Bach Ma National Park, Vietnam, 2002

THE TIGER (*Panthera tigris*) ECOLOGY IN BACH MA NATIONAL PARK

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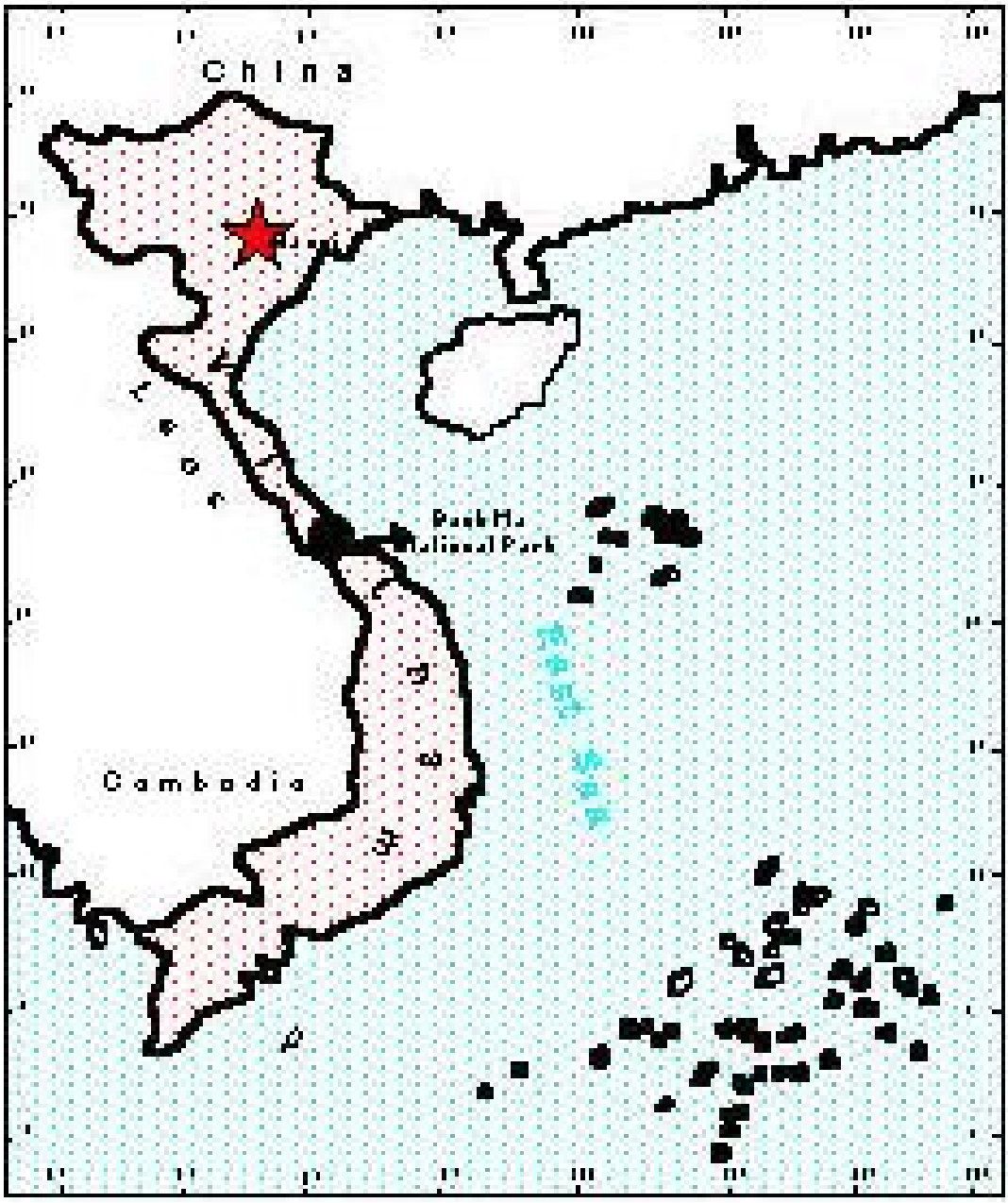
I. Introduction

Bach Ma National Park is one of the 18 national parks in Vietnam focused on high biodiversity with many rare and endangered species. It is located in central Vietnam, between the cities of Hue and Danang. It is entirely included in the province of Thua Thien Hue and demarcated on the east by the administrative boundary of Quangnam Danang province. A part of the buffer zone is actually within this province. The national park covers the territory of 3 districts and 10 communes. It is delimited on the north by the highway $N^0$1. The park's relief is very broken, with steep slopes, extending from almost sea level (20m) to mountains at about 1450m. the geological substrata is dominated by granite and yellow and red colored ferralitic soils. Forest forms the dominant vegetation, but it is found here at all stages of regeneration, from primary forest to grassland. The general aspect of the park is mountains covered with secondary growth and forests. The northern boundary comes down to a large lagoon.

The park is one main piece of a mosaic of natural relic forests. It is located in the heart of a narrow forest strip linking the ocean to the mountains of Laos. The green transect, although often degraded, is the last example of an east/west forested succession in Vietnam. Bach Ma National Park is a national institution and could oversee the network of existing protected areas constituted by Cu Lao Cham Island Nature Reserve, Son Tra Peninsula Nature Reserve, Hai Van Special Use Forest, Ba Na Nature Reserve, Bach Ma National Park and Xesap Sanctuary in Laos. Bach Ma mountains form with Hai Van and Ba Na mountains a biogeographical unit which should be monitored as such.

The fauna of Bach Ma National Park is very rich in variety of species and is one of the elements that form the biodiversity of the humid tropical forest ecosystem. The fauna of Bach Ma National Park with its particular characteristics is seen to represent the fauna of Central Vietnam. A total of 124 species of mammals, 333 species of birds, more than 500 species of insects and many species of reptiles, amphibians and invertebrates have been recorded there. Some of them are new species: such as Large-antlered Muntjac *(Megamuntiacus vuquangensis*), Saola *(Pseudoryx nghetinhensis)* and Truongson Muntjac *(Muntiacus truongsonensis*); There are also white-cheeked (Siki) gibbon (*Hylobates leucogenys* Siki), Red-shanked Douc langur (*Pygathrix nemaeus nemaeus*) and Pig tailed macaque (*Macaca nemestrina leonina*). Specially, existing populations of samba deer muntjac , wild boar, and barking deer constitute an adequate prey base for tiger conservation, although the diversity of prey has declined in the past 20 years with

the “functional” disappearance of wild cattle species, deer, and other large ungulates. The conditions noted above, will enable tiger management planning informed by good data which is essential to addressing the issues to supply species composition of their preys, the distribution status, density of population, supplying some ecological data and implementing a management plan for the conservation of Tiger in Bach Ma National Park, Thua Thien Hue, Vietnam.



Map 1: Bach Ma National Park in Vietnam

II. Natural resource

1. Climate

- Rainfall

The quantity of rainfall results from the particular geographical location of these mountains where the Annamitic Chain comes down to the sea, and from the cape profile of the coast where sea winds bump into the east-west facing mountains.

Locally, precipitation fluctuates according to relief, altitude and seasons. One notes a strong difference between the summit of Bach Ma (8000mm average annual rainfall) and Namdong located at the back of the park, (3500mm). September, October and November are the wettest months, while March and April are the driest. Variations in precipitation are important between the northern and southern parts of the park, mountains and lowlands, even though all areas are copiously watered.

- Humidity

Humidity is high all through along the year, although like rainfall it fluctuates according to seasons, altitude and localities: lower on the coast than at the top of the mountains which remain in the clouds notably during the rainy season and in winter. The drier season is obviously during the dry and hot season, from May to August.

- Temperature

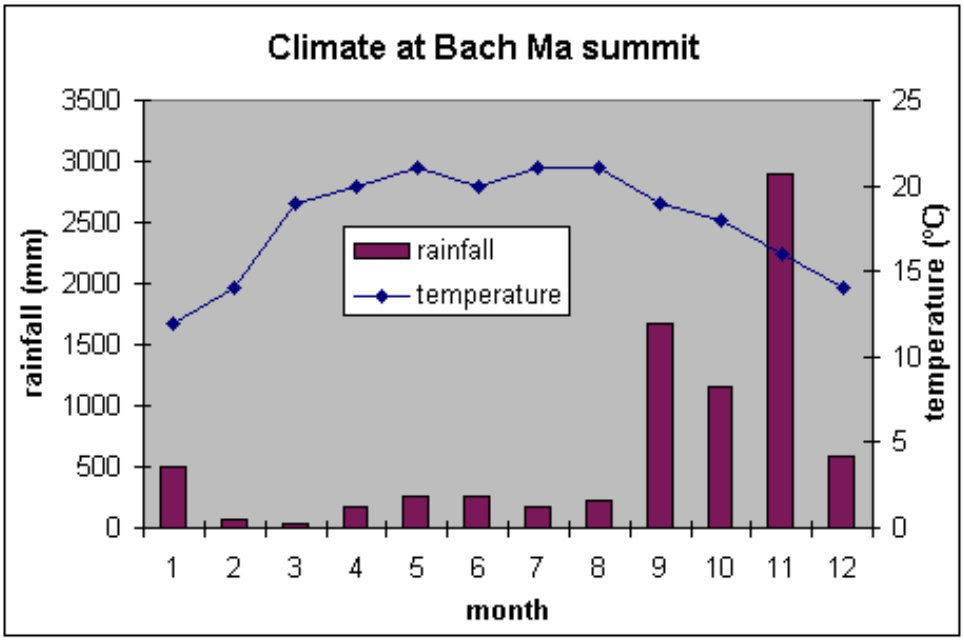
Temperature also vary according to seasons, altitude and localities, cooler in the mountains than in the lowlands. Mean annual temperature is 26^0C in Dannang and 18^0C in Bach Ma. The hottest season occurs in June-July, the coolest in December -February. For at least six months in the year, minimum temperature in Bach Ma is likely to deter from developing tropical tourism. Chimneys found in ruins of the villas were there to fight cold as much as humidity. Considering a tropical climate, temperature range is high between summer and winter.

- Monsoon

Tropical climate in Bach Ma region is characterized by two major weather patterns:

+ The wet monsoon, called north east monsoon, from September to April

+ The dry monsoon, called south-west monsoon, from May to August.



2. Geology, geomorphology and penology

- Geology and geomorphology

Bach Ma mountains belong to the Annamicte Chain, which is actually formed by a series of deeply eroded plateau with higher isolated massifs. The plateau extend quickly down to the Annam plain where they are intersected by narrow and deep valleys. On the Laotian side, the plateau decline slowly towards the Mekong valley and are indented by the long erosion of the tributaries of the Mekong river. Between the Annamite range and the China Sea lies the Annam plain, along strip extending a long the provinces of Quang Tri, Thua Thien Hue and Quang Nam Da Nang. It is cut in two when the Annamite Chain runs out into the sea and extends to islands off the coast.

Three types of landscape are found in the area of the park:

+ Very steep mountains with outcrop granite cliffs on the slopes

+ At the foot of the mountains, hills which slowly slope down towards the plain.

+ A very narrow coastal plain even missing in some parts.

+ A lagoon which is wide at this place (about 6 km) and is preceded by a longshore sand bar.

- **Penology**

The land located north of the park, bordering the lagoon up to the foot of the hills, consists of 3 types:

+ Alluvia in the lowlands occupied by paddy fields

+ Red and yellow podzolic soil on acidic rocks in the non flooding plain and uphill. Graves are usually dug there.

+ Regosol on yellow and white sand.

3. Forest status

Two types of forests are found in the park: the lowland tropical monsoon rainforest and the subtropical monsoon forest found at higher altitudes.

- **The tropical greenever monsoon forests**

Bach Ma National Park was created with the aim of preserving this specific forest habitat which is the richest in terms of biodiversity, but also the most threatened. There is no more undisturbed primary forest in the park, but well preserved sectors still remain where only selective logging of precious timber was carried out. Large areas have been logged or destroyed by defoliants. Nearly all the threatened and/ or endemic species occurring in the park are associated with monsoon forests. The stage of degradation has a great effect on productivity. Observing one individual of a species in degraded forest does not necessarily mean that the environment is able to sustain a whole population. The individual encountered could be imported from a better forested sector where breeding success is higher. The effect of forest degradation on the density of animal population is exemplified by the pheasant *Rheinartia ocellata.* This bird was recorded as common in primary forests, occasional in logged primary forests, occasional in old secondary forests and absent from secondary forests and scrubland (Truong Van La and Nguyen Cu, 1991)

- The subtropical evergreen monsoon forests

This type of forest is found at altitudes above 900m. It is restricted to a few hundred hectares at the summit of Bach Ma, but has been heavily disturbed at the time of the hill resort, then during the war.

It supports a specific flora and fauna found nowhere else. Several studies have shown the specificity of the montane stage and its complementarily with lowland forested habitats for conservation (Ngo Dac Chung et al 1994 concerning reptiles and amphibians, Monastryr skii and Bui Xuan Phuong 1996 concerning diurnal butterflies, Eve 1996 concerning birds, Mai Van Pho 1996 concerning Conifers).

Today hill and montane forests are threatened by an inadequate management of the park and by tourism infrastructure at the summit of Bach Ma. In order to ensure a full success to the conservation of montane forests, surrounding mounaints should be included in the national park. This would reinforce the mountainous character of the park and would increase the number of conservation spots.

Table 1: Forest states and their areas in Bach Ma National Park

Land and forest states	Area (ha)	Percentage (%)
Land with forest cover		
- Rich forest	2,705	12.28
- Medium forest	5,922	26.90
- Poor forest	6,530	29.65
- Young forest	1,743	7.89
Land without forest cover	5,131	23.28
Total	**22,031**	**100.00**

4 Population:

Total population is 79,921, with 16,591 households and a population-growth, rate of 2.3%

The people living in Bach Ma National Park as well as in the buffer zone are two types:

- Those whose livehoods depend maining on the forest (hunting, collecting), they usually have a low standard of living.
- Those who live by fishing Agriculture cultivation. Their fields are very small, production is low, and they are short of food, so they have to burn the forest for

cultivation. After crophavest, they encroach the forest for firewood and forest products, harvesting things such as rattan, palm leaf, dipterocarpus oil and resin for bird traps.

III. Expedition members

Ord.	Name	Main role
1	Van Ngoc Thinh	Team manager
2	Do Tuoc	Mammal classification
3	Tran Thien An	Flora classification
4	Le Quoc Khanh	Habitat research
5	Truong Cam	Patrol to stop illegal activities on forest
6	Vo Cong Chanh	Patrol to stop illegal activities on forest
7	Truong Ky	Carry food, Cook and guide staff in forest
8	Nguyen Van Thi	Carry food, Cook and guide staff in forest

IV. Fieldwork and research

1. Overall Aims

The need to focus on one aspect of tiger ecology is important. We propose to work in the most productive habitat of Bach Ma National Park which in total comprises about 42,330 ha of core and buffer zones. The main objective will be to document movement patterns of the tigers within this area, thereby permitting inference of:

1. habitat use through remotely triggered cameras and telemetry of tiger and their prey species;

2. population size during the tracking and monitoring;

3. prey characteristics from kill and scat analysis.

The habitats will be quantitatively delineated at a scale meaningful to tigers and prey through sampling of characteristic vegetation composition and structure. Such an approach will provide insights into the exact nature of recent declines, as well as set the stage for follow up work on prey populations.

2. Observed lines:

We have chosen two areas with 6 observation lines
There are 6 main observation lines, as follows:
(1). Line 1: Bach Ma summit- Coldebay**.** Two expeditions
(2). Line 2: Km 14 BachMa - Tri Sao waterfall. One expeditions
(3). Line 3: Km 14 BachMa - Truoi lake. One expedition
(4). Line 4: BachMa summit- Lien Chi slope. One expedition
(5). Line 5: Khe Ao - Truoi Lake. One expedition
(6).Line 6: Khe Ao – Coldebay. One expedition

3. Study methods

Seven infrared cameras will be placed along routes where tiger and their prey have been seen to record data and pictures. Members of the Forestry Inventory and Planning Institute, Hue University and Rangers of Forestry Protection Department of Thua Thien Hue and Quang Nam Provinces will simultaneously run random transects through the study area with permanent plots at intervals for reserve monitoring and evaluation. An evaluation of prey base will be made from sightings within the defined habitats and enumeration of signs (e.g. pellets in the dry season).

Along each observation line, we have observed and looked for footprints, droppings and other signs of animal as well as listening for calling and singing of all species. For each observation, we used the GPS machine to define the position of each species.

In addition, to gain more information about tigers, we interviewed hunters, lumbermen and local people who have a lot of experience and knowledge about wild animals.

V. Results

A. Results research:

1. Results of the interviews with hunters and other local people

INTERVIEW PAPER

(Local people)

Number: 01

- Name of lumberman : Nguyen Dinh Nam, age: 40
  Address: Huong loc village, Nam Dong district.
- Number of tiger seen: 03; prey eaten by tiger: 01, from 1997 to 2000

Dates	Numbers of tiger					Location and form of observation	Forest status
	Total	Male	Female	Young	Baby		
April 1997	01					Khe Ao, Nam Dong district. Forest block 1291. Direct observation.	Restored forest, vegetation has many reeds, shrubs.
July 1998	01					Khe Cat, forest block 1202. Direct observation.	Restored forest, vegetation has many reeds, shrubs.
November 1999	01					Khe Truong, forest block 1202. Observation: A Muntjac had been eaten by tiger on reeds.	Restored forest, vegetation has many reeds, shrubs.
May 2000	01			x		Khe Mon, forest block 1192. Direct observation.	Restored forest, vegetation has many reeds, shrubs.

INTERVIEW PAPER

(Local people)

Number: 02

- Name of hunter: Nguyen Van Thi, age: 42.
  Address: Thuong Lo village, Nam Dong district.
- Number of tiger seen: 03; prey eaten by tiger: 03, from 1995 to 2000

Dates	Numbers of tiger					Location and form of observation	Forest status
	Total	Male	Female	Young	Baby		
October 1995	01					Forest block 1219. A deer was eaten (half hind body) by tiger.	Rich forest.
February 1997	01					Coldebay area is contiguous to forest of Da Nang province. Forest block 1202. Direct observation.	Medium forest restored after selective exploitation, the vegetation has many reeds, alang grass, shrubs.
December 1999	01					Khe Ao area, forest block 1200, near stream. A deer was eaten by tiger, the parts of body were head and front leg.	Restored forest after selective exploitation, the vegetation has many reeds and shrubs.
September 2000	02		X		X	Phuong waterfall area, forest block 1195. Direct observation.	Medium forest, the vegetation has many creepers and shrubs.

INTERVIEW PAPER

(Local people)

Number: 03

- Name of hunter: Truong Ky, age: 53
  Address: Loc Dien village, Phu Loc district.
- Number of tiger seen: 02; prey eaten by tiger: 01, from 1995 to 1998

Dates	Numbers of tiger					Location and form of observation	Forest status
	Total	Male	Female	Young	Baby		
February, 1995	01			x		Bach Ma Coldebay area, forest block 1198. Direct observation.	Medium forest, the vegetation has many creepers and bush.
July, 1996	01					Forest block 1177, near Truoi lake. A serow weighing about 80 - 100 kg which was eaten by tiger.	Restored forest, the vegetation has many creepers and shrubs.
November 1998	01	x				Forest block 1196. Direct observation.	Poor forest, there are scattered small trees, creepers and shrubs.

INTERVIEW PAPER

(Local people)

Number: 04

- Name of hunter: Klon A Luon, age: 47
  Address: Thuong Long village, Nam Dong district.
- Number of tiger seen: 03, from 1995 to 2000

Dates	Numbers of tiger					Location and form of observation	Forest status
	Total	Male	Female	Young	Baby		
December 1998	02		x		x	Bach Ma - Coldebay area, forest block 1198. Direct observation of mother and baby tiger.	Poor forest, the vegetation has many reeds, shrubs.
October 2001	01					Forest block 1202, Khe Truong. Direct observation of a tiger drinking water from stream.	Restored forest with many creeper and bush.

So, from the results of the above interviews, we can conclude that at Bach Ma National Park there is the presence of Tiger including in recent years. As Tigers require a very large territory, they pass through nearly all the areas, and are active in every habitat in the Park. They appear especially to be present in the areas Khe Ao, Khe Truong - Coldebay Nam Dong, and the area near Truoi lake. These areas include a lot of different forest habitats: rich forest, medium forest, poor forest and restored forest, although restored forest is dominant and the vegetation includes a lot of reeds, creepers and shrubs. At the same time the topography in these areas is not very complicated, only a little steep with a lot of streams, so many prey animals look for food, especially in the rainy season. According to the above results Tigers are seen in most months in the year, however they are easier to see in the rainy season (from September to February the following year). The Tigers are seen in the areas of reeds or along the streams while they are wandering looking for food at night. According to the interview reports, Tiger numbers have been decreasing over time, as in recent years local hunters have been seeing fewer Tigers than before. The Tiger's environment had been influenced by the activities of man (hunting, logging) and their source of food has decreased so they are now active over larger areas in order to hunt for prey and hide. Although in recent years the work of

management and protection of Bach Ma National Park is very good, in the neighboring areas of the forest (Forest enterprise: Phu Loc, Khe Tre, Nam Dong (Thua Thien-Hue province) and Song Nam (Da Nang city)) exploitation of wood by machine is still carried out so it is clear that the environment of wild animal is influenced.

These are only the results collected through the process of interview, but are the basis for the field investigations in order to build a strategy for conservation of the species of Tiger and its prey.

2. Results of the field surveys

Before starting the study, we had a training day for all personnel participating in the investigations in using the automatic camera and recording the data. In addition the training covered recording and identification of animal species from signs such as footprints, excrement, voice. At the same time, this course of training was an occasion for exchanging experience with specialist Do Tuoc.

We conducted 7 fields surveys and set the camera traps following the 6 main observation lines.

- Line 1: Bach Ma - Coldebay, through forest blocks 1197, 1198 and 1201. Total length of line is 15 km, inclusive of 5 cross-cutting subsidiary lines. Number of surveys: 2.

  + First survey: 8 days (from 7 to 15 July 2001). Participants: 8 people, including Mr Do Tuoc (Forestry Inventory and Planning Institute), 3 members of science research department of Bach Ma National Park, 2 forest guards and 2 guides/ porters.

  + Second survey: 7 days (from 12 to 19 August 2002). Participants: 7 people, including 3 members of science research department of Park, 2 forest guards and 2 guides/ porters.

- Line 2: Km 14, Bach Ma road- Tri Sao waterfall, through forest blocks 1176 and 1175. Total length of line is 6 km, inclusive of 4 cross-cutting lines. Time of investigation: 6 days (from 19 to 25 August 2001). Participants: 6 people, including: 3 members of science research department of Bach Ma National Park, 2 forest guards and 1 guide/ porter.

- Line 3: Km 14, Bach Ma road - Truoi lake, through forest blocks 1176, 1177 and 1197. Total length of line is 15 km, inclusive of 6 cross-cutting lines. Time of investigation: 7 days (from 09 to 16 October 2001). Participants: 7 people, including 3 members of science research department of Bach Ma National Park, 2 forest guards and 2 guides /porters.

- Line 4: Bach Ma summit - Doc Lien Chi, through forest blocks 1197, 1196 and 1177. Total length of line is 15 km, inclusive of 6 cross-cutting lines. Time of investigation: 7 days (from 09 to 16 October 2001). Participants: 7 people, including 3 members of science research department of Bach Ma National Park, 2 forest guards and 2 guides /porters.

- Line 5: Khe Ao - Truoi, through forest blocks 1199, 1200 and 1196. Total length of line is 16 km, inclusive of 5 cross-cutting lines. Time of investigation: 7 days (from 10 to 17 March 2002). Participants: 8 people, including Mr Do Tuoc, 3 members of science research department of Bach Ma National Park, 2 forest guards and 2 guides/ porters.

+ Line 6: Khe Ao - Coldebay, through forest blocks 1203, 1201 and 1202. Total length of line is 14 km, inclusive of 6 cross-cutting lines. Time of investigation: 7 days (from 02 to 09 May 2002). Participants: 7 people, including 3 members of science research department of Bach Ma National Park, 2 forest guards and 2 guides/ porters.

Table 2: General dates, areas of investigation and investigators

Date of survey	Survey line	Investigators
7-15 July 2001	Bach Ma - Coldebay	Thinh, Khanh, An, Do Tuoc, Cam, Cai Anh and 2 local people
12-19 August 2002	Bach Ma - Coldebay	Khanh, An, Tho, Cam, Chanh and 1 local person
19-25 August 2001	Km 14 Bach Ma road - Tri Sao waterfall	Thinh, Khanh, Hung, Cam, Thu and 1 local person
9-16 October 2001	Km 14 Bach Ma road - Truoi lake	Thinh, Khanh, Hung Lanh, Tuong and 2 local people
5-13 December 2001	Bach Ma - Doc Lien Chi	Thinh, An, Tho, Cam, Phuong and 2 local people
10-17 March 2002	Khe Ao - Truoi lake	Do Tuoc, Thinh, Khanh, Tho, Chanh, Tuong and 2 local people
02-09 May 2002	Khe Ao - Coldebay	Thinh, Khanh, Hung, Cam, Chanh and 2 local people

2.1. Habitat

2.1.1. Sub-tropical evergreen monsoon forest:

This type of forest is distributed at altitudes above 900 m, the vegetation is mainly from the following families: Podocarpaceae, Fagaceae and Theaceae, Magloliaceae with species including Bach Ma pine (Dacrydium elatum), Castanopsis chapaensis, Gordonia axillaris, and Podocarpus imbricatus. Here Dacrydium elatum is a dominant species, creating forest stands around mountain tops.

However, this type of forest usual see stand of forest sexual reproduction between Gymnospermae and Angiospermae. The species composition of plant are very rich and diversified in here. There are 3 main states: Young forest, poor forest and medium forest. Generally, in areas to be of this forest type usual seeing some species of Squirrel and species of primates order.

2.1.2. Tropical evergreen monsoon forest

This type of forest is distributed at altitudes up to 900 m, terrain is few full of obstacles and difficult of access. This forest type has large area. It includes species from the following families: Dipterocarpaceae, Sapindaceae, Fabaceae,... and some trees of species have big size such as *Parashorea chinensis*, *Hopea siamensis* Heim are a dominant species. The fauna and flora are very rich, diversity in here

All above forest type, base oneself on classifiable standard of Loetchau, There are 4 states as follows:

- Young forest (Restored forest)

The forest have become by war and exploited by human. We see species such: Macaranga denticulata Muell, Prltophorum dasyrrachis Kurz, Litsea glutinosa Rob, Endospernum chinensis Benth, Ormosia inflata Merr, Croton argyratus BL. Beside, the height areas, species of bamboo are strong developing. The lowland has many shrubs, creepers, reeds. We often saw species hoof such as wild Pig, Sambar Deer, Common Barking Deer.

- Poor forest:

This forest is not concentrated distribution. They become by preal dioxin and exploitation. Some big woody trees has good quality which had been cutting; the creeper, shrub are strong developing, species of flora is very rich, diversity, usual seeing species of bamboo and shrub. Some species of animal had seen in this forest.

- Medium forest:

Forest exists in this state because it was influenced by war or exploited for big timber trees. The species composition and the structure of canopy layers as a whole are the same as the rich forest. This type forest dispose almost at altitudes of mountain and the species of Dipterocapaceae, Euphorbiaceae, Fabaceae, Sterculiaceae, Lauraceae are dominant with vegetation cover being 50-60%.

- Rich forest:

This forest not influenced strong by human and distributed from 200 m 800m high. This forest, the species of angiospermae, such as Dipterocarpaceae are dominant. The forest have developed stable, canopy cover are very large and have many big woody trees. Seeing many animal, specially, primates had seen in this forest.

2.2. Occurrence and distribution of Tiger (*Panthera tigris*) and its prey species

The results were obtained through the research and surveys on the six trails, including identifying signs such as mammal tracks and dung as well as listening for the vocalization of animals, then recording and analyzing the sound. With the automatic camera traps, we have caught sight of some animals in the park on the research trails. To record the geographic coordinates of each individual seen on the trails we used GPS. After collating and analyzing the data, we now have the results: the total of animals seen during the research is 44 species, in which there are 7 species of primates, and 37 other species (see appendix for full list).

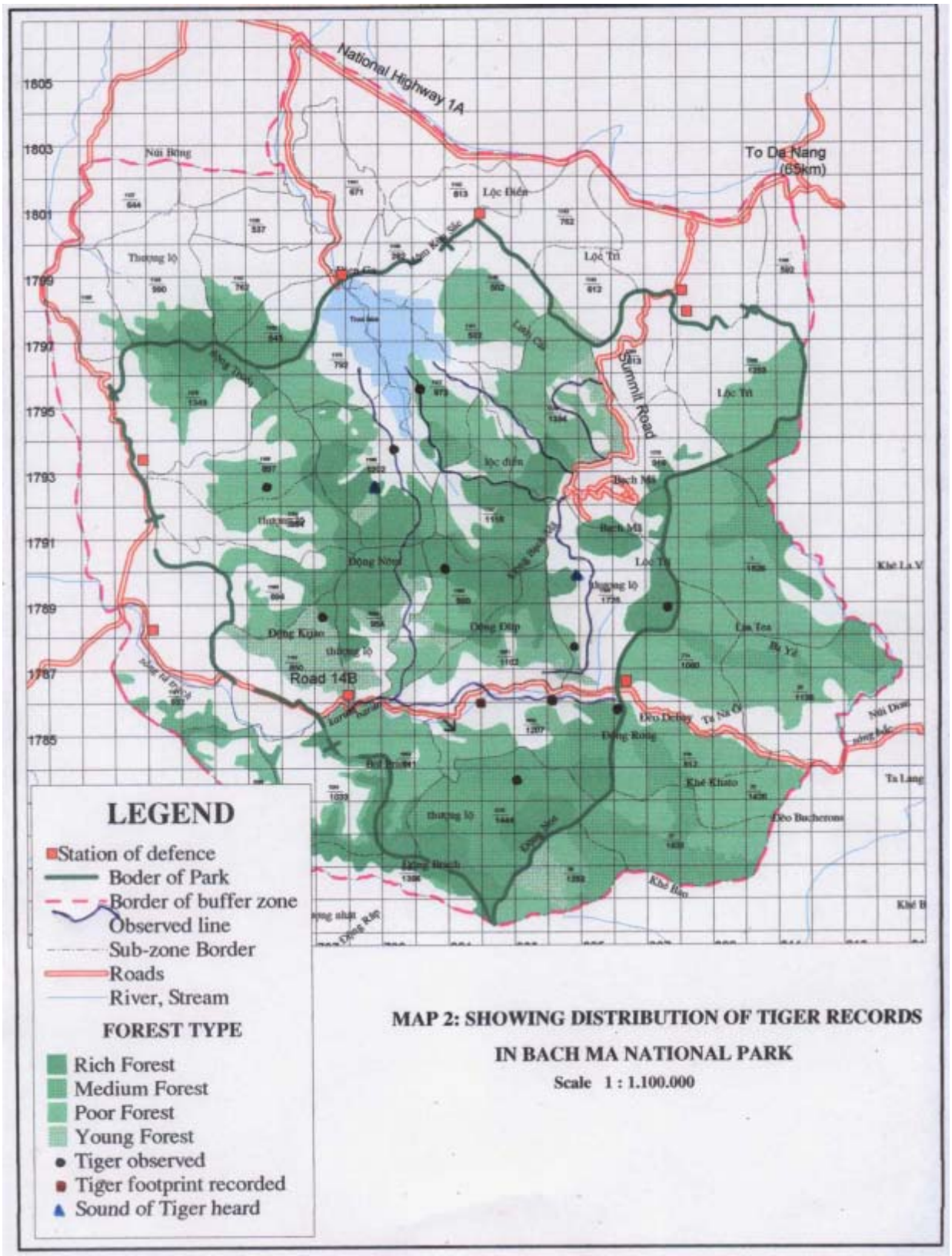
Some animals have been photographed with pictures such as: Wild Pig, Sambar Deer and Common Muntjac (see appendix for list). Other species were identified either from direct sightings, or from signs left on the trails such as foot prints, dung, scratch marks on trees, newly dug-over earth etc.

While surveying on trail 6, we found Tiger tracks close to the streams at Khe Truong, in forest block 1202 (see figure) with these measurements: 13.5 cm length, 12.6 cm width. The forest is in restoration phase with vegetation of many climbers, reeds and bushes. Covered with many young, fast growing trees, the forest here is dominated by species of Euphorbiaceae, Rubiaceae, Sterculiaceae, Myrtaceae and Rutaceae. This type of forest used to be destroyed by local people in the years before, but the situation has been getting better especially since the establishment of the National Park. Based on the identification of Tiger, we could conclude that this is the track of a mature Tiger, with the body length of about 1.8-2 m and weighing about 150-180 kg.

Moreover, whilst surveying on trails No. 1 and No. 5, we caught the sound of a mature Tiger. At the forest unit 1198 on trail No.1 we heard roaring, and in the forest unit 1200 on trail No.5 we heard another sound which may be the sound from a Tiger's prey. These two sounds happened at night, and perhaps it was the time when the Tiger was hunting. As we know, the Tiger is a solitary and nocturnal animal. The ecology of the two above areas is similar, under the altitude of 900 m, with average forests. This type of forest has abundant timber trees, of various diameters, some are big trees with the diameter of 35-40 cm, and height of 20-25 m. Dominated by Dipterocarpaceae, Euphorbiaceae, Lecythidaceae, Fagaceae, Clusiaceae, Rubiaceae, Sterculiaceae, Fabaceae and Lauraceae, the vegetation cover consists of climbers and bushes. This ecology system seems not be much impacted by human beings, but might be a little destroyed by bombing in the war.

Furthermore, from the results of interviews with hunters and foresters, and discussion with local people, we acknowledge that recent Tiger sightings were from the areas of Khe Ao, Khe Truong, Coldebay, and also nearby Truoi Lake. The highest frequency of Tiger occurrence is in Khe Ao, Khe Truong, Nam Dong district. It could be concluded that Tiger often roam in these areas. In the past, at these areas people have found Sambar (*Cervus unicolor*), Common Muntjac (*Muntiacus muntjac*) and Serow (*Capricornis sumatraensis*) preyed upon by Tiger, finding the remains of heads, legs, horns and bones. Tigers often hunt in vegetation of thatches, reeds and bushes, or close to streams and small rivers, which is understandable because these areas are often foraged by the prey species. While surveying, we often saw the tracks and dung of mammal species of Artiodactyla such as Sambar (*Cervus unicolor*), Common Muntjac (*Muntiacus muntjac*) and Serow (*Capricornis sumatraensis*).

Map 2. For larger image click here.



2.3. Density of Tiger prey species:

From the data found on all survey trails we see that the Artiodactyla species are the main food of Tiger such as: Wild Pig (*Sus scrofa*), Sambar (*Cervus unicolor*), Common Muntjac (*Muntiacus muntjac*), Serow (*Capricornis sumatraensis*) and Lesser Mouse Deer (*Tragulus javanicua*). Samples of heads, horns and bones of these animals are often found left on the ground after being killed and preyed on by Tiger on the trails or in the survey areas. It could be concluded that these species are the best animals that the Tiger feeds on.

Simultaneously the research shows that the Tiger's prey species are widely distributed in the park. They are Common Wild Pig (*Sus scrofa*), Sambar (*Cervus unicolor*), Common Muntjac (*Muntiacus muntjac)* and Serow *(Capricornis sumatraensis),* among them Wild Pig *(Sus scrofa*) is the one of highest sighting and widest distribution.

The results of the geographical survey also show that most of the mammals are solitary, except those which live mainly in trees such as primates, squirrels, and species of Rodentia. Some other species such as Common Wild Pig (*Sus scrofa*), Sambar (*Cervus unicolor*) and Common Muntjac (*Muntiacus muntjac*) occur in small groups and are often found in areas near streams and small rivers. Besides being sighted, many signs of digging and foraging for food of Common Wild Pig (*Sus scrofa*) and Sambar (*Cervus unicolor*) are found on the research trails. It seems that greater numbers and variety of species of Artiodactyla are sighted in the areas of Nam Dong and Truoi Lake vicinities, forests with altitudes under 900 m (found on trails 1,3,4,5,6), than in the surrounding summit and administrative areas. This is appropriate to the practical condition of the latter areas: the forest ecology, topography, geography and environment of these areas are all disturbed. With this conclusion, we could see that, at Bach Ma National Park, most of the mammals are distributed in all types of forests, significantly in the lower impact forest or areas near streams, where a variety of vegetation mean wild animals can live, hide or feed.

In order to quantify the density of species of Artiodactyla seen in the survey areas, we used the formula:

$$M_{MG} = \frac{\text{Total of } \textit{Artiodactyla}}{\text{Total of study area}}$$

In which:

Sl: total of *Artiodactyla* numbered by counting all individuals on survey trails (trail 1 only counted one time)

$Sl = Sl_1 + Sl_2 + Sl_3 + Sl_4 + Sl_5 + Sl_6 = 12 + 8 + 16 + 15 + 16 + 19 = 86$ individuals.

Total survey areas counted by addition of all six trail areas. Area of each trail: Area = length of trail x 0.2 km (average width of trail)

$A = A_1 + A_2 + A_3 + A_4 + A_5 + A_6 = (15 \times 0.2) + (6 \times 0.2) + (15 \times 0.2) + (12 \times 0.2) + (16 \times 0.2) + (14 \times 0.2) = 15.6$ km^2.

$$M_{MG} = \frac{86}{15.6} = 5.5 \text{ individual/ km}^2.$$

This is just preliminary and relative counting since most of the animals move freely in the areas. Moreover there are problems of limited visibility associated with the inaccessibility and difficulty of topography and geography of the survey areas of Bach Ma National Park in particular, and evergreen tropical rain forests in general. However, the above results show the high density of *Artiodactyla* species in Bach Ma, which appear to be abundant food for Tiger.

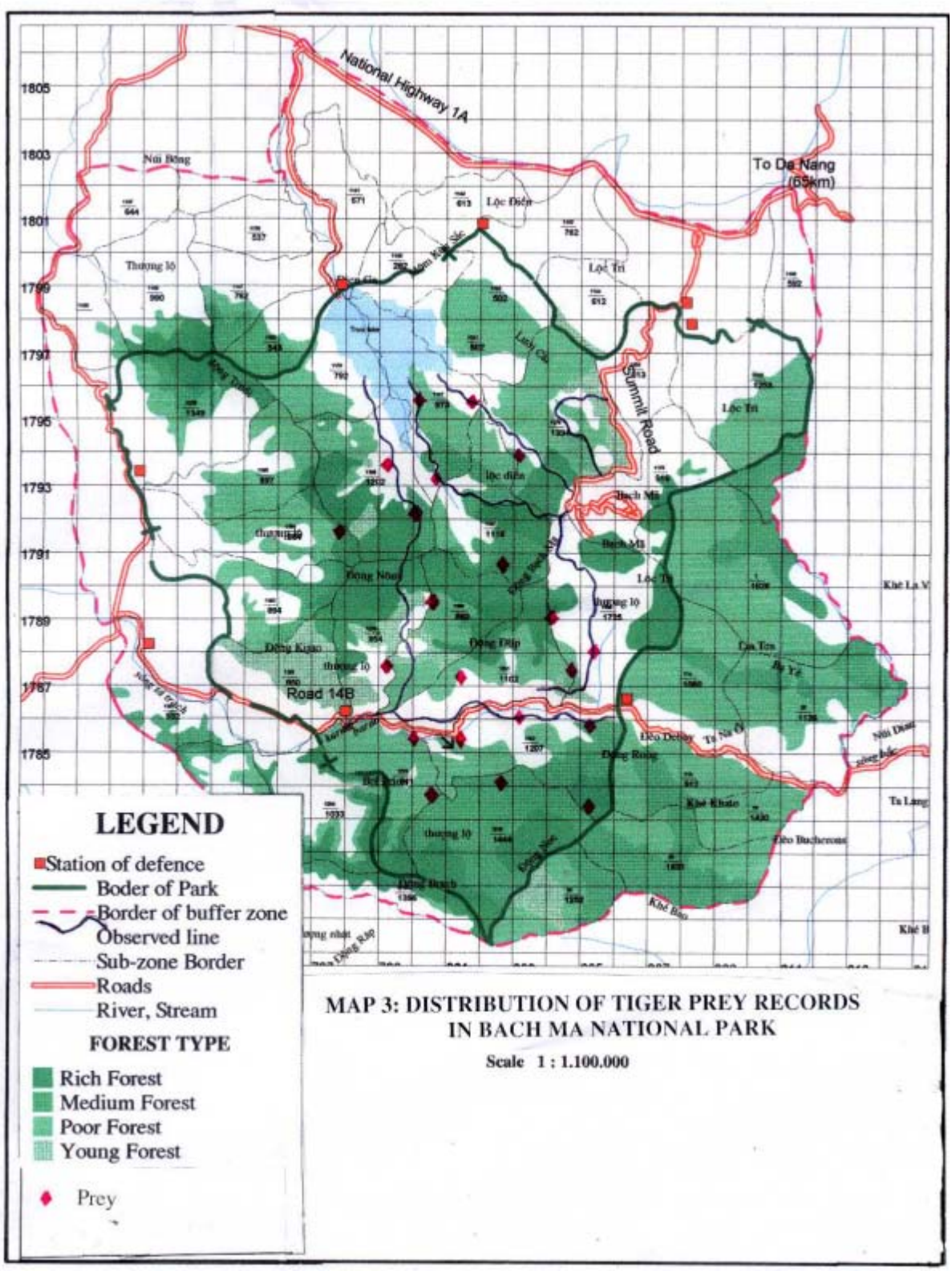
Furthermore, most of the other wild animals seen during the research are food for Tiger such as: Sunda Pangolin (*Manis javanica*), Small Indian Civet (*Viverricula indica*), Binturong (*Arctictis binturong*), species of Rodentia etc. However, due to the limited time and frame of project, we are not able to research the density and distribution of the all above species.

With the satisfactory result, there is rich food resource for Tiger at Bach Ma. This is one of the important conditions for Tigers to live in an area. If the density of prey is low, Tigers must move further to look for food.

Through the interviews and geographical research, with camera traps set in the field, we can conclude that there are about 2-3 Tigers in Bach Ma National Park and the vicinity. Two areas where Tigers are most found are Khe Ao, Khe Truong and Coldebay in Nam Dong district. These are bordered with green forest ranges in the districts of Nam Dong and A Luoi in Thua Thien Hue province, and Hien and Giang in Da Nang province, and the Viet - Laos boundary. This range of forest is rather large, rich in biodiversity and ecology, and includes rich forests (forests with

low impact by people), poor forests (forests with selected timber cutting), regenerating forests (forests previously much destroyed by people's exploitation and slash and burn activities), and some plots of grasses, reeds and bushes. The topography is not so complex, with few steep cliffs and high mountains, many rivers and streams. This factor, together with the rich food resources (high density of Common Wild Pig (*Sus scrofa*), Sambar (*Cervus unicolor*), Common Muntjac (*Muntiacus muntjac*) etc) mean the conditions are suitable for Tiger.

Map 3:For a larger image click here.



B. Threats to the Tiger population and conservation options:

1. Threats:

As far as we know, there are many reasons to endanger the number of Tiger in Bach Ma National Park, significantly:

+ Pressure of hunting Tiger and its prey species:

- Hunting and trapping are the main factor to decrease the number of Tiger. The high value of Tigers have stimulated local people in illegal hunting and poaching.

- Species of animals which are the main food of tiger (prey) are considerably dwindling due to their limited habitat caused by the high pressure of illegal hunting at present. The park has conducted many plans to curtail hunting activities; however, there are still hunters and poachers because of the park's forest guard shortage.

- Wildlife meat is still sometimes sold at some restaurants in Nam Dong and Phu Loc. Moreover, illegal wildlife trading to China, especially in rare and precious species with high economic value, such as those used in medicines (bear, tiger) still exists. Tiger can bring much money to the trader. The park staff has made their best effort to stem the illegal trading activities; many traders have been captured and sentenced.

+ Loss of habitat

This is the main cause of danger to all species of wildlife as well as Tiger. The park guard force is working hard to stop the illegal harvesting of timber in the park, and now it is only hand-exploitation and on a small scale. Moreover, Re Huong tree is cut and processed in stoves to get oil, and people still come to the forest to cut down trees (by saw or axe), and to collect other forest products such as rattans, palm-leaves and bee-honey. All these activities happening in the park have a negative impact on the habitat of Tiger and its prey species.

2. Achievements of conservation:

To conserve and protect Tiger in Bach Ma, the project has partly contributed to conservation by the following activities:

- While researching in the forest we found and removed a number of traps, and also discovered and stopped some illegal hunters and foresters.

- Destroying all the Re Huong stoves in the forest, and now these activities have been stopped.

- Held a training course on Tiger conservation awareness for local people, aimed at educating people to improve awareness about tiger conservation as well as other wild animals, and improve local understanding of nature conservation.

VI. Conclusions and comments:

1. Conclusions:

All the above results have been achieved through implementing the project, and in a short time the project has brought some considerable outcomes:

+ On research:

The initial research has got some information and believable figures by interviewing local people. The field observation, especially camera traps, have shown us the park, the ranges of the last remaining green forest transect in Vietnam, the centre corridor of tiger, contains favorable conditions for Tiger, with good habitat, rich in number and species of Tiger prey. Only in a short time of research, we have recorded 44 species of mammals in the park, in which those belong to *Artiodactyla* (main food for Tiger) have a high density.

Though the field surveys only recorded the tracks and roar of Tiger, with the results of interviews we could conclude that at the present time there are still 2-3 Tigers moving and roaming in the park border and the vicinity. If the Tiger habitat was kept in good condition, and if we have more professional programmes with bigger scale and longer time frame, we are sure that the identification of Tigers will be more comprehensive.

Identification of the areas where Tigers move and live in the park, and the ecology and density of prey, form a basis for future work of the park with more methodology of monitoring, management, and conservation.

It is clear that in order to conserve the Tiger, a precious and rare animal in endanger of extinction, we need to consider the Tiger habitat and its prey.

+ Public Awareness:

Through the interviews, we took time to raise the awareness of hunters and other illegal forest users of the importance of wildlife conservation to save the lives of precious species as Tiger, Sao La, Bear, Red-shanked Douc Langur and Edward’s Pheasant from extinction. What we do is try to encourage hunters to stop their illegal activities and then start to protect the species which they have hunted in the past.

In coordination with the local authorities, we have held training courses raising the public awareness of natural resource conservation and biodiversity

protection with some local communities. The aim was to help them to have a better understanding of the role of each species, the mutual relationship between species, the ecology and threat of extinction of some species, including the Tiger which is on the list of species threatened with extinction.

2. Recommendations

To ensure the park conservation work improves its effectiveness, we have the following suggestions:

- The Forest Guards (rangers) force should be more intensive in patrolling and preventing the trapping of wild animals, cutting of timber and harvesting of other forest products in the park.

- There is a need for close cooperation between the park and local authorities and other organisations in the area to work together to limit the pressure on the park from hunting, poaching and illegal logging.

- Intensify the education activities on forest protection and biodiversity conservation for local communities and schools in the buffer zone. At the same time, encourage local people to make a commitment not to carry out illegal activities (including hunting) in the park.

- We need to have research and more professional studies on the precious wildlife in the park, especially the species in danger of extinction. There is also a requirement for a general study of the presence and distribution of species within the park to complement and complete the wildlife list for Bach Ma.

Photo 1: Habitat in Khe Mon

Photo 2: Sambar in forest

Photo 3: Habitat of young forest

Photo: Habitat in Coldebay area

Photo 4: Animal skulls, collecting in forest

Photo 6: Set up camera trap

Photo 7: Red Shanked Langur

Photo 8: Tiger footprint in beside stream

Photo 10: Stump-tailed Macaque

Photo 11: Northern Pig-tailed Macaque

Appendix I: Camera - trap Data

Species	**Camera trap number**	**Coordinates**	Status of forest	**Date** (dd/mm/yy)	**Photo taken**	
					day	**night**
Sus scrofa	2	801,5:1793,2	Medium forest	10/2/01		x
	7	802,0:1787,3	Medium forest	6/5/02		x
Cervus unicolor	4	799,8:1789,9	Medium forest	13/3/02		x
Ursus thibetanus	5	802,8:1793,4	Rich forest	13/10/01	x	
Muntiacus muntjak	6	802,7:1796,7	Young forest	15/10/01	x	
	4	803,8:1786,6	Medium forest	7/5/02		
Capricornis sumatraensis	3	798,7:1788,4	Young forest	12/3/02	x	
Tragulus javanicus	3	805,2:1788,9	Medium forest	22/8/02		x
	7	800,5:1784,2	Young forest	4/5/2002	x	

Appendix II: Wildlife observation paper on survey lines

WILDLIFE OBSERVATION PAPER

Line 1: Bach Ma Summit – Coldebay.
Date: 07th – 15th July 2001
Investigators: Do Tuoc, Van Ngoc Thinh, Le Quoc Khanh, Tran Thien An, Truong Cam, Cai Anh.
Weather: warm sunshine and no rain.

Date	Hour	Coordinates	Species	Number	Form of record	Status of forest
07 July	16h08'	803,1:1791	Sus scrofa	3	Direct observation Sign	Medium forest
08 July	5h35' 6h08' 17h02	803,6:1791 803,8:1791 803,5:1790,5	Macaca arctoides Tamiops rodolphei Cervus unicolor	4 - 6 5 1	Direct observation Direct observation Droppings, Sign	Rich forest Rich forest Medium forest
09 July	7h25' 15h10' 16h14'	803,7:1790,3 804,2:1790,0 804,0:1790,1	Viverricula indica Muntiacus muntjak Ptaurista petaurista	1 1 x	Direct observation Hear sound Direct observation	Rich forest Rich forest Rich forest
10 July	8h03' 8h30' 15h38'	804,5:1790,0 804,9:1789,7 804,7:1789,5	Capricornis sumatraensis Lepus peguensis Macaca mulatta	1 1 2	Skull, bone, Sign Direct observation Direct observation	Medium forest Medium forest Medium forest
11 July	6h30' 7h05' 17h00' 20h15'	804,7:1789,5 804,8:1789,2 805,0:1789,0 805,5:1789,0	Rattus moliculus Dremomys rufigen Tragulus javanicus Pathera tigris	3 2 1 1	Direct observation Direct observation Direct observation Hear sound	Medium forest Medium forest Medium forest Medium forest
12 July	13h15' 16h30'	805,1:1788,7 805,3:1788,5	Ursus thibetanus Megamuntiacus	x 1	Sign Direct	Medium forest

			vuquangensis		observation	Medium forest
13 July	7h07' 10h30' 15h40'	804,7:1788,5 804,3:1787,9 804,5:1786,8	Sus scrofa Artictis binturong Muntiacus muntjak	2 1 1-2	Sign Direct observation Sound, droppings	Poor forest Poor forest Young forest

Note: x: No exact number.

WILDLIFE OBSERVATION PAPER

Line 1: Bach Ma summit – Coldebay.
Date: 19th – 25th Aug, 2002
Investigators: Le Quoc Khanh, Tran Thien An, Nguyen Le Tho, Truong Cam, Vo Cong Chanh.
Weather: warm sunshine and no rain.

Date	Hour	Coordinates	Species	Number	Form of record	Status of forest
13 Aug.	11h00' 13h15' 17h30'	804,2:1790,3 804,8:1790,1 803,5:1790,4	Petaurista petaurista Hylobates leucogenys Sus scrofa	2 x 2-3	Direct observation Hear of calling Sign	Rich forest Rich forest Medium forest
14 Aug.	7h05' 7h30' 9h23'	805,4:1789,1 805,3:1789,7 804,6:1790,0	Martes flavigula Cuon alpinus Macaca arctoides	1 1 2	Direct observation Footprint Direct observation	Medium forest Medium forest Rich forest
15 Aug.	7h05' 11h20' 18h07'	804,9:1789,4 805,8:1788,7 805,2:1788,9	Nycticebus pygmaeus Pygathrix nemaus Tragulus javanicus	2 x 1	Direct observation Direct observation Photo-trap picture	Medium forest Medium forest Medium forest
16 Aug.	8h30' 17h00'	805,4:1788,5 804,7:1787,2	Neoofelis nebulosa Cervus unicolor	1 1	Footprint, droppings Direct observation	Medium forest

	19h15’	805,5:1787,3	Rattus moliculus	5	Direct observation	Poor forest Poor forest
18 Aug	6h10’ 14h30’	804,5:1786,7 804,0:1787,5	Cervus unicolor Sus scrofa	2-3 1	Footprint Direct observation	Young forest Young forest

Note: x: No exact number.

WILDLIFE OBSERVATION PAPER

Line 2: Km 14 Bach Ma road – Tri Sao Waterfall.
Date: 19 th – 25th Aug, 2001
Investigators: Van Ngoc Thinh, Le Quoc Khanh, Luong Viet Hung, Truong Cam, Vo Tuong Thu.
Weather: warm sunshine and no rain.

Date	Hour	Coordinates	Species	Number	Form of record	Status of forest
20 Aug.	7h40’ 8h45’ 16h30’	805,3:1793,2 805,1:1793,2 805,0:1793,1	Sus scrofa Ratufa bicolor Muntiacus muntjak	x (2-3) 3 1	Sign Direct observation Direct observation	Medium forest Medium forest Medium forest
21 Aug.	6h50’ 9h00’ 16h07’	805,1:1793,0 805,5:1792,6 804,6:1793,5	Nycticebus pygmaeus Macaca arctoides Capricornis sumatraensis	1 2 1	Direct observation Direct observation Direct observation Footprint	Rich forest Medium forest Poor forest
22 Aug.	7h30’ 9h15’ 17h00’	804,3:195,1 804,4:1794,7 805,2:1795,3	Hylobates leucogenis Ursus thibetanus Muntiacus muntjak	x 2 1	Hear calling Sign Sound, Sign	Rich forest Medium forest Medium forest
23 Aug.	8h05’ 8h30’ 15h10’	804,5:1794,2 804,6:1794,7 804,9:1794,8	Lepus peguensis Pygathrix nemaeus	3 6-7 1	Direct observation Direct observation	Poor forest Rich forest Medium forest

			Sus scrofa		Direct observation Sign	
24 Aug.	6h30’ 7h09’ 17h05’	805,4:1795,4 805,0:1795,2 804,8:1795,0	Rattus koratensis Menetes bermodrei Cervus unicolor	1 2 1-2	Direct observation Direct observation Footprint	Medium forest Medium forest Medium forest
25 Aug.	8h30’ 9h45’	805,5:1795,5 805,7:1795,8	Prionailurus bengalensis Viverricula indica	1 1	Direct, Footprint Direct observation	Young forest Young forest

Note: x: No exact number.

WILDLIFE OBSERVATION PAPER

Line 3: Km 14 Bach Ma road – Truoi Lake.
Date: 9 th – 16th Oct, 2001
Investigators: Van Ngoc Thinh, Le Quoc Khanh, Luong Viet Hung, Tran Duy Lanh, Tran The Tuong.
Weather: Rain, cold.

Date	Hour	Coordinates	Species	Number	Form of record	Status of forest
10 Oct.	7h00’ 8h15’	805,1:1792,5 805,0:1793,1	Ratufa bicolor Sus scrofa	8-10 x (3-4)	Direct observation Sign	Medium forest Medium forest
11 Oct.	6h45’ 7h00’ 10h05’ 14h20	804,7 :1791,8 804,5 :1792,6 804,6 :1793,1 804,7 :1793,0	Capricornis sumatraensis Hystrix brachyura Pygathrix nemaeus Ursus thibetanus	1 2 3 x	Direct observation Direct observation Direct observation Sign	Medium forest Medium forest Rich forest Rich forest

13 Oct.	7h00’ 8h30’ 10h10’ 16h15’	803,2 :1794,2 803,3 :1794,3 802,2 :1794,8 802,8 :1793,4	Paguma larvata Pseudoryx nghetinhensis Cervus unicolor Ursus thibetanus	1 1 2 1	Direct observation Sign Footprint Photo-trap picture	Medium forest Medium forest Poor forest Rich forest
14 Oct.	6h20’ 7h08’ 11h00’ 15h30’	803,0 :1794,8 802,4:1795,7 803,5 :1795,1 802,5 :1795,0	Manis javanica Macaca arctoides Muntiacus muntjak Macaca nemestrina	1 8 - 10 1 1	Direct observation Direct observation Hear sound Direct observation	Medium forest Rich forest Medium forest Rich forest
15 Oct.	7h37’ 8h45’ 9h30’ 14h30’	802,8:1795,1 801,9:1795,3 801,7:1794,7 801,5:1794,8	Sus scrofa Atherurus macrourus Muntiacus muntjak Lutra lutra	3 1 1 1	Direct observation Direct observation Photo-trap picture Direct observation	Medium forest Medium forest Medium forest Medium forest
16 Oct.	9h00’	801,6:1795,2	Cervus unicolor	4-5	Footprint	Poor forest

Note: x: No exact number.

WILDLIFE OBSERVATION PAPER

Line 4: Bach Ma summit – Lien Chi slope.
Date: 5 th – 13 th Dec. 2001
Investigators: Van Ngoc Thinh, Le Quoc Khanh, Luong Viet Hung, Tran Duy Lanh, Tran The Tuong.
Weather: Rain, cold.

Date	Hour	Coordinates	Species	Number	Form of record	Status of

						forest
06 Dec.	7h15’ 9h20’ 15h15’	803,5:1792,1 803,2:1792,7 803,2:1794,0	Sus scrofa Capricornis sumatraensis Neofelis nebulosa	x (5-7) x (1-2) 1	Footprint Footprint Footprint, droppings	Medium forest Medium forest Medium forest
07 Dec.	8h45’ 10h00’ 17h05’	803,2:1793,7 803,0:1793,3 802,8:1792,8	Bandicota indica Viverricula indica Cervus unicolor	5-7 1 x	Direct observation Direct observation Footprint, droppings	Medium forest forest Medium forest Poor forest
08 Dec.	7h20’ 16h07’ 78h15’	801,8:1794,6 802,4:1793,8 802,5:1794,2	Megamuntiacus vuquangensis Catopuma temmincki Rattus koratensis	1 1 4	Skull, bone Direct observation Direct observation	Poor forest Medium forest Poor forest
10 Dec.	4h10’ 11h25’ 13h05’ 20h00’	801,5:1793,2 801,0:1794,1 801,4:1794,3 801,7:1795,0	Sus scrofa Macaca arctoides Ursus thibetanus Muntiacus muntjak	1 5 – 7 x 1	Photo-trap picture Direct observation Sign, droppings Hear sound	Medium forest Rich forest Rich forest Medium forest
11 Dec.	6h45’ 9h07’ 16h40’	801,5:1795,2 801,9:1795,7 800,7:1796,2	Callosciurus erythraeus Rattus sabanus Tragulus javanicus	3 10-12 1	Direct observation Direct observation Direct observation	Medium forest Medium forest Medium forest
12 Dec.	7h03’ 8h15’ 9h45’	801,0:1796,4 800,5:1796,0 800,3:1796,2	Cervus unicolor Sus scrofa Lutra perspicillata	1 1 1	Direct observation Sign, bone Direct observation	Poor forest Poor forest Poor forest, beside stream

Note: x: No exact number.

WILDLIFE OBSERVATION PAPER

Line 5: Khe Ao Nam Dong – Truoi lake.
Date: 10 th – 17 th March 2002
Investigators: Do Tuoc,Van Ngoc Thinh, Le Quoc Khanh, Nguyen Le Tho, Vo Cong chanh, Tran The Tuong.
Weather: drizzle, gloomy.

Date	Hour	Coordinates	Species	Number	Form of record	Status of forest
10 Mar.	15h20’	798,6:1786,5	Sus scrofa	5-7	Direct observation	Young forest
	17h00’	801,8:1787,1	Cervus unicolor	2-4	Footprint	Young forest
12 Mar.	6h45’	798,7:1788,4	Capricornis sumatraensis	1	Photo-trap picture	Young forest
	9h00’		Tragulus napu	x	Sign, observe	Young forest
	10h30’	798,5:1788,6	Ursus thibetanus	x	Sign	Young forest
		800,8:1788,7				
13 Mar.	8h00’	798,2:1789,3	Pseudoryx nghetinhensis	1	Skull, bone	Medium forest
	8h45’		Viverricula indica	1	Direct observation	Medium forest
	21h00’	800,5:1789,6	Cervus unicolor	1	Photo-trap picture	Medium forest
		799,8:1789,9				
14 Mar.	6h20’	800,3:1790,4	Manis javanica	1	Direct observation	Medium forest
	7h00’		Pygathrix nemaeus	4-6	Direct observation	Medium forest
	10h00’	801,1:1790,8	Hylobates leucogenys	x	Hear calling	Rich forest
	15h30’	799,5:1791,5	Muntiacus muntjak	1	Hear sound	Rich forest
	22h00’			1	Hear sound	Medium forest
		800,6:1791,0	Panthera tigris			
		801,3:1790,7				
15 Mar.	7h00’	801,0;1792,5	Tupaia begangeri	3	Direct observation	Medium forest
	7h30			x	Footprint	Medium forest

	9h30 16h00	799,8:1793,1 797,7:1793,3 800,9:1794,7	Muntiacus muntjak Lutra lutra	1 1-2	Direct observation Footprint	Poor forest Poor forest
16 Mar.	9h00 17h15’	801,4:1794,0 802,5:1794,1	Cervus unicolor Sus scrofa	1 x	Skull, bone Sign	Poor forest Poor forest

Note: x: No exact number.

WILDLIFE OBSERVATION PAPER

Line 6: khe Ao –coldebay Nam Dong.

Date: 2 th – 9 th May 2002

Investigators: Van Ngoc Thinh, Le Quoc Khanh, Luong viet hung, Vo Cong Chanh, Truong Cam.

Weather: warm sun shine, no rain.

Date	Hour	Coordinates	Species	Number	Form of record	Status of forest
3 May	15h08’ 17h00’	798,4:1785,5 798,7:1786,1	Sus scrofa Cervus unicolor	3-5 4-5	Sign Footprint	Young forest Young forest
4 May	6h45’ 11h20’ 15h00’	798,9:1786,8 800,5:1784,2 800,2:1784,9	Capricornis sumatraensis Tragulus javanicus Muntiacus muntjak	1 1 2	Direct observation Photo-trap picture Hear sound	Young forest Young forest Young forest
5 May	7h00’ 8h45’ 16h10’	801,1:1785,5 800,7:1784,9 801,9:1787,2	Lutra perspicillata Nycticebus coucang Megamuntiacus vuquangensis	1 2 1	Sign Direct observation Direct observation	Medium forest Medium forest Medium forest
6 May	3h20’ 6h30’	802,0:1787,3 802,6:1785,	Sus scrofa Panthera tigris	1 1	Photo-trap picture Footprint	Medium forest Young forest,

	8h00’ 18h30’	9 803,7:1787,0 803,1:1785,5	Nycticebus pygmaeus Mus musculus	4 6	Direct observation Direct observation	beside stream Medium forest Young forest
7 May	1h35’ 7h30’ 15h00’	803,8:1786,6 804,4:1787,2 804,5:1785,9	Muntiacus muntjak Sus scrofa Rattus sabanus	1 2 3	Photo-trap picture Footprint Direct observation	Medium forest Medium forest Young forest
8 May	8h05’ 10h08’ 17h20’	804,9:1784,5 805,2:1785,0 805,0;1786,2	Cervus unicolor Sus scrofa Arctonyx collaris	1 x 1	Direct observation Sign Sign	Young forest, beside stream Young forest Young forest

Note: x: No exact number.

APPENDIX III: Summary list of mammals recorded on the survey lines

Order	Scientific Name	English Name	Vietnamese Name
	SCANDENTIA		
	Tupaiidae		Hä §åi
1	**Tupaia belangeri**	Northern Treeshrew	Sãc B¾c
	PRIMATES		
	Loridae		Hä Cu li
2	**Nycticebus coucang**	Slow loris	Cu li Lín
3	**N. pygmaeus**	Pygmy loris	Cu li Nhá
	Cercopithecidae		Hä KhØ
4	**Macaca arctoides**	Stump-tailed macaque	**KhØ MÆt §á**
5	**Macaca mulatta**	Rhesus macaque	KhØ Vµng
6	*Macaca nemestrina*	Pig-tailed macaque	KhØ §u«i lîn
7	*Pygathrix nemaeus*	Red-shanked Douc langur	Chµ V¸ Ch©n N©u

	Hylobatidae		Hä V-în
8	*Hylobates leucogenys (Nomascus leucogenys*)	White-cheeked gibbon	V-în §en M¸ Tr¾ng
	CARNIVORA		
	Canidae		Hä Chã
9	**Cuon alpinus**	Asian Wild Dog	Sãi §á
	Viverridae		Hä CÇy
10	**Viverricula indica**	Small Indian civet	CÇy H-¬ng
11	*Arctictis binturong*	Binturong	CÇy Mùc
12	*Paguma larvata*	Masked palm civet	CÇy Vßi Mèc
	Mustelidae		Hä Chån
13	**Martes flavigula**	Yellow-throated marten Gibbon	Chån Vµng
14	**Arctonyx collaris**	Hog Badger	Löng lîn
15	*Lutra lutra*	Eurasian otter	R¸i C¸ Th-êng
16	*Lutra perspicillata*	Small Otter	R¸i C¸ L«ng M-ît
	Felidae		Hä MÌo
17	**Panthera tigris**	Tiger	Hæ
18	*Neofelis nebulosa*	Clouded leopard	B¸o GÊm
19	*Catopuma temmincki*	Asiatic Golden cat	B¸o Löa
20	*Prionailurus bengalensis*	Leopard cat	MÌo Rõng
	Ursidae		Hä GÊu
21	**Ursus thibetanus**	Asiatic Black Bear	GÊu Ngùa
	ARTIODACTYLA		
	Suidae		Hä Lîn
22	**Sus scrofa**	Wild Pig	Heo Rõng
	Cervidae		Hä Sõng §Æc
23	**Muntiacus muntjak**	Red Common Muntjac	Ho½ng
24	*Megamuntiacus vuquangensis*	Large-antlered (Giant) Muntjak	Mang Lín
25	**Cervus unicolor**	Sambar	Nai
	Bovidae		Hä Sõng Rçng
26	*Capricornis sumatraensis*	Serow	S¬n D-¬ng
27	*Pseudoryx nghetinhensis*	Sao La	Sao la

	PHOLIDOTA		
	Manidae		Hä Tª Tª
28	**Manis javanica**	Sunda Pangolin	Tª Tª Java
	Leporidae		Hä Thá rõng
29	**Lepus peguensis**	Siamese Hare	Thá N©u
	Petauristidae		Hä Sãc Bay
30	**Petaurista petaurista**	Red Giant flying Squirrel	Sãc Bay Tai §en §u«i §Ëm
	Sciuridae		Hä Sãc C©y
31	***Ratufa bicolor***	Black Giant Squirrel	Sãc §en
32	**Callosciurus erythraeus**	Pallas's Squirel	Sãc Bông §á
33	**Dremomys rufigenis**	Red-cheeked Squirrel	Sãc Mâm Hung
34	**Menetes berdmorei**	Berdmore's Squirrel	Sãc V»n l-ng
35	*Tamiops rodolphei*	Cambodian Striped Squirrel	Sãc Chuét löa
	Hystricidae		Hä NhÝm
36	**Hystrix brachyura**	East Asian Porcupine	NhÝm §u«i Ng¾n (NhÝm Bêm)
37	*Atherurus macrourus*	Asian Brush-tailed Porcupine	§on
	Muridae		Hä Chuét
38	**Mus musculus**	House Mouse	Chuét Nh¾t Nhµ
39	*Bandicota indica*	Great bandicoot Rat	Chuét Tói lín
40	*Rattus koratensis*	Sladen's Rat	Chuét Bông B¹c
41	*Rattus moliculus*		Chuét Rõng
42	*Rattus sabanus*	Noisy Rat	Chuét Tói
	Tragulidae		Hä Cheo Cheo
43	**Tragulus javanicus**	Lesser Mouse-Deer	Cheo Cheo Nam D-¬ng
44	***Tragulus napu***	Greater Mouse-Deer	Cheo Cheo Napu

<u>Appendix IV</u>: Rare and endangered mammal species in Bach Ma National Park

Order	**Species**	**Degree 18 of Vietnam Minister Council**	**Vietnam Red Data Book**	**IUCN**	**CITES**
1	**Nycticebus coucang**		V	V	II

2	*N. pygmaeus*	IB	V	V	II
3	*Macaca arctoides*	IIB	V	V	II
4	*Macaca mulatta*	IIB			
5	*Macaca nemestrina*	IIB	V	V	
6	*Pygathrix nemaeus*	IB	E	E	I
7	*Hylobates leucogenys*	IB	E		I
8	**Cuon alpinus**	IIB	E	V	II
9	*Arctictis binturong*	IB	V		
10	*Lutra lutra*	IIB	T		I
11	*Lutra perspicillata*		V	V	**II**
12	*Panthera tigris*	IB	E	E	I
13	*Neofelis nebulosa*	IB	V	V	I
14	*Catopuma temmimcki*	IIB	V		I
15	*Prionailurus bengalensis*	IIB			II
16	*Ursus thibetanus*	IIB	E	V	I
17	*Megamuntiacus vuquangensis*		*		I
18	*Capricornis sumatraensis*	IIB	V	V	I
19	*Pseudoryx nghetinhensis*		*	E	I
20	*Petaurista petaurista*	IB	R		

Legend: V: Vulnerable species ; R: Rare species ; E: Endangered species ;
T: T hreatened species.
IB, IIB : Protection items
* Discovered after publication of Viet Nam Red Data Book.

<u>Appendix V</u>: Some of special characteristic big timber species on the survey lines

Order	Scientific Name
	ACERACEAE
1	*Acer oblongium* Wall in DC.
2	*Acer tonkinensis* Lec.Susp.tonkinensis
	ACTINIDIACEAE
3	*Saurauja roxburghii* Wall.

Order	Scientific Name
	HAMAMELIDACEAE
64	*Symingtonia tonkinensis*
	ILLICIACEAE
65	*Illicium parvifolium* Merr.

	ALANGIACEAE
4	*Alangium chinense* (Lour.) Harms.
	ANACARDIACEAE
5	*Rhus semialata* Murr.
6	*Rhus succedanea* L.
7	*Semecarpus perniciosus* EVrard et Tard.
	ARACEAE
8	*Raphidophora bonii* Engler.
9	*Raphidophora chevalieri* Gagnep.
	ARALIACEAE
10	*Schefflera globulifera*
	BURSERACEAE
11	*Canarium album* Raeusch.
12	*Canarium begalense*
	CAPRIFOLIACEAE
13	*Sambucus javanicus* Reinw ex Blume.
	CEPHALOTAXACEAE
14	*Cephalotaxus mannii* Hook.f.
	CLUSIACEAE
15	*Garcinia tinctoria*
	CONNARACEAE
16	*Cnestis palala* (Lour.) Merr.
	CUPRESSACEAE
17	*Fokienia hodginsii* Henry. & Thomas.
	DILLENIACEAE
18	*Dillenia heterosepala* Finet et Ganep.
19	*Dillenia indica* L.
	DIPTEROCARPACEAE
20	*Hopea siamensis* Heim

	LAURACEAE
67	*Cinnamomum cassia* (blume.) Presl.
68	*Cinnamomum iners* Reinw.ex Blume,Bi; dr.
69	*Cinnamomum mairei*
70	*Cinnamomum melastomaceum* Kost.
71	*Cinnamomum ovatum*
72	*Lindera racemosa* M.Lec.
73	*Litsea cambodiana* Lec.
74	*Litsea cubeba* (Lour.) Rers.
75	*Litsea griffithii*
76	*Litsea lancilimba*
77	*Litsea monopetala* (Roxb.) Pers.
78	*Neocinnamomum* delavayi
79	*Cinnamomum glaucescens* Drury.
80	*Cinnamomum longetiolatum* Kost.
81	*Cinnamomum magnificum* Kost.
82	*Litsea glutinosa* Rob.
83	*Neolitsea merilliana* Allem.
84	*Lindera caudata* Hook.f.
85	*Phoebe attenuata*
	LECYTHIDACEAE
86	*Barringtonia acutangula* Gaertn.
87	*Barringtonia macrostachya* Kurtze
	LYTHRACEAE
88	*Lagerstroemia calyculata* Kurz.
	MAGNOLIACEAE
89	*Michelia foveolata*
90	*Michelia tonkinensis* Chev.
	MELIACEAE

21	*Parashorea chinensis* Wang Hsie.
	ELAEOCARPACEAE
22	*Elaeocarpus viguieri* Gagnep.
23	*Elaeocarpus dubius*
24	*Elaeocarpus ovalis*
25	*Elaeocarpus tonkinensis* DC.
26	*Elaeocarpus darlacensis*
27	*Elaeocarpus angustifolius*
	EUPHORBIACEAE
28	*Aleurites montana* (Lour.) Wilson.
29	*Antidesma cochinchinensis* Gagnep.
30	*Antidesma hainanensis* Merr.
31	*Baccaurea sapida* Muell-Arg.
32	*Bischoffia javanica* Blume.
33	*Endospernum chinense* Benth.
34	*Macaranga denticulata* (BL.) Muell.
35	*Sapium discolor* Muell- Arg.
36	*Sapium sebiferum* (L.) Roxb.
37	*Baccaurea oxycarpa* Gagnep.
38	*Glochidion hypoleucum*
39	*Glochidion tamyanum*
	FABACEAE
40	*Peltophorum pterocarpum* Back ex Heyne.
41	*Pelthophorum dasyrrachis*
42	*Sindora tonkinensis* A. Chev.
43	*Milletia latifolia*
44	*Dalbergia multiflora* Heyne&Wall.var.glabrescens Prain.
45	*Archidendron poilanei* (Kost) I.Niels.
	FAGACEAE
46	*Castanopsis dinhensis*

91	*Cipadessa braccifera*
92	*Azadiracta excelsa* (Jack.) Jacobs.
	MORACEAE
93	*Artocarpus lowii*
94	*Ficus erecta*
95	*Ficus lankokensis* Drake in Mor.
96	*Ficus stenophylla var nhatrangensis* Corner
97	*Arthocarpus melinoxy*la Gagnep.
98	*Ficus amplissina* Bl.
99	*Ficus subtecta*
	MYRISTICACEAE
100	*Knema pachycarpa*
	MYRTACEAE
101	*Eugenia bractyata* Roxb.
102	*Syzygium chloranthum*
103	*Syzygium ternifolium* Roxb.
104	*Syzygium hance* Merr & Perry.
105	*Syzygium polyanthum* (Wight) Walp.
	PINACEAE
106	*Keteleeria evelyniana* Marsters.
107	*Pinus merkusii*
	PODOCARPACEAE
108	*Dacrydium elatum* Wall ex .Hook.
109	*Dacrycarpus imbricatus* De Laub.
110	*Nageia wallichiana* Kuntze.
111	*Podocarpus neriifolius* D.Don.
	RHAMNACEAE
112	*Zizyphus oenoplia* (L.) Mill.
	RUTACEAE
113	*Xanthoxylum avicenniae*

47	*Castanopsis indica*
48	*Lithocarpus coalitus*
49	*Lithocarpus pachycarpus*
50	*Lithocarpus pseudosundaicus*
51	*Lithocarpus touranensis*
52	*Quercus poilanei* Hick.
53	*Castanopsis ceratacantha*
54	*Castanopsis chapaensis* Toan.
55	*Castanopsis fissoides* Chun& Hoang .
56	*Castanopsis ninbienensis* Hick& Cam.
57	*Castanopsis semiserrata*
58	*Lithocarpus ombrophila* A. Cam.
59	*Quercus setulosa* Hick.
	FLACOURTIACEAE
60	*Flacourtia jangomas* (Lour.) Raeusch.
61	*Homalium cochinchinensis* (Lour.) Druce.
62	*Hydnocarpus annamensis* Lecot et Sleum.
	GNETACEAE
63	*Gnetum montanum* Markgr.

	(Lank.) DC.
114	*Zanthoxylum nitidum* (Lan) DC.
	SAPINDACEAE
115	*Sapinda rarak*
	SAPOTACEAE
116	*Mimusops elengi*
	SAXIFRAGACEAE
117	*Dichroa febrifuga* Lour.
	STYRACACEAE
118	*Allniphyllum fortunei*
119	*Allniphyllum pterospermum* Mats.
120	*Styrax rufopilosus*
	TAXODIACEAE
121	*Cunninghamia lanceolata*
	THEACEAE
122	*Adinandra petelotii*
123	*Eurya tonkinensis* Gagnep.
124	*Gordonia axillaris*