DOG AND BULL

An investigation into carnivore-human conflict in and around Itanagar Wildlife Sanctuary, Arunachal Pradesh

Ambika Aiyadurai and Surendra Varma

Wildlife Trust of India

/0 Years in Service of Nature

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PREFACE

It took just one phone call from the field to launch a Rapid Action Project in Arunachal Pradesh, that has over the years resulted in this occasional report 'Dog and Bull'. The phone was from an agitated field officer, who had just attended a village elder's (*Gaon Burrhas*) meeting in Sagalee, near Itanagar in Arunachal Pradesh. He had heard their vow to eradicate all the carnivores of their surroundings due to the menace of wild dogs eating their traditionally prized, semi-wild cattle, the mithun, and had rung up requesting immediate action. This tribal pronouncement could well have been carried out had a rapid project not been conceived of to meet the needs of the local populace. And in this instance, the rapid project was nothing more than sending a senior field scientist, Surendra Varma, with the concerned field officer, Sunil Kyarong to work with the local communities to understand and alleviate the conflict. Two other field biologists worked on this project for differing lengths of time but basically all of them worked to defuse the potentially combustive situation.

It is gratifying to know that neither did the threat of wiping out carnivores actually take place, nor were there any large scale depredations reported from that area since then. More importantly, the locals, for the time that the project was ongoing, took out a proclamation protecting wildlife in the area. There was also subsequent governmental support to the villagers as a result of a specific recommendation of the report, that of corralling livestock. Man-animal conflict is nothing new globally but is likely to see an increasing trend over the years. Conservation actions such as this, seek to find locale-specific remedies to these problems and to implement them. This Occasional Report is the result of a very small, focused project but one which has lessons for many others across India.

Vivek Menon
Executive Director

ACKNOWLEDGEMENTS

EXECUTIVE SUMMARY

Mithun (*Bos gaurus frontalis*), a semi-domestic bovid is reported to be depredated regularly by predators, in particular the wild dog (*Cuon alpinus*) and the villagers retaliate by killing the predators.

This survey carried out in Itanagar Wildlife Sanctuary, Arunachal Pradesh, focused on the overall patterns and causes of the predator-human conflict. The survey was also aimed to evaluate methods that could be used to assess the status of forest and relative abundance of mammals in a remote and little explored tropical evergreen forest of northeast India.

The investigation was based on forest trail surveys for assessing status of forest and mammals and village surveys to assess the status of wildlife. Out of 23 species reported for the region, only 26% of the total species were encountered in the trail survey and only after spending 95% of the total time with the villagers, information on all the species was obtained.

Comparison of results of species number with other regions suggests that an expected mean number of 22 species could be computed for the survey area. Only 0.37% of man-hours was needed to encounter all the species for the current survey region. The village survey appears to be a robust method for a basic or advanced species list, but it may not be an appropriate method to evaluate the forest status.

The result showed that the region has more predators (56%) than prey (44%). The encounter rate (3.43/km) and frequency of occurrence of mithun signs (65%) were high compared to encounter rate (0.19/km) and frequency of occurrence (4%) of natural prey.

The findings suggest that, due to a low density of optimal prey species and relatively high density or encounter rate of livestock and their free ranging nature make livestock more susceptible to predation.

Elimination of mithun by predation may have a severe impact on culture and the local economy of the tribe. The loss of mithun and the interest of consuming the meat of predators may justify the local people to eradicate the predators.

Some species of predators have more ecological or conservation value as they are found in low numbers, sensitive to prey and habitat changes. If such species are identified as a problem species and exterminated by local people that could have a severe effect on the species.

1. INTRODUCTION

Arunachal Pradesh in northeast of India is known for a rich biological and cultural diversity and is recognized as one of the 25 "biodiversity hotspots" of the world (Myers et al. 2000). The state has a forest cover of about 68, 045 km^2 (Anon, 2001a) and is also the home of 27 ethnic human communities with distinctive cultures and rich traditions (Anon, 2002). Among them, *Nishis* are considered to be one of the dominant communities (Solanki 2002). *Nishi* belong to Mongoloid group of people and practice shifting cultivation (Fig.1) and have special association with

Fig. 1 Shifting cultivation in progress

mithun (Bos gaurus frontalis), the semi-domesticated cattle which is restricted to the northeastern states of India. *Mithun* is a crossbreed between gaur (*Bos gaurus*) and domestic cattle (*Bos indicus)* and is an integral part of *Nishi's* culture. It is the living wealth of them and few other tribal communities of Arunachal Pradesh (Singh, 1995). Among these communities, particularly *Nishi,* the status of an individual depends on the number of *mithuns* he owns. *Mithun*s are sacrificed during customary

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rites, special occasions, functions, elections and during *'Nyokum'** festival. In general, the animal is used to pay bride price, medical bills and education fees for children, fines and has many uses vital not only to the customs and traditions but also to the economic needs of the people. They are most acceptable as compensation for any crime including murder and were formerly used for ransoming captives. The socio-religious utility is so significant that they are treated with great care and affection (Shukla, 1965). *Mithun* is let into forests and are free ranging animals; the females are brought back to the houses when they are pregnant (Fig. 2) to prevent the calves from being killed by predators. When the calf is born, it is fed with salt so that the animal recognizes the owner. After a week or two, the calf and the mother is let out and as calf grows, it keeps visiting its house often for salt. This approach of letting the animals save the tribe a lot of time, resources and effort, which would have been spent otherwise on collecting fodder and maintaining the animal. The animal is never stall fed or used for milching. As *mithun*s are let into the forest, they are often preyed upon by predators, particularly dholes (*Cuon alpinus*) and to some extent by leopard (*Panthera pardus*).

Fig. 2: A pregnant *mithun* being brought from the forests

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*Nyokum is a harvesting festival celebrated by *Nishi* in February.

This problem is severe in some of the regions of Sagalee and Poma forest range of Arunachal Pradesh.

Reports of the dhole and other predators attacking and preying on *mithun* were first received by Wildlife Trust of India (WTI), New Delhi, during November, 2000 from Sagalee, Papum Pare district of the state. The reported killing of *mithuns* by predators resulted in severe human-animal conflict and the problem has been serious for the last 5-6 years. Researchers from Centre for Ecological Sciences (CES), Indian Institute of Science (IISc), Asian Nature Conservation Foundation (ANCF) of Bangalore and WTI visited and surveyed the areas to assess the situation. The initial survey speculated a number of reasons for the conflict in this region. It was hypothesized that the shifting cultivation practiced by the local people of these regions opened up dense forest, converting it into secondary forests, ideal for both prey and predators. Some of the species also became food sources for the villagers, resulting in depletion of natural prey and *mithun* became prime prey for some of the predators (Varma and Subba, 2001). The dholes were reported to be more in numbers in Itanagar and adjoining areas a few years ago. The developmental activities such as construction of buildings and related activities in the capital complex (Itanagar) in recent times is said to have driven the dholes and other carnivore populations from Itanagar wildlife sanctuary to Sagalee and adjoining areas resulting in carnivore-human conflict (Varma and Subba, 2001). The conflict and demand for compensation were regularly reported to the forest department.

A request from the Range Forest Officer, Poma Wildlife Range, Govt of Arunachal Pradesh was received in February, 2003 by WTI to study the status of the human–predator conflict issues in and around Itanagar wildlife sanctuary. According to the request, the predators were reported to kill domestic animals especially *mithun*s and cows, causing economic

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loss to the villagers. The villagers, out of anger started killing predators to protect *mithun*s and other domestic animals. Forest department requested WTI to provide some mitigation measures to solve the problem and a Field Officer from WTI visited the site in February 2003 for an initial survey. During the visit, it was understood that 22 *mithun*s and 5 cows were killed by predators and proportion of cattle killed by dholes was more. Villagers, who assume dholes as the major cause for the issue, have reported to have killed 2-3 dholes. As a follow up action, a field investigator (AA) and research advisor (SV) visited the sites around Itanagar WLS in March, 2003 for a survey of the problem.

2. OBJECTIVES

The objective of the survey was to assess the severity of the conflict, more specifically

1. To get an idea about the relative abundances of various prey and predator species.

2. Collect specific information on number of *mithun*.

3. To identify the status and reasons for the conflict.

4. To assess the effect of the conflict on the socio economic status of the villagers.

5. To review the earlier surveys and their out comes.

6. To develop an integrated conservation plan to mitigate the problem.

The above objectives evolved through the following concepts:

It is understood that there is greater dependency of people on the forests in this region. Shifting cultivation has been an important factor for forest conversion (Ramakrishnan, 1992). This has resulted in large-scale

conversion of the primary forests into open area with secondary forests. Assessment of disturbance level, anthropogenic activities and the type of forests (primary/secondary) may help in analyzing the reasons for the conflicts in the region.

Mithun is culturally and socio-economically important to *Nishi* and any threat to them will have an impact on the life of the people in the community. Hence, it was considered to be important to know, the degree of dependency of *Nishi* on *mithun, mithun's* population, age structure, birth and death and their causes. Unnatural deaths due to disease, predation or due to any other reasons is a major concern and thus authentic information on conflict based deaths become greatly essential. *Mithun* being a free ranging animal, it is getting attacked by predators. However, letting the animal into forest for free ranging could save the cost of stall feeding.

It is also imperative to know various aspects of conflict related information such as cause, severity, effect on culture and economy of the people, on the species conservation (positive and negative) and mitigation measures (both existing and suggested measures and its efficacy). Apart from these, information on behavior of the predator or prey, density of given prey and predator, attitude of people, consumption or commercial value of meat, hide, horn or any other product of predators, prey and *mithun* along with the socio-economic status of the conflict villages also become very important. Documentation of any developmental activities within, around or close to the forest and villages is also equally very important.

3.MATERIALS AND METHODS

3.1 Survey sites

The study site and the affected villages fall in Papum Pare district of Arunachal Pradesh. It is located between latitude 26° 55' and 28° 40' N

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and between longitude 92° 40' and 94° 21' E. The district headquarters is Yupia, which is about 20 kms from Itanagar. The district is approximately 3,462 km^2 in extent with 274 villages and 2 towns. The district is divided into two administrative subdivisions – Sagalee and Itanagar Capital Complex. There are nine administrative circles – Sagalee, Mengio, Toru, Laiporiang, Kimin, Balijan, Doimukh, Itanagar and Naharlagun.

3.2 Itanagar Wildlife Sanctuary

Itanagar Wildlife Sanctuary is located in the vicinity of the capital city of Arunachal Pradesh, Itanagar in the Papum-pare district (Fig. 3) and covers an area of 140.30 km^2. It was established in 1978 (Anon, 2000). It is one among the notable biodiversity areas. The region is mostly hilly (precipitous hillsides are the common feature of this area) and the average altitude of the terrain is 1000 m ASL. The terrain occupied by the forest is gently slopping southwards and is highly rugged with mountainous ranges. Four seasons could be identified; pre-monsoon is from March to May, monsoon from June to September. Monsoon retreats in October and November and winter is from December to February (Barthakur, 1986). The annual average rainfall is approximately 2500 mm and the month of June and July are the wettest. A large number of rivers drain the area, most of which run north to south. The area abounds in epiphytes, a variety of lianas and other creepers. The landscape is difficult to traverse due to rugged terrain and dense vegetation. Geologically, the forest area is prone to landslides during summer and is quite unstable. The soil on the hills is moderately deep, moist, fertile loamy the upper layer of which are stained with humus. The soil is very loose and heavily eroded.

The forest can be classified mainly as North Bank Tropical Evergreen (Nahor-Jutuli) Tropical Semi Evergreen and Secondary forests. At places, the evergreen and semi evergreen forests merge with one

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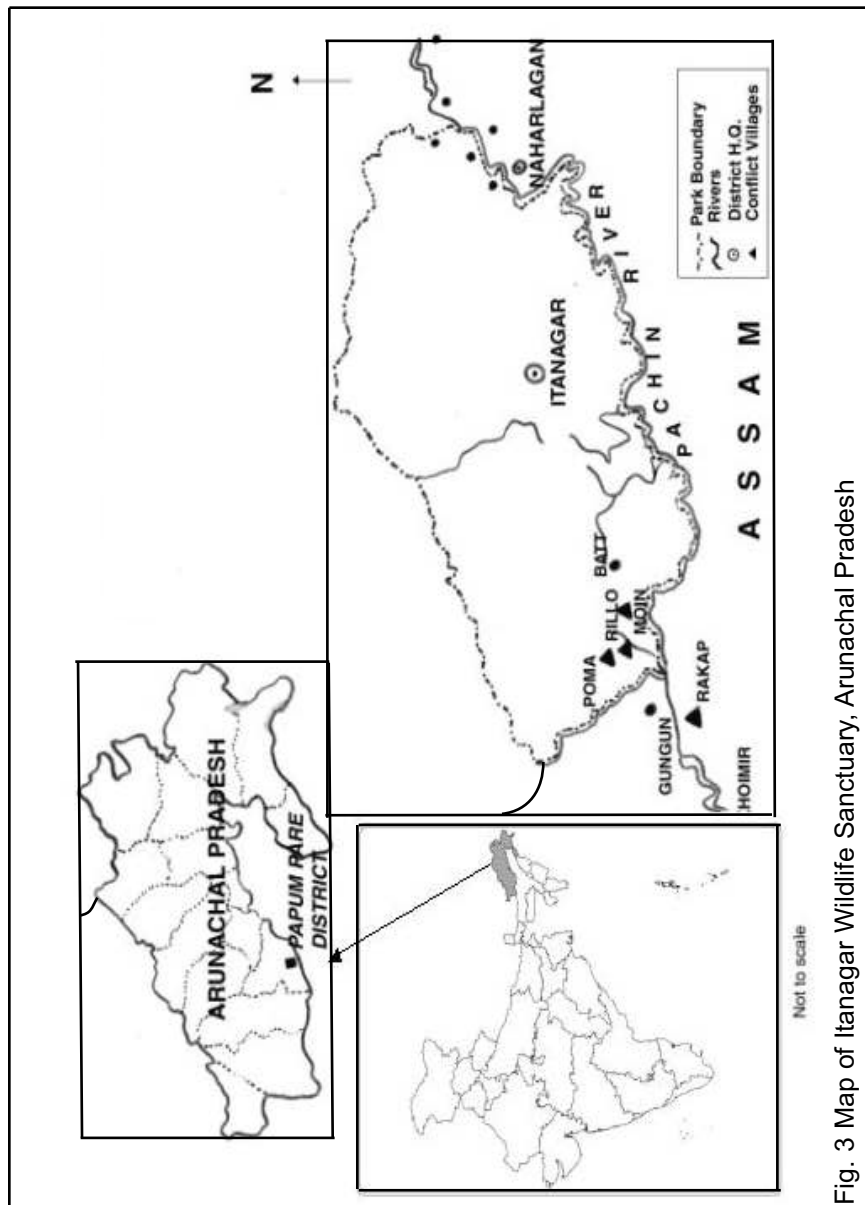
Fig. 3 Map of Itanagar Wildlife Sanctuary, Arunachal Pradesh

another and cannot be described separately. Structurally, these are multi-storeyed forests composed of a large number of plant species belonging to different families and genera. North Bank Tropical Evergreen (Nahor– Jutuli) forests occur at an elevation of 900 m. It is rich in species diversity with no single tree species dominating the canopy at 20 to 40 m. Associations of *Mesua – Altingia, Altingia – Engethardia, Altingia – Syzygium, Mesua – Syzygium* and *Canarium – Syzygium* can be noticed. Tropical Semi Evergreen forests occur up to an elevation of 600 m with 30-40 m tall trees. Commercially important species found in this forest are *Terminalia myriocarpa, Bombax ceiba* and *Canarium strictum.* This type of forests can be further classified as low hills and plain semi evergreen and Riverine semi evergreen forests.

Secondary forests occur due to both man-made (mainly shifting cultivation) and natural (mainly landslide or fire) reasons. This type could be further classified as degraded forest, bamboo forest and grasslands. *Macranga denticulata*, *Mallotus tetracoccus* and *Callicarpa arborea* are some of the trees of degraded forests*. Bambusa tulda, Bambusa pallida, Dendrocalamus hamiltonii and D. giganteus* occur in bamboo forest. *Saccharum spontaneum, Saccharum arundinaceum, Chryosopogon aciculate* and *Imperata cylindrica* are some of the species found in grasslands (Kaul & Hariharan 1987).

The region has a number of mammalian fauna. Notable among them are sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), wild boar (*Sus scrofa*), elephant (*Elephas maximus*), tiger (*Panthera tigris*), leopard (*Panthera pardus*), clouded leopard (*Neofelis nebulosa*), jackal (*Canis aureus*), dhole (*Cuon alpinus*) and small cats. Among the primates, Assamese macaque (*Macaca assemensis)*, rhesus macaque (*Macaca mulatta)*, capped langur (*Trachypithecus pileatus*) and stump tailed macaque (*Macaca arctoides)* are found in this area.

3.3 Survey villages

Six villages located within and around Itanagar WLS *viz*. Poma, Rillo, Jothe, Rakap, Moin and Khoimir were the focus villages for the survey. Out of these, four (Rillo, Moin, Poma, Rakap) were reported to have conflict. The villages are around 10 - 15 km from Itanagar and can be approached by road. Most of the villages (*basti* or *napung*) are small with an average of 30-35 families, each with about 11 persons including children/family. Poma village has a Forest Range Office, a check post, an inspection bungalow, a middle school and a primary health centre. Jothe and Moin have a primary and a residential school respectively. All the villages have water and electricity.

4. PEOPLE AND THEIR DEPENDENCY ON FOREST AND ITS PRODUCTS

Nishi is one of the major tribes inhabiting this region and belong to the Mongoloid group of people. Due to the mountainous terrain and lack of sufficient suitable land for irrigation based cultivation, *Nishi* almost entirely dependent on slash and burn cultivation, which is popularly called *Jhum* or shifting cultivation. Shifting cultivation usually involves cutting of secondary bamboo forests. Since old growth or primary forest is less extensively available and is more difficult to clear, they are cultivated infrequently. Irrigation based cultivation is mostly for growing paddy, which is typically on land close to the village in front of their houses. Papaya and pineapple are grown around their houses. Pigs, chicken, cows and goats are reared in every house in these villages.

The tribe as a whole is fond of hunting and fishing. Hunting is a tradition among the *Nishi* and almost all men hunt regularly. Most of them possess guns. Traditional animal trapping/capturing methods are also used. Most of them have a set of bows and arrows in their houses. Hunting is both

an individual as well as a group undertaking. The forest in its entirety belongs to the village as a whole. Thus, any person is free to hunt in any part of the forest he likes; but he is forbidden to disturb the traps already laid (Shukla, 1965).

Nishi men carry a long flat knife called '*Dao'* hung around their shoulder. The knife is covered with flat bamboo stripes and sometimes with skin of wild animals specifically of capped langur (*Presbytis pileatus*) and Asiatic black bear (*Ursus thibetanus*) skin as shoulder belt. The young boys in the *Nishi* village always carry catapults with them, which seem to be their favorite toy. Foundation to become skilful hunters is laid right from childhood. *Nishi* also take part in other forms of resource gathering. Some men work for the forest department as casual workers. Villagers also work for Public Works Department in road construction near their villages. Women from the villages sell bamboo, wood and vegetables in the nearby markets.

The village headmen are called *Gaon bhurrahs.* The headmen wear special headgear decorated with the hornbill beak and feather attached to a unique cane cap. There are a few semi-precious stones embedded in their headgear. *Nishi* follow polygamy and the length of the hut gives an indication of the number of wives a *Nishi* man has. The village is a cluster of huts and is habitually situated in the valley. The huts are made up of bamboos and are built on stilts. Skills in their hunting tradition are proudly displayed at the entrance of each hut. The skull of a wild pig (*Sus scrofa*) is kept among the trophies. Monkey skull is hung near the door to keep the evil spirits away (Shukla, 1965). Women are involved in farming and do not go into the forest as much as men. *Nishi* speak *Nishi* language, which has no script and English is followed. It is believed that the God wrote the script of the language of *Nishi* on the back of a *mithun*, which was eaten up by the people, so a script for *Nishi* language does not

exist. Overall food, shelter and other needs of this community are met from the forest. One can notice a social, economic, cultural and even linguistic association of forest and its products in the life of *Nishi* and life that evolved over a period of time. Conservation of forest or wildlife or mitigating measures of *Nishi* and wildlife conflict has to take these aspects into consideration.

5. METHODS

5.1 General

The field survey was carried out during March, 2003. Considering the complexity in collecting reliable information from the villagers and the administration, poor documentation of the issue, poor visibility in the hilly terrain and other related issues, a review process of the subject was carried out. This review process was spread over a period of six months starting from March to September 2003. As an initial approach, a pilot survey was carried out to know the socio economic status of the people, number of *mithun* owned by them and other related information. The Deputy Chief Wildlife Warden (DCWW), Deputy Conservator of Forests (DCF) and the Range Forest Officer (RFO) were interviewed for specific information on the condition of forests, status and nature of the conflict and other aspects related to cultural and economic importance of *mithun.* The site was visited with the DCF and the RFO. The resource persons from villages were interviewed for information about the villages and specific details about the conflict. Overall, the following approaches were adopted in the field.

    a) Forest trail survey for assessing status of forest and some
       species of wildlife.

    b) Village survey for assessing status of some species of wildlife,
       mithun, conflict and socio-economics of the villagers.

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5.2 Status of Forests

There are well-established forest trails, which are normally used by villagers. These trails were located close to the villages, The trails were covered on foot. The walks were restricted to the trails as the undergrowth around was thick and could not be explored. The forests around 2 km radius of the villages were heavily under *jhum* cultivation and the type of forests within the regions were secondary and they were covered for assessing the status. At every 20-minute interval or observation points, four nearest trees, type and status of the forests and anthropogenic disturbances were recorded (Appendix 1 A). Information on plant species observed was collected to associate with the forest type surveyed. The forests were classified into three categories; open, partially open and closed forests, based on canopy cover. When there was no canopy over head, it was termed as open, when canopy of adjacent trees overlapped, with the sky still showing through, it was considered as partial and when the sky is no longer visible over head, it was considered as closed forest (Raman *et al*., 1998; Varma *pers .obs*).

5.3 Forest Trail Survey

Experienced individuals of the *Nishi* tribe were employed as trackers and forest trails surveyed for animal presence through direct and indirect signs. Before starting the trail survey, information on species that would probably be encountered during survey was collected from the trackers. This information was compared later with the species encountered during the survey. This helped to assess the knowledge of the trackers on the species found in this region. There were some areas where no such trails were available and in such areas, trail termed as 'non-existing trails' were traversed for comparison. This has also helped in assessing the bias (of an animal being attracted or keeping away from the trail) towards selecting and surveying the trails. Trails were walked for direct sightings

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or indirect evidences including pellets/scats/hoof marks, feeding and other signs (Appendix 1 A). On sighting the animal sign or on direct sightings, information on time of the sighting, number of signs (or individuals) and other related information were also recorded (Fig. 4).

5.4 Status of wildlife

Status of wildlife (specifically prey and predator) and other related information were gathered through both the forest trail and village surveys.

Fig. 4 Trail survey for animal sign investigation

5.5 Survey through village visit

The initial procedure of this approach was to establish the dependency on forest and its resources by different age and sex classes of village people. Information on wildlife and their abundance were collected from the villagers based on their visit to forest/day, time spent and other related information. It was established that men spend more time in the forest and it was planned to interview two individuals of each age class (two old and experienced persons, 2 middle aged and 2 individuals from the age class in which they start going to forest) from each village. The knowledge on wildlife species obtained from villagers helped in developing questionnaires (Appendix 1B) based on which interviews were carried out (Appendix 2). Most of the villagers could understand *Hindi* (one of the national languages of India) and some could speak also English. The young villagers were especially well versed with *Hindi* though there were some problems interacting with older *Nishi.* In reality, selecting specific

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age classes of people were not possible as most of the men were in the forest during the day. People were interviewed randomly as and when they were available (Fig 5).

Fig. 5 Village survey through interviews

5.6 Survey on the status of *mithun*, human-predator conflict and the effect on socio- economy of the villagers

These surveys were done by visiting villages and obtaining information through questionnaires (Appendix 1C) and direct observations. The status survey of *mithun* focused on information on the number of *mithun* owned by the village as a whole and by each villager; its influence on socio-economic status of the village and villagers, system of keeping the animal, maintenance, health care and other relevant aspects of rearing *mithun*. Data on *mithun* deaths due to the carnivores, place of attack, season of attack and the number were also part of data collected during the interviews. An attempt was also made to estimate *mithun* numbers by

forest trail survey. Status of carnovore- human conflict and its effects on socio economic status of the people were also assessed through questionnaire and direct observations. The socio-economic data included agricultural patterns, annual and alternate source of income, crop yield and the damage. The interviews were done with the help of trackers who translated the questions and the answers.

5.7 Review of the subject

As a primary approach, a data base of experts and experienced personnels (see Acknowledgments) of the subject was made. Discussions with the personnels were made through direct interaction and correspondence (email). Specific visit to Centre for Ecological Sciences, IISc Bangalore and Mudumalai Wildlife Sanctuary, Nilgiris and Wildlife Institute of India, Dehradun were made for discussions and field based experience of the subject. Incorporating experience of surveying other regions (south India and Southeast Asia) was also part of the review process. Apart from these approaches, literature survey (see reference section) was also done. Comments and suggestions from the experts, experienced personnels and knowledge gained from literature survey were incorporated for an understanding of the subject.

6. RESULTS

6.1 Status of forests

The *Nishi* villages are located in the valley and the forests were observed to be degraded. The forests were much less disturbed on the other side of the valley. The undisturbed part of the forests was not sampled during the survey due to lack of time. The habitat along the forest trail varied drastically. This variation was found within and across the trails. The microhabitats encountered during the survey were open scrubland, area under shifting cultivation, bamboo or reed dominated, woodland and

riverine. About 58% of the forests surveyed was under open forest and 27% under partially open, indicating the region has more open forest (Fig. 6).
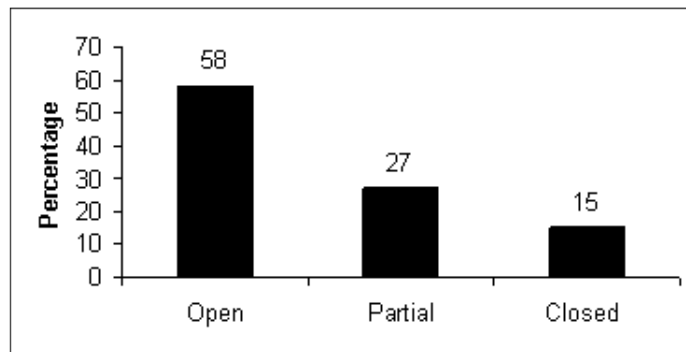
Fig. 6: Percentage of forests under different categories

The status of forests between the trails covered was compared (Fig. 7).
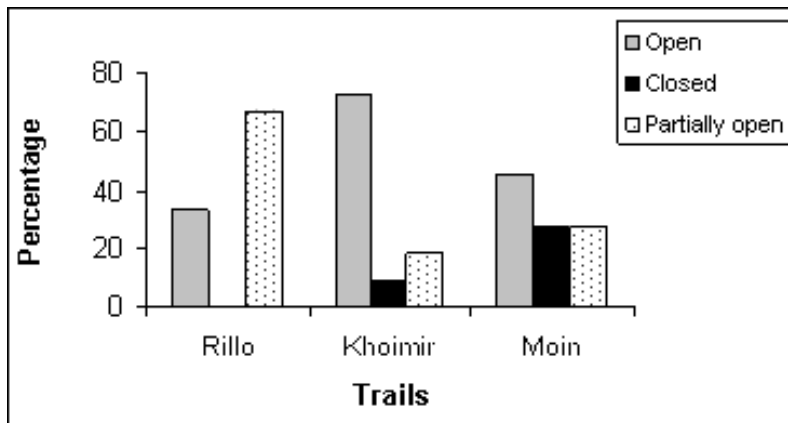
Fig. 7 The percentage of forest under different categories in each trail

Khoimir trail had the highest percentage of open forest (72%) followed by Moin (45%). Rillo trail had no closed forests.

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6.2 Status of wildlife (specifically of prey and predator)

No wildlife species except the *mithun* was sighted directly along the trails. However, several signs of animal presence were recorded.

6.3 Relative abundance of animals (based on trail survey)

The encounter rates of the signs/km were calculated and trail wise encounter rate was compared with the category of forests for correlations. For this exercise, the encounter rates of the different wildlife species/km were compared between the trails (Fig.8). The result shows that encounter rate of wildlife signs/km is high for Rillo (3.50) followed by Khoimir and Moin trails.
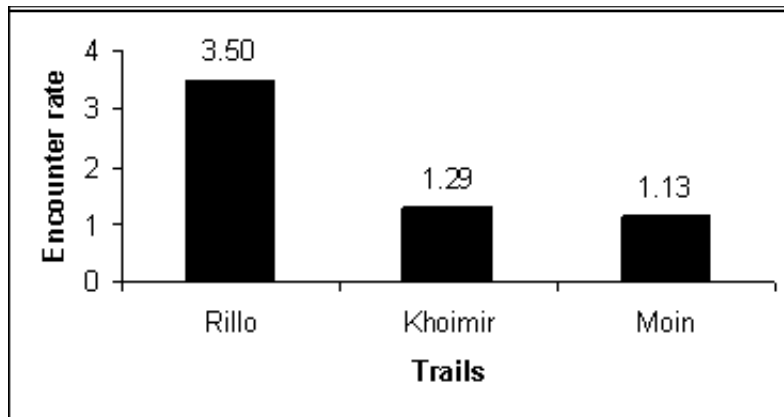
Fig 8: Encounter rates of wildlife signs/km across trails

6.4 Encounter rates of signs in relation to status of forest

The encounter rate/km was high along the trail with less closed forest. Rillo had only open and partially open forests and more signs were observed in this trail. Moin with the least encounter rate/km (1.13) had high percentage of closed forests. Species encounter rate in relation to the total man-hour spent for each trail shows that for the trail close to Rillo, within 60% of time spent, all the species were encountered. Khoimir

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and Moin encountered only 83% of the species during the survey and this was achieved through 43% of man-hour spent in Khoimir and only after 85% of man-hour in Moin (Fig. 9).
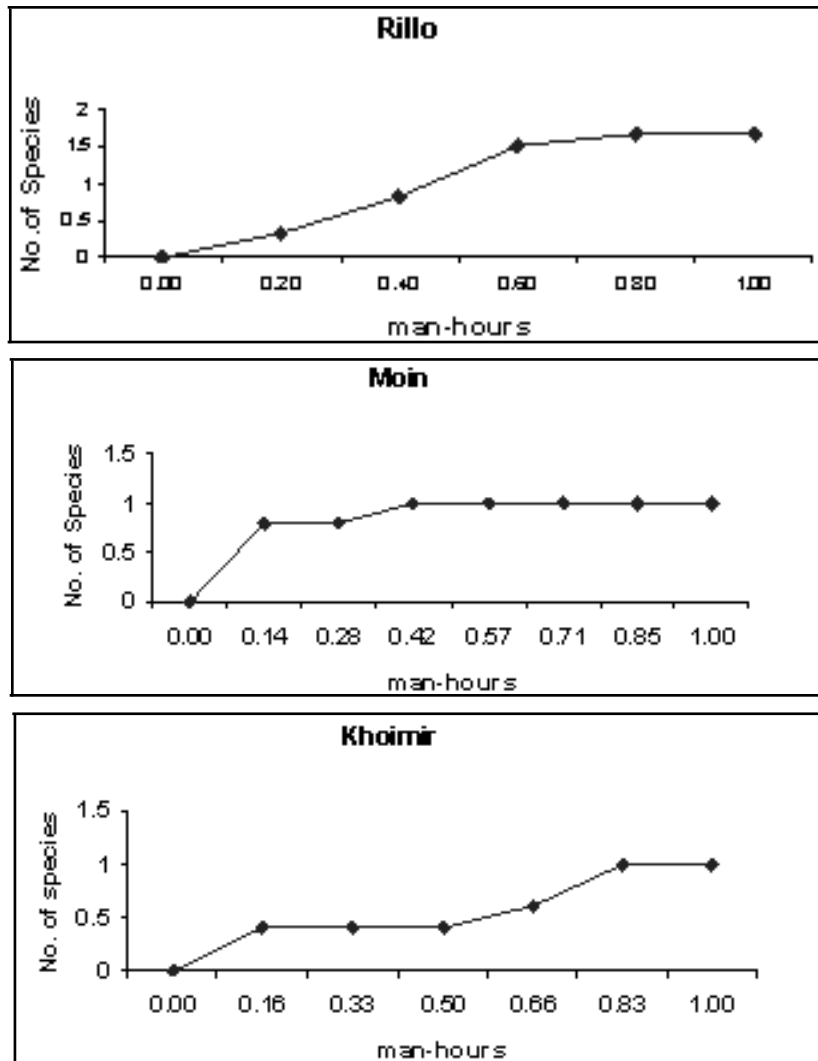
Fig.9: The Species Time Curve for the three trails

6.5 Status of wildlife signs

Overall, a number of indirect evidences of wildlife species (scats, tracks, pellets and dung piles) were present and a few scats were collected for identification and further analysis. The highest number of signs observed was of elephants (Fig. 10). Dung piles, track marks and feeding signs of
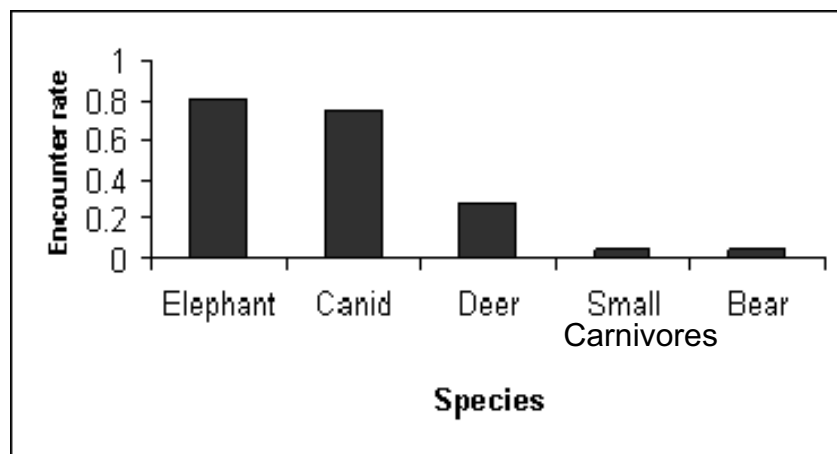
Fig. 10: Encounter rates of wildlife signs/km of different species along the tracks

elephants were recorded and the dung piles were about two weeks old. Signs of debarking by elephants were also observed. Bear (species not known) claw marks on trees were noted in Rillo trail. Claw marks of a small carnivore were observed on a tree. The animal, however could not be identified based on this evidence. Canid foot prints and scats were found in all the three trails. Out of the 12 encounters of canid scats and tracks, all the scats except two were single. Two had a group size of four. There is a possibility that these scats belong to jackals (*Canis aureus*). Jackal howls in the evenings and nights from the Poma village shows that jackals are present in the regions (the field investigator has experience of studying jackals and is familiar with the calls of the animal). There were a number of constraints as it was not easy to spot and identify footprints

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and tracks of animals because of the heavy litter on the ground. Care was taken in the identification process of the scats, as there could be chances of scats belonging to domestic dogs (*Canis familiaris*). However, the scats are unlikely to belong to domestic dogs as they hardly move farther into the forest and they do not accompany their master during hunting trips. Though a few villagers keep 'shepherd dogs' to take care of the goats, they do not move into forests.

6.6 Relative abundance of animals (based on village survey)

The diversity and the relative abundance were assessed based on reasons for *Nishi* visiting forest, time spent, forest products used and the animals that visit human habitations.

6.6.1 Reasons for visiting forests

A number of reasons were identified for a *Nishi* to visit forests. The reasons were; in search of *mithun*, to collect bamboo, for *jhum* cultivation and collection of vegetables and hunt animals. Sixty three percent of villagers visit the forest to look for *mithun*, 26% for collection of wood, bamboo, to *jhum* and to collect other forest products. It was found that 78% go to the forest for hunting animals. About 11% felt there were no animals in the forest and do not go into the forests. About 11% of the persons interviewed go to the forest to observe animals (Fig.11).

Time spent in the forest varied and depended on the purpose of the visit. It was found that the time spent was anywhere from one whole day to a few days and sometimes they spent more days in the forest till they found their *mithun*. Men usually visited forests more than women.

6.6.2 Forest products used

Nishi use a number of products derived from wildlife. These products are used for different purposes like ornamental, medicinal, consumable
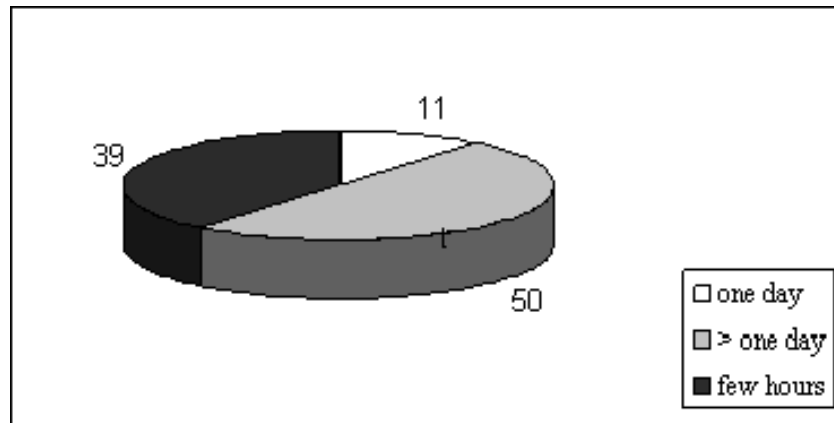
Fig. 11: Percentage of time spent by Nishi in the forests

commercial uses. Skulls, horns and jaws of various wildlife species were displayed on the entrance of most of the *Nishi* houses. Beaks and feathers of great Indian hornbill (*Buceros bicornis*) and wreathed hornbill *(Aceros undulates)* are used on the headgear of the village men. The beak is fitted to a cap made of cane and worn as a headgear. The headgear also has other animal parts like tail of small mammals mostly squirrels. One head gear had part of the racket-tailed drongo (*Dicrurus paradiseus)* at the back of the cane cap (Appendix 4). *Mithun* horns are generally kept in the houses, some are displayed at the entrance of the huts and some are kept inside. *Mithun* horns are used as containers to keep small things (coins, tooth brush and tablets) and were hung on the walls. Deer and *mithun* hides are used as mats on the floor during winters. During winter, *mithun* hide is used as sleeping mats for warmth and deer hide is used as sitting mats. According to Solanki *et. al.* (in press), *Nishi,* after *jhum,* enjoy a great deal of rest by hunting*,* tracking and stalking wild game. They wait near salt licks and near crop fields for animals. Bows, arrows, spears, self-designed mechanical traps and guns are used for trapping and killing animals. Animals are hunted for

supplementary food and curing different ailments. Primates are killed more, followed by deer. Monkeys (both macaque and langurs) are hunted for skin and meat. Deer are killed for skin, horn and meat. Bears are killed for gall bladder, skin, claw, fur and meat, and tiger and leopard for skin, claw, teeth and meat. Wild boar is mainly hunted for meat. Solanki *et. al.,* (in press) have found that *Nishi* from 20 villages have hunted 11 species of mammals. There are some medicines derived from the animals. Tiger and leopard bones are used to treat rheumatism. Animal hides are used for ritual purpose and jaw with teeth are used to decorate their huts. Bear gall bladder is believed to cure dysentery, jaundice and intestinal troubles. Barking deer antler is for curing impotence, hypertension and arthritis. Primate meat is used for the treatment of malaria.

6.6.3 Animal visit to human habitation

With reference to the animal visits near human habitation during a particular season, 52% of the villagers interviewed felt that there was no seasonal difference in sighting animals. Twenty six percent of them felt that more animals were sighted during the winter season where as the rest of the villagers did not have any answer. Sightings of more animals during winter season were attributed to flowering and fruiting of some of the wild and cultivated species around the settlement. Twenty six percent of the answers for the animals that visit settlement were jackals. The visit was for chicken, lambs and piglets. Villagers also reported that jackals raid maize fields. Fifty seven percent of the people interviewed said that animals visited villages to steal chicken. Elephants often visit once in a year mainly for paddy. Elephant cause more damage and the economic loss is about Rs. 5000 to 6000/year (approx. US $ 100 -170). No human casualty due to wildlife has occurred so far.

6.6.4 Variety and frequency of wildlife encountered by villagers

The analysis of villagers visit to forest, time spent, forest products used

and animal visit to villages revealed the presence of 23 species of mammals in the region (Table 1).

Table 1 List of mammals reported by people during village surveys

S.No.	Species	Scientific Name	Remarks
1.	Leopard	*Panthera pardus*	
2.	Tiger	*Panthera tigris*	
3.	Dhole	*Cuon alpinus*	
4.	Jackal	*Canis aureus*	
5.	Wild goat		Species not known
6.	Wild pig	*Sus scrofa*	
7.	Clouded leopard	*Neofelis nebulosa*	
8.	Capped langur	*Trachypithecus pileatus*	
9.	Elephant	*Elephas maximus*	
10.	Asiatic black bear	*Ursus thibetanus*	
11.	Barking deer	*Muntiacus muntjak*	
12.	Sambar	*Cervus unicolor*	
13.	Gaur	*Bos gaurus gaurus*	
14.	Mongoose	*Herpestes spp.*	
15.	Jungle cat	*Felis chaus*	
16.	Indian porcupine	*Hystrix indica*	
17.	Soku*		a small canopy dwelling animal
18.	Taas*		a small canopy dwelling animal
19.	Sukung*		small canopy dwelling animal
20.	Aama kochchi*		Squirrel-like brown coloured small animal.
21.	Sekke*		Canopy dwelling animal (brown-black in colour, long tail)
22.	Tahi*		Canopy dwelling animal with long tail
23.	Juamola*		a small cat

* *Nishi* names of the animals described by the local people and their English names could not confirmed

Among all these species, barking deer was more frequented. Other commonly seen animals are capped langur, wild boar, dhole and jackal. Sambar, tiger, leopard, Asiatic black bear, elephants and gaur are rarely seen.

6.7 Comparison of the results of relative abundance of animals across the survey methods

Proportion of time spent in collecting information through different approaches show that 63% of the total time was spent for village interview and 37% on trail survey. Comparison of survey results of these two methods indicate that out of 23 species, only 26% of the total species were encountered in the trail survey. The species time curve for trail thod shows that within 16% of the time spent, all the species (26% of total species) were encountered through this method (Fig. 12) and there was no new species or increase in species encounter rate after this time.
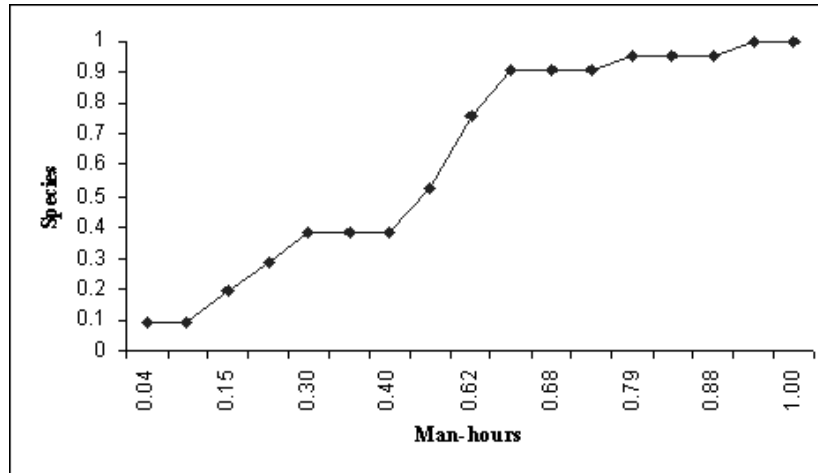
Fig. 12 The species time curve for the trail survey. The proportion of the total number of species encountered is plotted against the proportion of total man-hours spent.

Based on the time spent with each villager, a species time curve was developed for village interview method and it was found that there was a gradual increase in the number of species as more and more people were interviewed. Only after spending 95% of the total time with the villagers, information on all the species were obtained. It appears that more than 50 man-hours are needed with villagers to get information on all the species encountered and to reach the asymptote in the species time curve (Fig. 13).
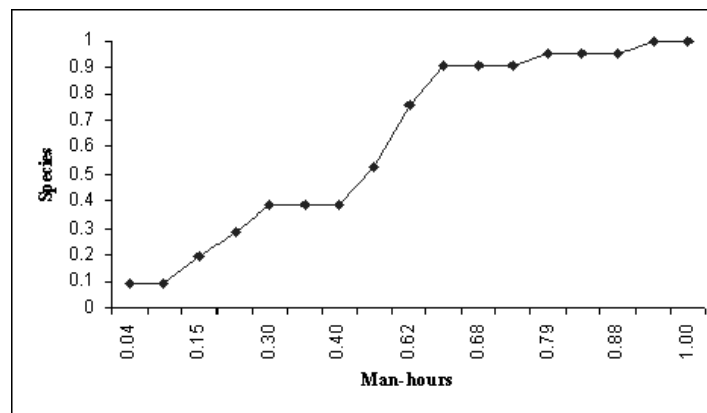
Fig. 13 The species time curve for the village survey. The proportion of the total number of species encountered is plotted against the proportion of total man-hours spent.

6.8 Comparison of the results across different regions

A comparison of species diversity across similar habitats elsewhere was attempted to estimate an expected number of species that could be key species or easy to locate or species of conservation interest for the survey area. A comparison of species recorded in some of the regions in Myanmar was made. Some regions in Myanmar have similar landscapes, altitude and terrain, some similar wildlife species, low density of human groups, with similar cultural or traditional affinities, food and other

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resource gathering approaches through shifting cultivation, hunting of wildlife and dependency on forest products. In Myanmar, Bogo Yoma, Rakhine Yoma and Alaungdaw Kathapa National Park (AKNP) regions, number of species reported are 24, 21 and 20 respectively (Varma. *pers. obs*), with an average of 21.6 (95% CI 18.7 to 24.4) species.

If current survey species number is also included, an average of 22.2 (95% CI = 19.9 to 24.1) species could be calculated for all these regions. Based on this, an expected number of 20 to 24 species (this assumption is based on the 95% CI of the average number of the species of all these regions) could be computed for the survey area and the current survey estimated a number of 23 species. If the species number reported for large mammals in mixed deciduous habitat in south India is included, an average of 25 (95% CI = 18.7 to 31.2) key species could be estimated (Sivaganesan & Desai, unpublished report; Varma *pers. obs*). A comparison across both evergreen (Southeast Asia) and mixed deciduous (south India) shows that the expected number of species for
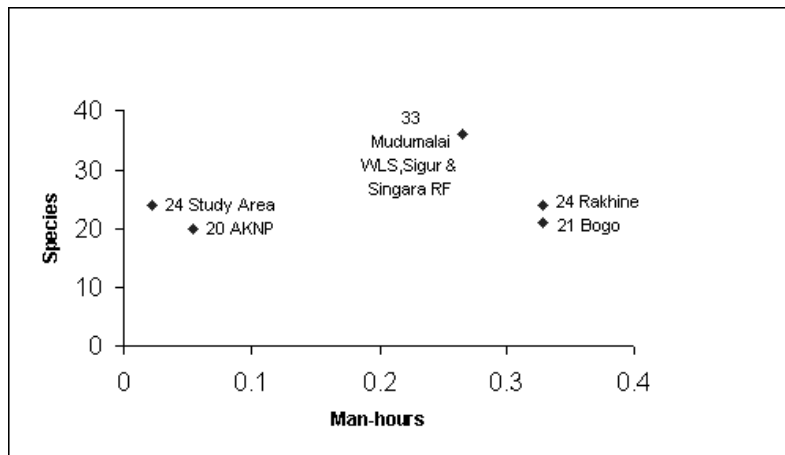
Fig. 14 Number of Species encountered across different regions

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the survey area could be 19 to 31. The other interesting part of the comparison is that with only 0.37 % of man-hours all the species are encountered through the current survey (Fig. 14)

7. STATUS OF CARNIVORE-HUMAN CONFLICT

7.1 Status of predator-human conflict

Information on estimated and expected number of key species for the region provided interesting inferences towards the status of prey and predator and their influences on the conflict issues. Through identifying optimal or possible prey species from the list for the region, it was found that the region had more species of predators (56%) than the prey (44%). It is possible that number of *mithun* found here or their encounter rate is more than other prey species and this summons for a comparison of encounter rate of all species, including *mithun*. Comparison of all the species encountered through trail survey shows that the frequency of occurrence of *mithun* was 64%, canids 14% and deer only 5% (Table 2). Comparison of *mithun,* canid and deer show that *mithun* signs seen was 77%, canid was 17% and deer was only 6%. Comparing deer and canids, the canids dominated (73%). Between the deer and *mithun*, deer signs frequency was only 7%. This pattern could suggest that there may be relatively more *mithun*s or they are encountered more followed by canids and the sign or encounter rate of natural prey was very low.

Table 2 Percentage of species-wise encounter rates of signs

S.No	Species	I	II	III	IV	V
1	Bear	0.88	2.4			
2	Elephant	15	41.4			
3	Deer	5.3	14.6	6.3	27.2	7.6
4	Small Carnivore	0.88	2.4			
5	*Mithun*	63.7		76.5		92.3
6	Canid	14.1	39	17	72.7	

I = % of all species;II = % without *mithun*;III = % of deer, *mithun* and canid, IV = % of deer and canid, V = % deer and *mithun.*

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Through village survey, it was found that barking deer, wild pig, capped langur, dhole and jackal were the more commonly reported prey and predator species (Table 3). Rarely seen prey and predator species are sambar, gaur and tiger.

Table 3 List of species sighted frequently and occasionally by villagers

S.No	Frequently	Occasionally
1	Barking deer	Tiger
2	Capped langur	Sambar
3	Dhole	Asiatic black bear
4	Jackal	Elephant
5	Wild pig	Gaur
6		Wild goat (species unknown)

7.2 Prey-predator interaction and its influence on predator-human conflict

Given the tough terrain, dense forest cover, poor visibility, low density and encounter rate of animal species, less or no resources and with less time availability, it is not easy to understand the prey predator interaction and its implication on the predator-human conflict in the present survey. However, a comprehensive knowledge of prey predator interactions, specifically on some of the predators and their prey species (focus species of the survey) is available from other studies and this would positively provide an insight to the problem of carnivore-human conflict. This information can be incorporated into the current state of affair and a few possible solutions to the problem could be determined. In tropical mixed deciduous forests of south India and in Sri Lanka, spotted deer (*Axis axis*) is the most preferred species of leopards and dhole (Muckenhirn & Eisenberg, 1973; Venkataraman *et.al*., 1995; Varman & Sukumar, 1993; Johnsingh, 1983; Karanth and Sunquist, 1995; Arivazhagan, *1998*). This species is not found in the survey area. In south

India, where spotted deer are found in large number, sambar biomass consumed is only 7 to 9% by leopard and 0-5% by dhole (Arivazhagan, *1998*). However, in mixed deciduous and evergreen dominated Mundanthurai forest of south India, leopard mainly fed on sambar, followed by hare, spotted deer and livestock (Sathya Kumar, 1998).

In the grassland and shola habitats of Eravikulam National Park, southern India, where spotted deer was absent, sambar formed the major prey species of dhole (Easa, 1995). In mixed deciduous and moist evergreen forests of Khao Yai National Park in central Thailand, predominant prey species of dhole across all seasons was sambar and the percentage selection was 60 to 100% (Sean, unpublished report). In Mudumalai forest of southern India, tiger showed a strong preference for sambar (Varman & Sukumar, 1993), though the density and biomass of spotted deer was more than the sambar. In Eravikulam, sambar formed the major prey of most of the predators though Nilgiri tahr dominates in biomass (Easa, 1995). In Nepal, it preyed upon spotted deer (79%) and evidences of sambar was absent in scat, probably due to sambar being confined to specific area, which are not used by tiger (Stoen & Wegge, 1993). This suggests that wherever spotted deer is not found or found in low density, sambar become the optimal prey species for all these predators and it could be the optimal prey species in current survey area also.

Among the medium sized prey, barking deer was only the second major prey and seasonal variation in the selection by dhole was 0 to 30% across the season. Surprisingly, the deer were not found in greater proportion of sample given the abundance of the prey in the region (Sean, unpublished report). Remains of wild pig were found to be in small proportion in leopard scats in Nagarhole, and in another areas in south India, presence of remains of wild pig in leopard scats was only 0-4%. There is a speculation that due to the aggressive nature of the prey, some of these

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predators avoid species like wild boar (Karanth and Sanquist, 1995). Very interestingly, tiger in Nepal killed wild boar more than expected and barking deer was preferred less. Wild pig has more localized distribution and has distinct foraging areas, hence was more prone to attack by tiger (Stoen & Wegge, 1993). But the reasons for not selecting barking deer by tiger or dhole could be the size of the animal, its nature of being very alert and its patchy distribution (Varma. *per. obs*). Barking deer seems to be a low preference prey species by any of these predators and this was observed in Mudumalai Wildlife Sanctuary of south India (Varman & Sukumar, 1993). This suggest that given a choice, wild pig is more preferred than barking deer and could be the second optimal species in the current survey area.

No or low preference of gaur by predators was observed in south India. Leopard and dhole preference ratio for gaur was zero and for tiger, it was very low in relation to the biomass of the animal (Varman & Sukumar, 1993). Gaur is reported from the survey area and in the absence or low density of primary or secondary optimal prey species, gaur could be part of the food species of some of the predators, at least of tiger. However, their large body size, alertness and low encounter rate may make them difficult to be hunted (Varma. *pers. obs*). When there is an overlap of prey selection, competition may result among the predators.

This phenomenon has been observed between dhole and leopard (Venkataraman *et al.,* 1995). In spite of high biomass and prey diversity, leopards are apparently ousted to the periphery of the park in Nepal, suggesting co-existence based on inter-species competition rather than food availability (Stoen & Wegge, 1993). The degree of such co-existence of predators in the current survey region is not known but conflict between leopard and dhole and between leopard and clouded leopard could be expected here. That would also restrict the prey availability for some of the predators.

Factors important for a predator to hunt prey species are the number of prey species, their age, size class or body weight but it is unclear to what makes these patterns operate in a given area. With the variety and large biomass, leopard in Serengeti National Park killed 30 species of prey (Bertram, 1978) and the same number of species were reported in Tai National Park, Ivory coast (Hoppe-Dominik, 1958). Including peacock (*Pavo cristatus*), 10 species were killed by leopard in south India (Arivazhagan *1998*) and small prey was found to be in significant percentage in leopard diet in Tsavo (Hamilton, 1976). Dholes in central Thailand region are reported to have a very broad prey base that includes birds, insects, reptiles, large and small mammals and scavenging carrion. From the scats of dhole, porcupine quills, termite exoskeleton, birds' feathers, snake scales and rodent hair were reported (Sean, unpublished report).

With reference to the size class and body weight of prey, dhole killed more spotted deer fawns. Fawns were found to be in greater proportion than their availability in the population (Venkataraman *et al*., 1995). It was found that there was no correlation of body weight of the prey killed and pack size of dhole and this pattern could not be due to the group size but by number of hunters present in a pack (Venkataraman *et al*., 1995). Among all these predators, tiger seems to be very specific in terms of its habitat and prey selection. Like other regions, dhole and leopard may depend on a broad prey base and this would be decided by low density and encounter rate of optimal and other prey species found in the survey area.

The survey region is known for its primate diversity (Sarkar *pers. com.*) which could form a prey base for predators and hence it is important to have an understanding on the choice of the predators on primates. Being arboreal and cryptic, some of the predators have ability to hunt primates

in comparison to other predators. However, when prey is abundant, primates are taken occasionally (Seidensticker, 1983). High level of vigilance, relatively low body weight or biomass, availability of other prey species are also factors responsible for the predators to avoid primates (Varma. *pers. obs.*). In areas where predators depend on primates, the proportion was observed to be very low. For example, leopard kills in different sites in south India was reported to have only 3-4% and 6% of arboreal prey and the primate preference ratio was lower than the other species selected (Venkataraman *et al*., 1995; Arivazhagan *et al*., 2000). However, in Gir Wildlife Sanctuary, western India, Chellam (1993) found that 25% of the leopard kills were of common langur (*Semnopithecus entellus*). Tiger kills on common langur in Nepal were observed to be 2.2%.

Primates were hunted by tiger only when some individual come down to ground and thus, they are occasionally hunted and their curiosity of observing or following predators may result in their attack (Varma *per.exp*). Hoolock Gibbon (*Hylobates hoolock)* and pig-tailed macaque (*Macaca nemestrina*) are quite common in Thailand and no hair of these animals was found in analyzed fecal samples of dhole in Thailand (Sean, unpublished report). Proboscis monkey (*Nasalis larvatus*), pig-tailed macaque (*Macaca nemestrina*) and even orangutans (Santiapillai and Ashby, 1988; Santiapillai, 1989) are killed by clouded leopard in Borneo (Davis, 1962; Payne *et. al.,* 1985). This predator, believed to be entirely arboreal may depend more on primate species. However, information from villagers shows that the animals are equally seen on the ground (Rabinowitz, 1998).

This may suggest difficulties of hunting primates or that they do depend on large terrestrial prey. Deer, porcupine and pigs are reported to be killed by clouded leopard and occasionally catching fish has also been reported

(Santiapillai and Ashby, 1988). Prater (1971) has reported clouded leopard to hunt large mammalian prey. Illegal logging and uncontrolled fuel wood collections and shifting cultivation are responsible for habitat or prey loss for this species (Santiapillai and Ashby, 1988; Santiapillai, 1989). The present survey region has four species of primates *viz.* slow loris (*Nycticebus coucang)*, rhesus macaque (*Macaca mulatta*)*,* Assamese macaque (*Macaca assamensis)* and capped langur (*Trachypithecus pileatus*) (Sarkar.*pers.com*) and how much of these species are part of predator's diet in the survey area is not known.

The major issue of carnivore-human conflict arises through predators preying on domestic animals and therefore it is a prerequisite to have knowledge on the relationship from other regions. When large cats live in proximity to human habitation, the amount of conflict at the border area is inevitable (Sawarkar, 1989). If density of cattle is more than wild prey in forest edges and if the predators are free ranging, then cattle is prone to attack. Factors such as free ranging, presence of the grazers with the cattle and time of cattle entry and exit from the forest also need to be considered (Venkataraman *et al*., 1995; Arivazhagan *1998*). In south India, the reasons behind leopard depredation on 20 cattles within 5 months was speculated to be depletion of prey bases and higher encounter rate of domestic livestock (Arivazhalagan, 1998).

In Mudumalai, cattle were preferred by a substantial extent by dhole. However, they were not killed in proportion to their availability or biomass. This could indicate less preference for cattle or availability of variety and good density of natural prey (Venkatarman *et al*., 1995). Cattle biomass consumed by dhole was 6-26% and more cattle (26%) were killed in cattle dominated area (Venkataraman *et al*., 1995). The pattern of more cattle getting killed (37%) in cattle dominated area was observed for leopard and they preferred cattle (17%) even in less cattle dominated

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area (Arivazhalagan, 1998). These observations on selection of cattle as prey could suggest two models; cattle are killed more in cattle dominated area (through their density or encounter rate) and even with the availability of variety of prey or convincingly good density or biomass of them, these predators do prey on cattle.

Based on the observations from the previous studies, expected prey predator interaction or choice of prey for the current survey area is summarized in Table 4.

Table 4 Expected pattern of prey selection for the survey area

Sl. No	Prey	Tiger	Leopard	Wild Dog	Clouded Leopard	Jackal	Asiatic Black Bear
1	Sambar	XXXX	XX	XX	XX	-?	-
2	Wild boar	XXX	X	X	?	-	-
3	Barking deer	XX	XX	XX	?	X	-
4	Gaur	X	-	-	?	-	-
5	Small prey	-	XX	XX	-	XXXX	XX
6	Primates	-	X	-	XX	-	-
7	Cattle	X	XX	XXX	X	?	X

X: Order of selection of prey (the rating is based on size, patchy or place of distribution and availability of prey species to a given predator).
XXXX : Primary, XXX: Secondary, XX: Tertiary, X: Less selection, ?: Not known

7.3 Status of *mithun*

The population of *mithun* in each village varied with the number of families in each village. There was a greater inconsistency in the number reported. The villages surveyed, on an average had around 250 *mithun*s. Average number of *mithun* owned by a villager is 13. *Mithun*s are used as bride price in *Nishi* community and *Nishi* women are gifted with *mithun* by bridegrooms during the wedding. The source of *mithun* for the *Nishi* is

mostly through bride price (53%) and they also purchase it from either market or from other villages whenever they require them (14%) and the rest (33%) of the villagers interviewed said that they own the *mithun* through family property. Seventy two percent of the villagers reported that there is a decrease in the number of *mithun* reared in the villages over years (Fig. 15). This is attributed to the rise in expenses and the demand of more *mithun*. Some also attributed to their deaths due to carnivores.
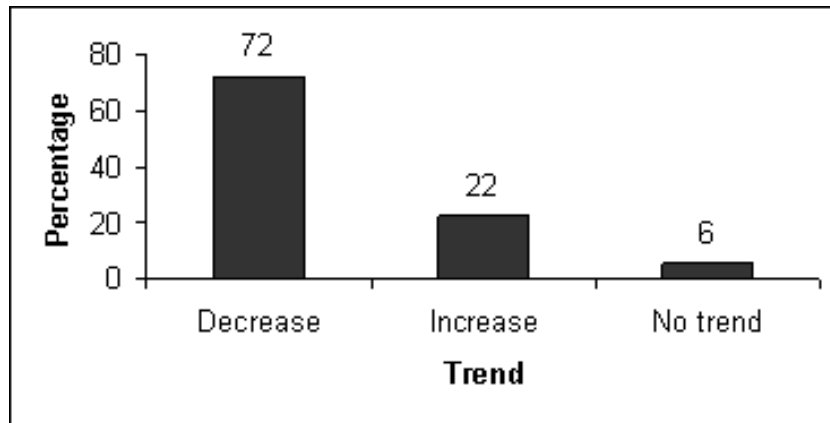
Fig. 15 Changes on the trends of *mithun* in the villages based on interviews with villagers

7.4 Status of conflict

Out of six villages visited, one village (Jothe) reported no conflict. Villages where conflict was reported felt (82%) that dhole was the problem animal, 6% interviewees felt it was tiger and the remaining felt that other carnivores were also responsible for the problem. In the case of dhole, the sites where the *mithun* were killed were around 1 km from the village. If the attack was by tiger, the site was much farther from the village (2-5 km).

The frequency of attack could not be ascertained through the questions. However, the attacks by tiger are less frequent than the dholes. Over all,

dhole, leopard, tiger and Asiatic black bear are known to kill *mithun.* Dholes were claimed to take more *mithun* while bears occasionally killed them*. Mithun* calves were reported to be primarily attacked and calves of 2 months to 1 year old were reported to be more vulnerable to attacks by carnivores. There were reports of *mithun*s of age class up to 7 years old being attacked by predators and there is an indication that more females die due to such attacks. Pregnant females are especially more vulnerable. However, there was a feeling that calves are susceptible to attack during the calving season of March-April. There are reports of m*ithun* getting killed in January, October and November. Disease and accidents (falling-off the cliffs and due to land slides) are also other causes of deaths of *mithun* (Fig. 16). *Mithun* population has shown a declining trend due to indiscriminate slaughter during customary rights and festivals (Anon, 2001b). However, death due to predators is reported to be more.
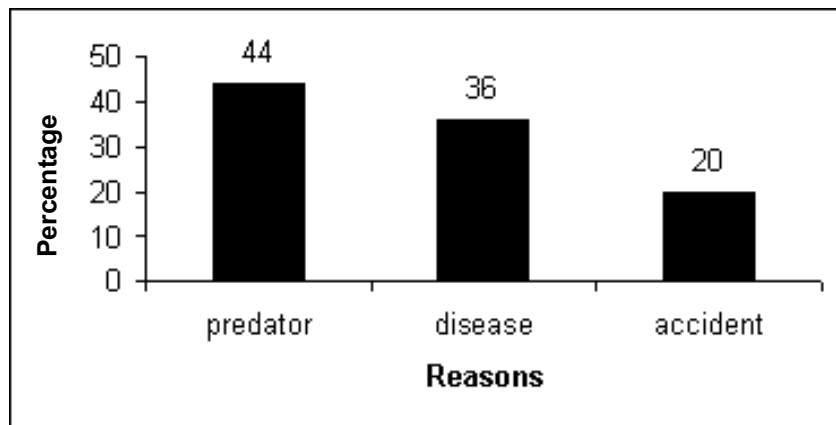
Fig. 16 Percentage of reasons attributed for *mithun* deaths

7.5 Involvement of Dholes

From the earlier investigations, forest department and other source of information, the dhole appear to be a major source of conflict. Based on earlier complaints by people of Sagalee sub-division and subsequent site visit and investigation by forest department officials (District Wildlife Warden, Deputy Chief Wildlife Warden, Range Forest Officer, Poma) in 2000, 85 *mithun*s including calves and domestic animals were reported to have been killed by the dholes. Leopard and tiger were also reported to be attacking *mithun*, but number of animal attacked by them appears to be low. Assessment of livestock depredation in Sagalee suggests that dholes were responsible for most of the predation followed by leopard, clouded leopard and tiger in and around Sagalee (Babu & Venkataraman, 2001). The complaints from people registered in the records of the Itanagar WLS shows dhole as a major contributor to the conflict. In 2000, two *mithun* calves observed by a researcher in the Apop and Sango settlements in Sagalee division were reported to have been attacked by dholes (Babu, unpublished report). Both the calves had teeth marks around the anal, the areas of attack were eye and lip region, a sign of dhole attack. There were no claw/bite marks around the neck to indicate the attack by a large cat. The field investigator was shown one *mithun* calf (3 months old) with injuries around snout and on the rear end in Rillo village. The owner informed that the calf was rescued from dhole attack and later treated by a veterinarian.

7.6 Population status, resource gathering and socio-economy of villagers

The survey revealed that each village has an average number of 300 people belonging to around 45 families. The major source of income and subsistence is agricultural practice either through *jhum* or permanent agricultural practice. In some villages, *jhum* is the major source of

income. Agriculture is practiced for 8 months roughly from January to August. Maize (*Zea mays)*, Paddy (*Oryza sativa*), yam (*Dioscora spp*), ginger (*Zingiber officinale)*, chilli (*Capsicum annuum*), millet (*Setaria spp*), cucumber *(Cucumis sativus)*, pumpkin (*Cucurbita maxima*), papaya *(Carica papaya)* and few other vegetables are grown in *jhum* field. There is no fixed size of land for this cultivation. Paddy is the only crop grown in permanent agriculture land and each family owns around 3 acres of land. The cropping season is June-July, harvesting is done in December, and an average annual income through these agricultural practices per family could not be determined, as crops have less commercial value but cultivated mainly for subsistence. Villagers rear chicken (*Gallus domesticus*), goats (*Capra hircus*) and pig (*Sus domesticus)*. *Mithun* is purchased through cash and it costs Rs. 20,000 to Rs. 25,000.

7.7 Review of earlier surveys and recommendations

Ever since the problem has been highlighted, there were few surveys and suggestions for understanding and alleviating the carnivore-human conflict issue. Initial survey of the problem was carried out by Babu (2001) and was followed by Varma & Subba (2001). Babu (2001) had suggestions related to the management of the problem through establishing effective wildlife or conservation wing within the forest department, fenced enclosures to keep m*ithun* and keeping watcher or guard dogs. Translocation of problematic predator/s, development of a livestock compensation fund, and conservation of wildlife species outside Protected Area also were few management-oriented solutions to the problem. At local level, community participation is important through which the hunting and trapping of wildlife species could be stopped. Developing alternate sources of revenue based on extraction of forest products through joint forest management and assuring forest benefits to local communities, possibilities of eco-tourism and employment for local people will help in solving the issue.

There were some overlaps in the results and suggestions made by the previous surveys. However, some specific recommendations were made by Varma & Subba (2001). They suggested a specific area of 20 to 30 acres for construction of an enclosure to keep the *mithun*s during gestation period in consultation with villagers. Location and the design of wire fences to block the trails of *mithun*s and dholes were also discussed in the recommendations. Appointment of temporary watchers (3 persons/village) from the villages to monitor the dhole movement and patrolling the affected area were also part of the proposed solutions. They had given more emphasis for a comprehensive understanding of the problem through collecting detailed information of conflict villages, number of *mithun*s in the villages and other related information. Requirement of information on Protected Areas surrounded by the villages (the list of prey species within the Protected Areas and village limits), number of *mithun*s, dholes and other predators killed over a period of time were also discussed by them. People and landscape based information, area under shifting cultivation and its role in creating secondary forests, list and number of wildlife species found and hunted by the villagers before and after shifting cultivation practice would also be important. As problem is community based, there is a necessity to understand their recommendations. They also were skeptical about the suggested recommendations. If these recommendations are accepted and killing of dholes can be stopped with the support of villagers, time gained by this process may help in understanding the problem more clearly, based on which a long-term solution could be evolved.

8. DISCUSSION

The current survey area is dominated by more open forest indicating a large-scale damage to forest cover in the region. However, its influence on wildlife is not known. Studies in Laos show that excessive agricultural

activity of shifting cultivation not only decreased the forest cover, but also changed the forest into open secondary woodland shrub. Survey done on large mammals in eastern Cambodia identified the practice of shifting cultivation as one of the threats to wildlife habitat (Desai, 1996). On the other hand, in the recent survey, patterns of high encounter rate of species in less closed trails and species time curves for all the trails could support the assumption that open forests attract more large mammals. It is also possible that the secondary forests permit more undergrowth and provide greater forage availability for herbivores, and may allow carnivore to venture in. However, it is also possible that signs are easy to sight in the open forest than the closed forests. More importantly, primary forests were not walked during the survey and the status and hence the encounter rate of secondary forests could not be compared.

Species encountered through trail survey was very low and this could be reflection of low density of wildlife species. The species (26 % of the total number) encountered during the survey were within 16% of time and this pattern suggests that more attempts are needed to encounter the remaining 74% of the species. In village interview method, 60% of time was spent in obtaining the information. However, the information on wildlife species is based on a vast and accumulated experience and knowledge of villagers. This survey also illustrates that not only the number of people, but the time spent with each person is also a very important factor for obtaining reasonable level of information about a species. If enough time is not spent, it is likely that different people could refer a single species as two different ones or two different species could be considered as one. Yet, it is important to know the optimal period to be spent with a given person for the investigation. When there is a constraint of time, resources and manpower, there is a need to identify a robust way of collecting the information and this is possible only through adopting all existing methods or developing new approaches for data collections (Varman & Sukumar, 1995; Varma, 2000 ; Varma, 2001).

As experienced by Duckworth (1997) in Vietnam, villagers gave convincing reports of several key species of mammals through village surveys providing vital information of expected species in the survey area. The trail survey indicated a low density or encounter rate of animals in this region. Example of low density or encounter rate has been observed in other regions of Southeast Asia and a number of reasons could be speculated. Duckworth (1996) attributed these to the shy nature of the species, hunting pressure and setting fire by villagers.

Comparison of results from other regions indicates that the survey result matches with the expected number of species for regions that have similar settings. Conversely, when observations are compared with the regions with less or no similar affinities, there is a variance in the results. However, these surveys (area that are compared) resulted in knowing only key species or species that are easy to spot and has given no guarantee for others that are lesser known.

It is important to note that there is a difference between numbers of mammalian species found in a given region and expected number of species that could be encountered through surveys or experience of exploring forests. In Nam Phu National biodiversity area of Lao PDR, after 300 man days of survey, 46 species of non-volant terrestrial mammals were reported (Arun *pers.com*) and Duckworth (1996) reported 30 species for training and model forest of the Vientiane Forestry College in Laos. Desai 1996 reported 44 species of mammals for Monddulkiri and Rattanakiri provinces of eastern Cambodia and there is no assurance that all the mammalian species of these region are found through the surveys. The other important factor is the total area and number of mammalian species reported for a region. Sivaganesan & Desai (unpublished report) reported 33 species for 120 km^2 forest and only 31 species for 321 km^2.

This could indicate that there may be a relationship between the number

of species and quality of area or micro habitat found in a given area and the species number may not be related to the size of area. Apart from these uncertainties, the surveys need a lot of time, resources and expertise for all the species present to be encountered in a region.

A number of reasons could be identified for current survey area having more predators than prey species. The area could provide a variety of habitat niches for range of predators. These predators may be in a very low density, but the wide choise of prey species (including livestock) they have adopted to hunt may sustain a variety of predators in this region. Predators are also hunted for meat or commercial use. However, their low density, nocturnal habit and elusive nature makes them difficult to be located and hunted. For large prey species, the secondary forests may permit more undergrowth and provide more forage space. However, the reason that could restrict their numbers are the availability, density and distribution of food species. Secondly they have been hunted heavily for meat and for other purposes. The local people have an opinion that barking deer, wild pig and sambar were plenty in the past and with issuing of gun licenses, most of them are hunted extensively and the encounter rates have come down to one or two per year. There is also a feeling that the higher rate of increase in human population (@1120 persons in ten years/ 19 villages) has also contributed to the decrease in prey species, which were hunted to meet the increased requirement (Babu, 2001).

Studies on predators from other regions have given some insight to their feeding behaviour, prey selection and indications that the choice of prey varies from places to place. Overall, factors such as density, encounter rate, optimal size, distribution and anti-predatory behavior of prey have a very important role in prey selection. All these factors have direct or indirect role in prey selection and results in choice of natural prey species or domestic animals. Loss of habitat through shifting cultivation or

extraction of forest produce could have depleted the arboreal prey species. Besides the arboreal predator, tiger, dhole, Asiatic black bear and jackal depend only on a few terrestrial prey species. The lack of adequate number and variety of prey species may have forced some of the predators to depend strongly on *mithun*. The results obtained during the village and trail survey show that the more commonly seen predators have only deer and wild pig as prey and they may not be the optimal or favorable prey species. However, from other studies it is clear that gaur is not an optimal prey species for these predators. Low density or patchy distribution of sambar may make them difficult to hunt. Over all, low density or lack of optimal prey species, relatively high density or encounter rate of cattle and their free ranging nature make the domestic animal susceptible to predation.

The role of *mithun* in generating direct revenue is not known. Apart from other values, there could be an important indirect value to this animal. That is of good fortune, which may be reflected through good harvesting or resource gathering. Death of animal through any sources will not only be loss of money spent on the animal, but could be a de-motivating factor for other important sources of income. In this context, for villagers, killing dholes or other predators (Fig. 17 & 18) has number of values; it solves

Fig.17: Clouded leopard skin (killed by the villagers)
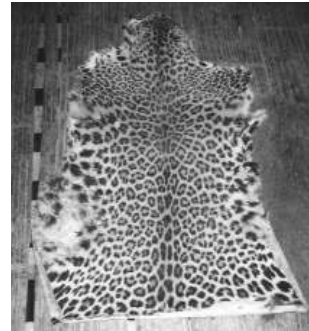
Fig.18:Leopard skin (killed by the villagers)

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their problem of conflict and also creates a source of meat for them. The combination of these two factors could have resulted in active killing of predators by villagers. Even if predators do not kill *mithun*, the predators have higher chances of getting killed by villagers whenever they are encountered. The villagers could justify this as eradication attempts to prevent future attacks on *mithun*. To understand and develop management plans, a number of other factors should be taken into consideration. According to the local people, the predators, particularly dholes go after other *mithun*s even before consuming the hunted one and this partial consumption could also indicate that *mithun*s are not a preferred prey species of the dholes.

Fig.19: Wild dog skin (killed by the villagers)

Solutions suggested by previous surveys have several problems in implementation. Patrolling large area for monitoring *mithun* or predator movement is not practical, identifying interested people for this work is not easy, compensation procedure takes a lot of time and ground investigation delays the process.

The more important question is the quantification of economic loss and the compensation. Factors such as source of fund, process, management and authorities involved make the compensation process even more complex. If there is a capital fund available, it could be used for compensation. A few other problems are false claims and lack of assurance from people that predators will not be killed. Varma & Subba (2001) observed that providing compensation would not solve the

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problems as each *mithun* cost about Rs.15,000-20,000 and a compensation of only Rs. 2000 is given. The amount is not reasonable and acceptable to the villagers. Erection of wire fences to block the trails of *mithun*s could restrict grazing area and *mithun* movement.

There are uncertainties and complexities in understanding the real state of problem. A *mithun* killed by predator is an important economic asset of the human community; the carnivores killed by people are endangered and at risk. Conservation of these species is complex but extremely essential. It is not clear whether it is because of poor understanding or exaggeration or exploitation of the situation? There are compulsions to assign a critical investigation into this issue. It is possible that the low density of prey could be due some ecological reasons rather than the assumed reasons. Increase in the population and their demand on forest resources also need to be analyzed.

The increase in population for 10 years/village was only 6 persons and subsequently there is a decrease (decrease 330 people/6years/19 villages) of 3 people/village. It is important to know what effect this changes in the population, shifting cultivation practice and other activities have on forest and wildlife. It is possible that the government supported forest clearing for commercial plantations, hydroelectric project, road net works and other form of developmental activities have caused more permanent damage than the shifting cultivation. Shifting cultivation may show a high degree of forest fragmentation, but net deforestation by this practice would be very low (Varma *pers. obs*).

As reported by Varma & Subba (2001), the villages, where the *mithun*s are reared are in hilly and tough terrain. Hunting of dholes and other wild animals takes a lot of time and effort. The villagers are not trained shooters and the availability and efforts involved in buying and making guns (cost of a Single Barrel Bridge Loader (SBBL) gun is Rs.18,000)

have favoured the dholes and other animals and hence some wildlife is still left in these areas. If these regions are not viable habitat for large or optimal preys, predators would consider some of the domestic animals as prey species and the conflict with people would continue. Some species of predators have more ecological or conservation value as they are found in low numbers, sensitive to prey and habitat changes. If such species are wrongly identified as problem species and exterminated by local people, that could have severe adverse effect on the species. Dhole appears to be a problem species and specific strategy is needed for conservation. It has been noticed that some locally influential people are benefited by these issues through their political influence. They exaggerate the issue, pressurize the government and its departments to release fund for problem mitigation. The resource is never spent nor accounted. Classification of these issues based on the priority and developing strategy could provide future to the both wildlife and human community of the region.

9. RECOMMENDATIONS

9.1 Forest around villages

The forest around the villages, approximately 2 km up the mountainside, is heavily used under *jhum* cultivation and has a negative impact on the forest cover and has become secondary forest. Secondary forests are good habitats for some species of wildlife, specifically large mammals. Some of these wildlife species, particularly prey species may be hunted by the villagers for food and other resources resulting in depletion of the prey base.

The subsequent increase in the domestic animals in the villages has resulted in shifting of food resource of predators from wild prey species to domestic animals. The status of shifting cultivation and its effect (effect of deforestation or creating a secondary forest), wildlife abundance (past

and present, before and after shifting cultivation) has to be studied through field and village surveys. It is also important to see the long-term viability of the practice in this region and its role in socio economic status of the villagers.

9.2 Hunting and other resource gathering

The dependency of *Nishi* on the forest and its products is well known, but it has not been well documented. *Nishi* have been hunting animals for several years. This is a major activity for them and they do enjoy and feel proud of their hunting skills. There is an urgent need for assessing their dependency on the forest products and the effect of hunting and trapping of wildlife species by them. This information will help in determining the status of prey and predator species and evolve strategies for conservation.

9.3 Developmental activities

Through understanding the past history of the status of dhole (the major predator and focus species of the conflict problem in this region), it was understood that, earlier, dholes were in good number in Itanagar WLS and adjoining areas the developmental activities in the capital complex in recent times have driven the dholes out of Itanagar to its adjoining areas of Sagalee and other areas. There is also a proposal to notify some part of the forest areas here for a number of reasons. Such activities could be also one of the reasons for current status of wildlife and their conflict with the local human communities. Past and current status of the development activities have a major effect on this problem.

9.4 *Mithun*

Mithun being free ranging animals, their actual numbers (by birth or death)/villager or village is not known. This is one of the reasons for the poor understanding of the status of *mithun*, conflict and actual number *mithun* died due to the predator or other causes. Systematic survey of all

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these aspects including direct and indirect value of rearing *mithun* is very crucial.

9.5 Alternate livelihoods

Other than shifting cultivation and irrigation based agriculture practice, the people in the area do not have any other source of income. Many people, during the

Fig.20: Mithun

survey expressed the need for alternate livelihoods.
Some of the suggestions that came from them were pig farm, poultry farm and fisheries, which will decrease the hunting and trapping of wildlife. Such alternate livelihoods were never tried in the area and it is worth giving a try at least in one village on an experiment. The problems encountered can be rectified immediately as these villages are very close to the capital town. A handicraft cooperative society can be set up as an alternate income generating scheme through which their dependency on forest and forest products are reduced. *Galle* (skirt of woven fibre with designs typical to *Nishi)* weaving can be taken up as an activity for supplementary livelihood. Products made up of bamboo (grown sustainably) can be sold through co-operative societies run by villagers.

9.6 Conservation education

Awareness and educational programs are a high priority activity to be taken up in these regions. Depredation of *mithun* by carnivores has created antagonism among the owners of the *mithun*, which has resulted in retaliatory killing. The *Nishi* and other local people should be the primary target groups for educational programme. The objective of the

educational programs should be to change the negative attitude of people towards dholes and other predators. Awareness programme could be carried out through meetings, talks, posters and slide shows in villages. The local schools should also be considered and be involved with the programme.

9.7 Study on the conflict

A long-term study on all aspects of the problem needs to be carried out, particularly in the Poma Range and other areas of Arunachal Pradesh to understand the conflict. Study on prey and predator abundance and distribution of *mithun* would help in understanding conflict issue better. Some aspects of the behavior of prey, predators and villagers should also be given priority in the study. Simultaneously, attempts should also be initiated to understand the population status, socio-economic condition, effect or influence of conflict on the socio economic status of livelihood of the human communities in this region.

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Appendix 1: DATA SHEETS

A) Survey of the status of forest and wildlife through trail survey:

Date	:
Location	:
Start time	:
End time	:
Observer	:
Trackers	:
Distance covered:	

Forest Survey (Observations of every 20 minutes)

S. No	Time	Tree spp.	Local names	Forest category (closed/open/partially open)	Remarks

Wildlife Survey:

S. No	Time	Species			Signs			Remarks
		Name	Sex	Age	Type	Status (Fresh/old)	No	

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B) Survey of status of wildlife through village interviews:

Date:
Village:
Name of the villager interviewed:
Sex/Age:
Location: close to forest/away from forest:

1. Reasons for visiting forests:
2. Time spent per visit:
a. Few hours:
b. One day:
c. > a day:
3. No. of animals seen/ visit:
4. Signs seen/ visit:
5. Animal products used:
a. List:
b. Usage (ornamental/medicinal/consumable/commercial):
6. Season in which more animals are seen:
a. Winter:
b. Summer:
c. Rainy:
d. Other comments:
7. Animals that visit/seen close to villages:
8. Reasons for visiting villages:
9. Any damage to property / people: cattle/chicken/crop/salt/arrack/ others:
10. Overall species list/person:

C) Survey on human population, socio- economy, *mithun* and conflict.

Date:
Village:
Name of the villager interviewed:
Age:

1.   No. of people in the village:
2.   No. of families in the village:
3.   No. of persons in the family of person being interviewed:
a. Male:
b. Female:
4.   Status of habitat around the village:
a. Logged:
b. Jhummed (bambooed/Reeded/other):
c. Forested:
5.   Source of income:
a. *Mithun*:
b. Crops:
c. *Jhum:*
6.   Amount generated/crop/year:
7.   Type of agriculture:
a. Permanent agricultural land (Wet crops/Dry crops):
b. *Jhum:*
8.   Crop data:
a. Name:
b. Area:
c. Season of planting:
d. Season of harvesting:
e. Income generated:
9.   Other source of income:

10.	Amount generated/ month
11.	No. of *mithun*s in the village:
12.	No. of *mithun*s owned by the person interviewed:
13.	Source of *mithun*:
	a. Purchase:
	b. Bride price:
	c. Family property:
14.	Since when *mithuns* have been reared in the community:
15.	Changes in the number kept over a period of time:
	a. Increase:
	b. Decrease:
	c. No change:
16.	Reasons for keeping *mithun*s:
	a. Status:
	b. Wealth:
	c. Ritual:
	d. Marriage:
17.	Any resource generated through *mithun*s:
18	Maintenance cost of *mithun*:
19.	Reason and number of *mithun* deaths:
	a. Accident:
	b. Disease:
	c. Predators:
	d. Natural :
20.	Animals that attack *mithun*:
21.	Place of attack:
22.	Frequency of attack:
23.	Season of attack:
24.	Age class of *mithun* attacked:
25.	Source of information about *mithun* death:
26.	Remarks:

Appendix 2: Details of the trail and village survey

a. Trail Survey

Sl. No	Trails	Distance (Km)	Man-hours spent (%)
1	Rillo	6	38
2	Khoimir	7	39
3	Moin	8	23
		21	

b. Village Survey

S. No	Time spent (min)	Man-hours spent(%)
1	45	5
2	47	5
3	60	6
4	30	3
5	120	12
6	56	6
7	45	5
8	38	4
9	180	18
10	35	3
11	27	3
12	58	6
13	60	6
14	34	3
15	56	6
16	62	6
17	55	6

Appendix 3: Methods of hunting and trapping wildlife

Some of the indigenous methods to trap animals are still in use We came across two traps (noose trap) set up on a tree branch to trap canopy-dwelling animals. The bait was tied to the branch with a string (reed) and a loop was made around the bait. The bait, in this case, a nut was positioned within the loop in such a way that the animal is forced to walk through the loop to get the nut. The end of the string is tied a heavy stone (around 3 kg weight). As the animal tries to feed on the nut, the loop would loosen and lock the animal in the loop. The animal gets trapped and the heavy stone connected to the loop would not allow the animal to escape. The trapped animal would get strangled and dies.

A trap (locally called *pan*) to capture/kill tiger was demonstrated to the field investigators by the villagers. The trap works on the principle of lever release. The trap is made up of a cane string tied on the trail at half feet above the ground. The string is then tied to the sharp bamboo spear, which is hidden in the bushes on the one side of the trail. The string is held tight that a slight disturbance in the string releases the bamboo stick. Any movement of animal over this trail would dislodge and release the bamboo spear hidden in the bushes and the kills the animal. The bamboo used in this trap is a special one and is usually grown in higher regions. This particular bamboo species is also believed to give some itching sensation and infection in the wound and would not heal so fast. There are times when humans have got killed by this trap. In one such accident, the person who has laid the trap had to give 15 *mithun*s as compensation to the victim's family. There was a decision made by the *gaon burrahs* not to use this trap any more and since then such traps are not used. Earlier, these traps were used very often, now there are more people and chance of humans getting injured or killed is high. According to the villagers, dholes can be killed using this trap. These days, villagers carry guns (SBBL) when they go to forests. They say it will protect them from wild

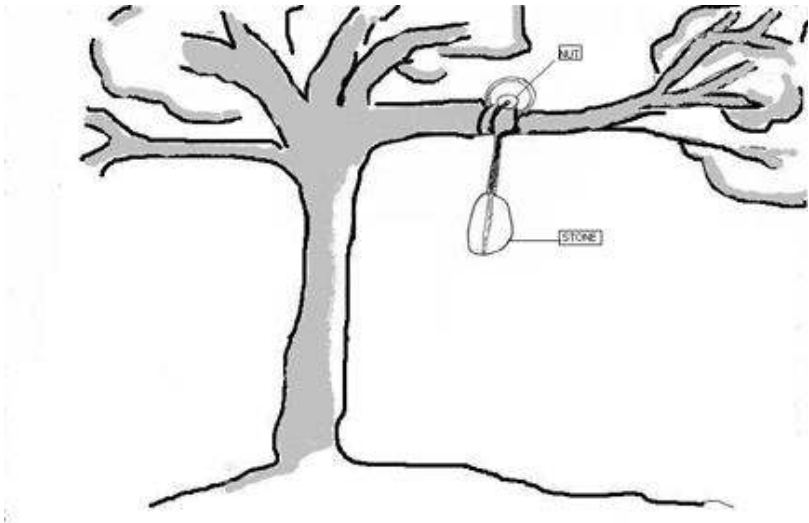animals and also used for shooting animals and birds (Fig. 21 and 22).

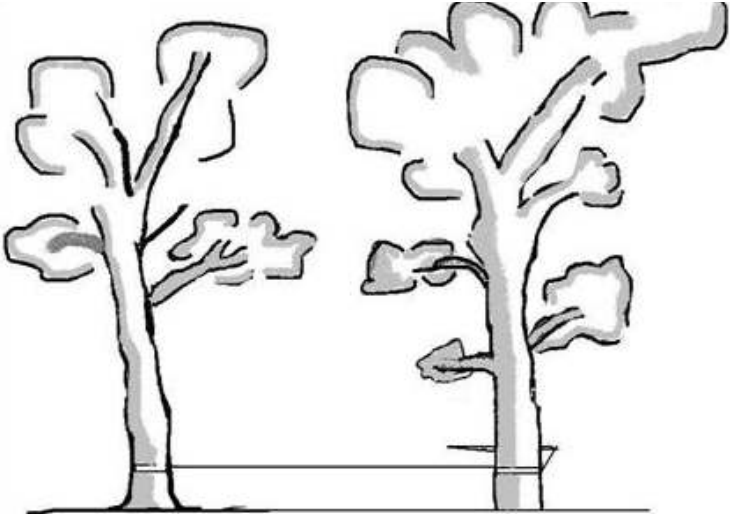Fig. 21: Trap for capturing small canopy dwelling animals.

Fig. 22:Trap used to capture/kill tigers and other trespassers(as demonstrated to the field Investigator)

Appendix 4: List of animal products and their usage.

Species	Body parts	Ornamental	Medicinal	Consumable	Commercial
Barking deer	Skin, horn	Mat, display		Meat	
Wild goat (?)	Skin, horn	Bag, display		Meat	
Hornbill	Beak, feather	Headgear			
Capped langur	Skull	Display		Meat	
Asiatic black bear	Skin	Shoulder belt	Bile		Sale
Greater racket tailed drango		Head gear			
Mithun	Horns, skin	Display, mat		Meat	Sale

Appendix 5: Glossary of *Nishi* names for animals

Paga – Hornbill

Path – Tiger

Siyal – Jackal

Eery   - Pig

Seb - Mithun

Goru / se – Cow

Sutun – Bear

Sachar – Sambar

Soku – A small canopy dwelling animal

Sorai – Birds

Taas – A small canopy dwelling animal

Langni – Racket-tailed drongo

Brum – Python

Kitla pohu – Porcupine

Aama kochchi –

Sekke –

Tahi –

Soni – Leopard

Sachcha – Dhole

Sibin – Goat

Paro – Chicken

Sebi – Langur

Sath – Elephant

Haren – Deer

Talim – Gaur

Niol – Mongoose

Nyoro – Forests

Aja mira – Khaleej pheasant

Tasu/ taso – jungle cat

Juamola – A felid (spp?)

Sukung – canopy dwelling animals

squirrel-like brown coloured small animal.

canopy dwelling animal (brown-black colour, long tail, diurnal, pair-living)

small, long tail, canopy dwelling

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Globally, carnivores face many threats including habitat modification and fragmentation, diminishing prey base, poaching for skin, bones and claws and direct persecution by people following attack on livestock. As a free ranging livestock found only across north-east India, Mithun (*Bos gaurus frontalis*) a semi-domestic bovid is susceptible to predation causing economic loss to the villagers. The villagers retaliate by killing the predators 'thought' to be responsible for the depredation. This survey attempts to identify the causes of conflict, incorporating socio-economic and livelihood strategies of local communities, status of mithun, predators and wild prey. It also identifies methods for documentation and compares and reviews methodologies adopted to investigate the status of forest and relative abundance of wild prey and predator and their influences on carnivore-human conflict.