	0.16	1	G,C	R,FL	HARD	HARDER

TABLE 4: MAMMALS AND REPTILES OBSERVED IN THE NAM NGIEP CATCHMENT

Species Name	English Name	Type of sighting									Observed in Land System	Habitat Type S=HILLSIDES; H=HIGH ALT; L=LOW ALT; R=RIVERINE; F=DENSE FOREST; FL=FLOOD LAND; N=NONG; C=CAVE; O=OPEN WOODLAND
		Facces	Calls	Pug Mark	Direct sight	Specimen	Scratching post	Trail	Nest	Diggings		
MAMMALS												
Bovidae												
Bos gourus	Gaur	0	0	9	0	0	0	0	0	0	1	L,F
Capricornis sumatraensis	Serow	2	0	2	0	2	0	0	0	0	2,3,9	S,H,F
Cercopithecidae												
Macaca assamensis	Assamese Macaque	2	0	1	80	1	0	0	0	0	2	S,H,L,R,F
Macaca arctoides	Stump Tailed Macaque	0	0	0	3	0	0	0	0	0	3,16	S,H,F
Macaca mulata	Rhesus Macacque	0	0	0	>20	0	0	0	0	0	10	S,H,F,N
Presbytis phayrei	Phayre's Langur	0	0	0	0	1	0	0	0	0	2	S,H,F
Spp.	Monkey	0	0	3	0	0	0	0	0	0	2,14	S,H,F
Cervidae												
Cervus unicolor	Sambar	0	0	9	2	0	0	0	0	0	1,2,3,5,14	S,H,L,R,F,N
Cervus porcinus	Hog Deer	0	0	4	0	0	0	0	0	0	1	O,F
Muntiacus feae	Fea's Barking Deer	0	0	2	0	1	0	0	0	0	2,14	S,H,L,R,F,O,N
Muntiacus muntjak	Common Barking Deer	0	0	3	0	3	0	0	0	0	2,3,5,14	S,H,L,R,F,O,N
Muntiacus spp.	Barking Deer	1	3	14	0	0	0	0	0	0	1,3,5,16,21,33	S,H,L,R,F,O,N
Spp.	Deer	4	0	27	0	0	1	0	0	0	3,14,21,33	S,H,L,R,F,O,N
Elephantidae												
Elephas maximus	Asiatic Elephant	38	0	21	0	0	0	7	2	1	1,2	H,L,F,N,O
Felidae												
Felis bengalensis	Leopard Cat	0	0	0	0	1	0	0	0	0	5	Unknown
Felis marmorata	Marbled Cat	0	0	0	0	1	0	0	0	0	5	Unknown
Felis spp.	Cat (Leopard or Fishing)	0	0	0	1 (Trap camera)	0	0	0	0	0	2	S,H,F,R
Felis spp.	Cat (small)	0	0	4	0	0	0	0	0	0	3,5,14	S,H,L,R,F,O,N
Felis spp.	Cat	0	0	3	0	0	0	0	0	0	21	R,F
Felis temmincki	Asian Golden Cat	0	0	0	0	1	0	0	0	1	5,14	S,H,R,F
Panthera tigris	Tiger	0	0	2	0	0	0	0	0	0	2	S,H,R,F
Hipposideridae												
Hipposideros lekaguli	Dr. Boonsong's Roundleaf Bat	0	0	0	0	4	0	0	0	0	3	C
Hystricidae												
Artherurus	Bush Tailed	0	0	2	0	1	0	0	0	2	2,3,5,14	S,H,L,R,F,FL

macrourus	Porcupine											.C
Hystrix brachyura	Malayan Porcupine	0	0	0	0	0	0	0	0	1	1	O,L,F
Manidae												
Manis javanica	Malayan Pangolin	1	0	1	0	3	0	0	0	3	1,3,14	Unknown
Muridae												
Mus spp.	Mouse	0	0	0	1	0	0	0	0	0	2	H,F
Pteropodidae												
Cynopterus sphinx	Greater Short-Nosed Fruit Bat	0	0	0	0	1	0	0	0	0	14	C
Macroglossus sobrinus	Greater Long-Tongued Fruit Bat	0	0	0	0	1	0	0	0	0	14	N
Megaerops ecaudatus	Tailless Fruit Bat	0	0	0	0	3	0	0	0	0	14	C
Rousettus amplexicaudatus	Geoffroy's Rousette	0	0	0	0	3	0	0	0	0	14	N
Rhinolophidae												
UNIDENTIFIED	Horseshoe Bat	0	0	0	30	0	0	0	0	0	2	C
Rhizomyidae												
Rhizomys spp.	Bamboo Rat	0	0	0	0	0	0	0	0	4	3,14,20	S,H,L,R,F,FL ,O
Rhizomys sumatrensis	Large Bamboo Rat	0	0	0	0	2	0	0	0	0	3,14	S,H,L,R,F,FL ,O
Sciuridae												
Callosciurus caniceps caniceps	Grey-Bellied Squirrel	0	0	0	0	5	0	0	0	0	2,3,5,14	S,H,L,R,F,FL ,O
Callosciurus finlaysoni	Variable Squirrel	0	3	0	1	1	0	0	0	0	1,2,5	S,H,L,R,F,FL ,O
Callosciurus flavimanus pranis	Belly Banded Squirrel	0	0	0	0	1	0	0	0	0	1	O
Callosciurus flavimanus thai	Belly Banded Squirrel	0	0	0	0	1	0	0	0	0	14	L,F
Callosciurus flavimanus zimmeensis	Belly Banded Squirrel	0	0	0	0	6	0	0	0	0	3	S,H,L,R,F,FL ,O
Dremomys rufigenis	Red-Cheeked Squirrel	0	0	0	0	2	0	0	0	0	14	S,H,F
Lariscus insignis	Three-Striped Ground Squirrel	0	0	0	1	0	0	0	0	0	2	S,F
Petaurista elegans	Lesser Giant Flying Squirrel	0	0	0	0	1	0	0	0	0	14	S,F
Hylopetes phayrei	Phayre's Flying Squirrel	0	0	0	0	1	0	0	0	0	1	H,S,F
	Squirrel	0	5	0	1	0	0	0	1	0	2,3	S,H,L,R,F,FL ,O
Suidae												
Sus scrofa	Common Wild Pig	0	0	22	1	3	0	0	0	3	1,2,3,5,14,21	S,H,L,R,F,FL ,O
Tragulidae												
Tragulus javanicus	Lesser Mouse Deer	0	0	1	0	2	0	0	0	0	1,5,14	S,H,L,R,F,O
Tragulus spp.	Mouse Deer	1	0	1	2	0	0	0	0	0	3,5,7	S,H,L,R,F,O
Tupaiidae												
Tupaia glis	Common Treeshrew	0	0	0	0	2	0	0	0	0	10,14	S,F
Tupaia spp.	Treeshrew	0	0	0	1	0	0	0	0	0	16	R,O
Ursidae												
Helarctos malayanus	Malayan Sun Bear	1	0	2	0	0	0	0	0	0	1,14	S,F,L,H,O
Selenarctos thibetanus	Asiatic Black Bear	2	0	5	0	0	0	0	1	5	1,2	S,H,F
UNIDENTIFIED	Bear	0	0	1	0	0	0	0	0	0	5	L,O

Viverridae												
ArctogaliDa trivirgata	Three-Striped Palm Civet	0	0	0	0	4	0	0	0	0	5,14	S,H,L,R,F,FL,O
UNIDENTIFIED	Civet	5	1	8	0	1	0	0	0	0	2,3,14,21	S,H,L,R,F,FL,N,O
Viverra zibetha	Large Indian Civet	0	0	0	1	1 (Trap camera	0	0	0	0	3,14	F,N
REPTILES												
Agamidae												
Physignathus cocincinus	Asian Water Dragon	0	0	0	1	10	0	0	0	2	1,5,10,14	O,R
Boidae												
Python reticulata	Reticulate python	0	0	0	1	0	0	0	0	0	2	R,O
Colubrine												
Pytos carinatus	Black Rat Snake	0	0	0	1	0	0	0	0	1	3,5	R
Rhabdopsis subminiatus	Red-Necked Keelback Snake	0	0	0	1	2	0	0	0	0	3,7,16	O
Elapidae												
Cobra spp.	Cobra	0	0	0	1	0	0	0	0	0	2	R,O
Ophiophagus hanah	King Cobra	0	0	0	0	1	0	0	0	0	7	O
Scincidae												
Mabuya multifasciata	Sun Skink (3)	0	0	0	0	3	0	0	0	0	2	
Varanidae												R
Varanus bengalensis	Yellow Tree Monitor	0	1	5	3	1	0	0	0	1		
Varanus salvato	Water Monitor	0	0	0	0	1	0	0	0	0	14	L,R

Species Name	English Name	Type of sighting							Observed in Land System	Observed in Habitat Type
		Call	Direct Sighting	Pug Marks	Scratching	Eggs	Feather	Specimen		
Megalaima asiatica	Blue Throated Barbet	9	0	0	0	0	0	0	2,3,5	Riverine, Forest
Megalaima asiatica	Blue Eared Barbet	2	1	0	0	0	0	0	5,20	Forest
Megalaima chrysopogon	Gold Whiskered Barbet	9	1	0	0	0	0	0	1,5,20,21	Riverine, Forest
Megalaima faiostricta	Green Eared Barbet	2	0	0	0	0	0	0	3	Riverine, Forest
Megalaima franklinii	Golden Throated Barbet	1	0	0	0	0	0	0	5	Riverine
Megalaima haemacephala	Coppersmith Barbet	3	0	0	0	0	0	0	1,5	Riverine
Megalaima incognita	Moustached Barbet	1	0	0	0	0	0	0	3	Forest
Megalaima rafflesii	Red Crowned Barbet	1	0	0	0	0	0	0	10	Forest
Megalaima spp.	Barbet	5	0	0	0	0	0	0	1,2	Riverine, Forest
Caprimulgidae										
Caprimulgus indicus	Grey Nightjar	0	7	0	0	0	0	0	1,5	Riverine
Chloropseidae										
Chloropsis cyanopogon	Blue Winged Leaf Bird	0	0	0	0	0	0	1	14	Riverine
Columbidae										
Chalcophaps indica	Green Winged Pigeon	1	2	0	0	0	0	0	1,5	Riverine
Ducula badia	Mountain Imperial Pigeon	1	2	0	1	0	0	0	1,10	Forest
Streptopelia orientalis	Oriental Turtle Dove	1	1	0	0	0	0	2	1,5,10	Forest
Streptopelia tranquebarica	Spotted Dove	0	1	0	0	0	0	1	14	Riverine
Treron bicincta	Orange Breasted Pigeon	0	1	0	0	0	0	0	10	Forest
Treron curvirostra	Thick Billed Pigeon	0	1	0	0	0	0	1	2,20	Forest
Treron vernans	Pink Necked	1	2	0	0	0	0	1	1,2,21	Forest

Species Name	English Name	Type of sighting							Observed in Land System	Observed in Habitat Type
		Call	Direct Sighting	Pug Marks	Scratching	Eggs	Feather	Specimen		
	Pigeon									
Corvidae										
Corvus macrorhynchos	Large-Billed Crow	0	1	0	0	0	0	0	1	Forest
Pica pica	Black-Billed Magpie	5	0	0	0	0	0	0	1, 2	Forest
Dendrocitta vagabunda	Rufous Treepie	1	0	0	0	0	0	0	1	Forest
Crrpsirina temia	Racket-Tailed Treepie	1	0	0	0	0	0	0	1	Forest
Cuculidae										
Phaenicophaeus tristis	Green-Billed Malkoha	2	2	0	0	0	0	0	1, 2	
Centropus sp.	Coucal	1	0	1	0	0	0	0	1, 2	Riverine
Centropus bengalensis	Lesser Coucal	2	1	0	0	0	0	0	1,2,5	Riverine
Centropus bengalensis	Greater Coucal	0	2	0	0	0	0	0	14	Riverine
Dicruridae										
Dicrurus aeneus	Bronzed Drongo	1	2	0	0	0	0	1	5,14	Riverine
Dicrurus macrocercus	Black Drongo	1	3	0	0	0	0	0	1,14,21	Riverine, Forest
Dicrurus paradiseus	Greater Racket Tailed Drongo	6	12	0	0	0	0	0	1,2,5	Riverine
Dicrurus remifer	Lesser Racket Tailed Drongo	0	1	0	0	0	0	0	14	Riverine
Eurylaimidae										
Psarisomus dalhousiae	Long Tailed Broadbill	0	1	0	0	0	0	1	14,20	Riverine, Forest
Hirundinidae										
Delichon dasypus	Asian House Martin	1	10	0	0	0	0	0	1,14	Riverine
Hirundo rustica	Barn Swallow	0	47	0	0	0	0	0	1,2,14	Riverine
Motacillidae										
Motacilla cinerea	Grey Wagtail	0	5	0	0	0	0	0	5,14	Riverine

Species Name	English Name	Type of sighting							Observed in Land System	Observed in Habitat Type
		Call	Direct Sighting	Pug Marks	Scratching	Eggs	Feather	Specimen		
Dendronanthus indicus	Forest Wagtail	0	0	2	0	0	0	0	1	Riverine, Forest
Muscicapidae										
Cyornis unicolor	Pale Blue Flycatcher	1	0	0	0	0	0	0	2	
Nectariniidae										
Aethopyga siparaja	Crimson Sunbird	1	0	0	0	0	0	1	5,20	Forest
Nectarinia asiatica	Purple Sunbird	1		0	0	0	0	0	1	
Oriolidae										
Irena puella	Asian Fairy Blue Bird	1	0	0	0	0	0	3	3,5,14	Riverine, Forest
Phasianidae										
Arborophila brunneopectus	Bar-Backed Partridge	1	0	0	0	0	0	0	1	Forest
Arborophila davidi	Scaley Breasted Partridge	3	2	0	1	0	0	1	1,14	Forest
Gallus gallus	Red Junglefowl	2	3	0	1	2	0	7	1,2,3,21	Forest
Lophura diardi	Siamese Fireback	0	10	0	0	0	0	1	1,10	Forest
Polyplectron bicalcaratum	Grey Peacock Pheasant	7	0	0	0	0	0	4	2,3,5,14, 16,20	Forest
Francolinus pintadeanus	Chinese Francolin	0	1	0	0	0	0	0	1	Forest
Pittidae										
Pitta phayrei	Eared Pitta	0	0	0	0	0	0	1	5	Forest
Pitta cyanea	Blue Pitta	1	0	0	0	0	0	0	1	Forest
Psittacidae										
Psittacula alexandri	Red Breasted Parakeet	0	1	0	0	0	0	0	14	Forest
Psittacula eupatria	Alexandrine Parakeet	0	1	0	0	0	0	0	5	Riverine
Psittacula finschii	Grey Headed Parakeet	0	20	0	0	0	0	0	2	Forest
Psittacula roseata	Blossom Headed Parakeet	1	51	0	0	0	0	0	1	Riverine, Forest
Pycnonotidae										
Criniger flaveolus	White Headed Bulbull	0	0	0	0	0	0	1	14	Riverine
Criniger flaveolus	White Throated	1	0	0	0	0	0	0	20	Forest

Species Name	English Name	Type of sighting							Observed in Land System	Observed in Habitat Type
		Call	Direct Sighting	Pug Marks	Scratching	Eggs	Feather	Specimen		
	Bulbull									
Pycnonotidae										
Criniger pallidus	Puff Throated Bullbull	2	1	0	0	0	0	0	1,2,14	Riverine
Hypsipetes flavala	Ashy Bulbull	3	2	0	0	0	0	0	1,2,14,21	Forest
Hypsipetes thompsoni	White Headed Bulbull	0	5	0	0	0	0	1	5	Forest
Hysipetes charlottae	Buff Vented Bulbull	2	0	0	0	0	0	4	2,14,20	Riverine
Pycnonotus atriceps	Black-Headed Bulbul	1	0	0	0	0	0	0	1	Riverine, Forest
Pycnonotus eutilotus	Puff Backed Bulbull	3	0	0	0	0	0	0	2,5	Riverine
Pycnonotus finlaysoni	Stripe Throated Bulbull	0	1	0	0	0	0	1	1,14	Riverine, Forest
Pycnonotus flavescens	Flavescent Bulbull	1	1	0	0	0	0	0	3,21	Riverine, Forest
Pycnonotus jocosus	Red Whiskered Bulbull	0	0	0	0	0	0	1	14	Riverine
Pycnonotus melanicterus	Black Crested Bulbull	8	3	0	0	0	0	0	1,3,5,14, 20	Riverine, Forest
Pycnonotus simplex	Cream Vented Bulbull	1	0	0	0	0	0	0	5	Riverine
Pycnonotus striatus	Striated Bulbull	2	0	0	0	0	0	0	2,10	Forest
Rallidae										
Amaurornis phoenicurus	White Breasted Waterhen	0	1	0	0	0	0	1	5,14	Riverine
Rostratulidae										
Rostratula benghalensis	Greater Painted Snipe	0	1	0	0	0	0	0	14	Riverine
Strigiformes										
Ninox scutulata	Brown Hawk Owl	0	0	0	0	0	0	1	14	Forest
Otus scops	Common Scops-Owl	1	0	0	0	0	0	0	1	Forest
Otus spilocephalus	Mountain Scops-Owl	0	1	0	0	0	0	0	1	Forest
Sturnidae										

Species Name	English Name	Type of sighting							Observed in Land System	Observed in Habitat Type
		Call	Direct Sighting	Pug Marks	Scratching	Eggs	Feather	Specimen		
Aplonis panayensis	Philippine Glossy Starling	1	0	0	0	0	0	0	1	Forest
Gracula religiosa	Hill Myna	3	3	0	0	0	0	0	1,2	Forest
Sylviidae										
Phylloscopus davisoni	White-Tailed Leaf-Warbler	1	1	0	0	0	0	0	1	Forest
Seicercus burkii	Golden Spectacled Warbler	0	0	0	0	0	0	1	14	Riverine
Timaliidae										
Gampsorhynchus rufulus	White Headed Babbler	1	0	0	0	0	0	0	16	Forest
Garrulax chinensis	Black Throated Laughingthrush	1	0	0	0	0	0	0	16	Forest
Yuhina gularis	Stripe Throated Yuhina	1	0	0	0	0	0	0	5	Riverine
Yuhina nigrimenta	Black Chinned Yuhina	1	0	0	0	0	0	0	5	Riverine
Garrulax leucolophus	White-Crested Laughingthrush	4	0	0	0	0	0	0	1, 2	Forest
Trogonidae										
Harpactes duvaucelii	Scarlet Rumped Trogon	0	0	0	0	0	0	1	20	Forest
Turdidae										
Copsychus malabaricus	White Rumped Shama	3	0	0	0	0	0	1	1,2,14	Forest
Myiophoneus caeruleus	Blue Whistling Thrush	0	0	0	0	0	0	1	5	Forest
Zoothera marginata	Dark-Sided Thrush	1	0	0	0	0	0	0	1	Forest
Turnicidae										
Turnix suscitator	Barred Buttonquail	0	0	0	0	0	0	2	2	Forest
Turnix tanki	Yellow Legged Buttonquail	2	0	0	0	0	0	0	2,20	Forest

Habitats of Particular Importance for Terrestrial Vertebrates

Most of the wildlife observed is not over-specialised in terms of the ecotypes available in the Nam Ngiep catchment surveyed. The exceptions are:

Giant Flying Squirrels and Phayre's Langur
These primates need fairly substantial areas of continuous tree canopy. When gaps appear between the crowns, and when the discrete area of continuous crowns decline below threshold levels, these animals cannot survive. We found only small areas of high quality tree canopy during the survey, and none of the area to be inundated can be considered as favourable to canopy primates or giant flying squirrels. An area needs to be located outside the catchment, with high quality canopy, which can be effectively protected. If there were a properly protected primate forest reserve it might be possible to translocate into it pockets of dwindling numbers of canopy species, isolated in deteriorating "canopy islands".

Water-Monitor
These species need permanent or almost permanent rivers and streams. In the extremes of the dry season they will tend to concentrate on the Nam Ngiep and its larger tributaries. At present their specific habitat requirements are not under threat. The conversion of the Nam Ngiep river to a reservoir will have a severe affect on these species, but will not eliminate them from the basin. It is not known how the reservoir, once it reaches biological stability, will perform as a habitat for water monitors.

Tiger and other large cats
The high levels of apparently uncontrollable hunting of the tigers food supply, and of the cats themselves, do not encourage one to consider the Nam Ngiep as a prime big cat habitat. The habitat changes which the reservoir inundation will bring about will not alter this position.

Elephant and Gaur
Both these species require degraded forest, with a balance of herbaceous and woody regeneration. One prime habitat was identified in LS2 through which at least 10 elephant, but possibly up to 100 migrate. The development of the Nam Ngiep Reservoir, and particularly the shallow water draw-down zones, could provide the type of habitat diversity which support elephant and gaur. It is recommended that studies and monitoring be undertaken with a view to determining if it is desirable or possible to use the reservoir and its environs (LS2/LS1) as an elephant and gaur reserve. Unfortunately the need to resettle a large population in the general vicinity of the reservoir will lead to serious difficulties in maintaining a reserve without very effective management. Some studies to see if elephant, at present resident in LS1 and LS2, can be moved into the Phou Khao Khouay NBCA a few kilometers to the west have also been recommended

Crocodile
This species, if it still survives in the Nam Ngiep, is probably limited by the scarcity of suitable egg-laying sites, and competition with visiting fishermen who fish the deep pools in the dry season. An ideal crocodile habitat was identified just below the proposed dam site although the last sighting was approximately 20 years ago. The actual inundation event might easily temporarily reduce the crocodile food supply to levels at which the species (probably almost extinct in the Nam Ngiep) disappears. The new reservoir environment could provide better egg-laying sites and, after reaching biological stability, more food. However the need to resettle a large population in the general vicinity of the reservoir and the inevitable development pressures that follow large infrastructure projects, will probably ensure that the crocodile's future is bleak.