EXTRACTION OF MAMMALS AND ITS IMPACTS ON BIODIVERSITY OF ARUNACHAL PRADESH, INDIA

P. Chutia[1], G. S. Solanki[2] & O. P. Singh[3]
Department of Zoology, D.R. College, Golaghat, Assam. India[1],
Department of Zoology, Mizoram University, India[2]
Centre for Environmental Studies, NEHU, Shillong, India[3]
E-mail: pabitra_sagar@yahoo.co.in

ABSTRACTS : The present study deals with tribal people participating in hunting exercise, their age group and the categories of animal extracted. The mean age of the hunter is found to be 35.5 (±12.3) years, the age group ranges from 16 - 57 years (N= 157). A total of 43 mammalian species have been extracted from natural habitat that includes carnivores, ungulates, rodents, primates, bear, chiropterans and pholiodota. Among the three studied tribal groups, the Nyishi has extracted maximum mammals followed by the Apatani and the Monpa group. Hunting tools are categorized as traditional and modern. Mechanical trap, spear, and bow and arrow are among the traditional hunting tools and the cartridge gun and explosives are the modern hunting tools. The rate of hunting animals is high among the Nyishi (44 %), and the Apatani (34 %) as compared to the Monpa (22 %) for mammals. The extraction of threatened categories of mammals such as vulnerable (52 %), endangered (24 %), and lower-risked or near threatened (20%) have been recorded in the study. The distances to different forests from the villages are one factor of animal hunting. Forest dwellers generally hunt more frequently than others, because they can devote more time in hunting. Thus it is found that the distance from the villages have negative correlation with hunting.

Key words : Mammal hunting, biodiversity, Arunachal Pradesh, impact in ecology

INTRODUCTION

Extraction of animals from wilderness for sustenance has been the way of life in many tribal communities. In the present study, the capturing of wild mammals, birds and reptiles, dead or alive, irrespective of the techniques used for the purpose has been considered 'hunting'. The kill obtained by hunting are utilized by different tribal groups differently viz; meat as protein supplements in diet, for traditional medicines, trophies and socio-cultural celebrations. Therefore, the rate of extraction and utilization of the animal species affect the population of species and the entire biological community of the region as well.

In recent decades the sustenance has been taken over by commercial extraction, the most common cause of animals' extinction followed by habitat destruction (Reid, 1992; Forester and Machlis, 1996; Mc Kinney, 2001; Harcourt and Parks, 2003). The habitat destruction and degradation, as per current assessments, are major activities that have depleted the animal species, which may ultimately lead to extinction of important species (Hillon-Taylor, 2000; Bird Life International, 2004). The conservation of animals is concerned with the documentation and analyzing the pattern of extraction of animals in tropical forests (Robinson and Redford, 1994; Bodmer *et al.*, 1997; Wilke and Carpenter, 1999; Robinson and Bennett, 2000; Bakarr *et al.*, 2001). Little information is available on amount and mode of extraction of animal species from forest habitat in the world. This information is essential and important in those areas where habitat loss is leading to decrease in population of species. Extraction of wild animals for meat on socio-cultural and magical and religious occasions has been a part of traditional life style in many tribal societies in African and Asian countries. Traditional hunting techniques have been documented in different geographical regions in accordance with the cultural entities of ethnic groups (Bailey and Aunger, 1989; Colell *et al.*, 1994). Each ethnic group has developed their own trapping and hunting techniques, the ways of utilizing animal resources and types of products derived from the animals. A study on hunting and bushmeat utilization has also been carried out in tropical African and neo-tropical countries (Auzel and Wilkie, 2000; Eves *et al.*, 2002). Bennett and Robinson (2000) and Bennett and Rao (2002) have studied the hunting and wild meat consumption in Asian tropical forests and reported that some of the animal categories have been hunted to observe their animistic ritual pelts and use as traditional and aphrodisiac medicine in ethnic societies. The Himalayas is one of the most important region in the world due to rich biological

diversity and contains many endemic and threatened animal species (Baillie and Grombridge, 1996; IUCN Red List, 2003) that are utilized by various ethnic people to maintain their rich cultural traditions (Borang, 1996; Sethi and Hilaluddin, 2001; Harit, 2001; 2002; Solanki, 2002; Solanki and Chutia, 2004; Solanki *et al.*, 2004; Solanki *et al.*, 2005). The biotic disturbances such as habitat loss, degradation of habitat and socio-cultural activities are a major cause for fast declining of primate population in northeast India (Srivastava *et al.*, 2001; Sunderraj and Johnsingh, 2001; Kumar and Solanki, 2004), but other groups of animal have not been given the desired attention. Wilderness species are protected from hunting and trade through the wildlife (protection) Act, 1972. But hunting in Eastern Himalaya, which was traditionally for subsistence, has become trade oriented among the tribal people of the region. Hunting and trading of animals and their parts still continue at an unknown scale. The Eastern Himalayan region including Arunachal Pradesh being a part of 'Hotspot' in India has its own significance at regional and international level. Therefore it becomes imperative to understand the phenomenon methodically. Therefore, present study has undertaken to understand the hunting practices and techniques, quantification of hunt and their impact on biodiversity in the region.

MATERIALS AND METHODS

Arunachal Pradesh, the largest state among north-eastern region covering an area of 83,743 km², is the part of Eastern Himalayan range situated between 26°28´ to 29°30´ N longitude and 91°51´ to 97°30´ E latitude. 10 - 15% villages of Nyishi, Monpa and Apatani tribes were surveyed to gather the information on hunting aspects, number and types of species hunted in last three years. Data were collected through personal interviews with inhabitants of villages about the number of persons/families involved in hunting. The above information collected was as per the structured questionnaires (Sethi and Hilaluddin 2001; Solanki *et al.*, 2002).

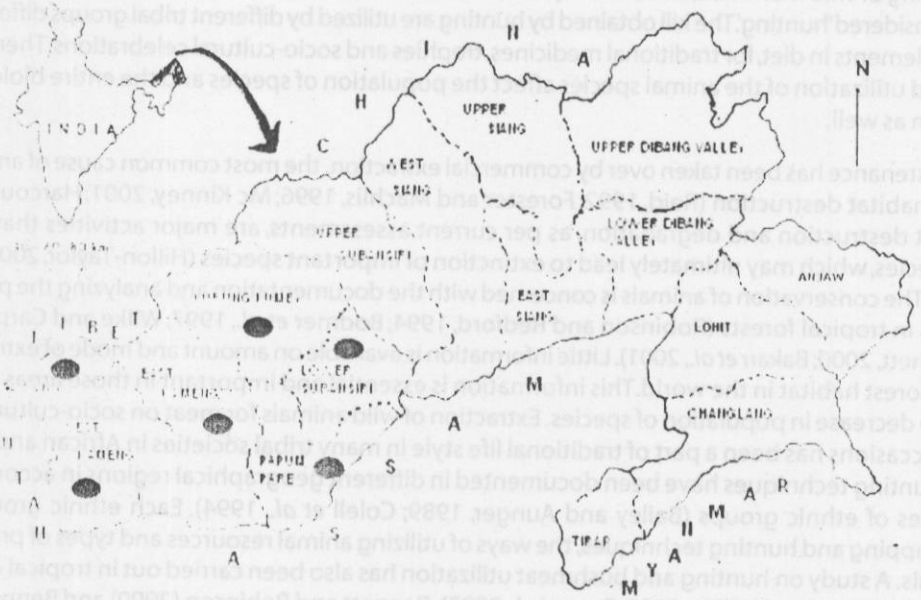

Fig. 1 : *Map of Arunachal Pradesh showing collection stations*

Longitude: 91°36´– 97°30´E Latitude: 26°30´– 29°28´N

Information on hunting and its related aspects are collected within social and cultural constraints in as much it is not possible every time to select people randomly for interview due to non-availability of respondent and sometimes the respondent is reluctant to answer. Data collected on the subject are analyzed for test of variance with the nonparametric chi-square (X^2) test. Correlation and regression analysis are applied to test the relationship with distance between the villages and hunting ground/forest, and the extent of hunting. Number and types of species hunted and the reasons

associated with hunting are also analyzed and evaluated. Extraction patterns of the species are analyzed at two levels: (a) the distance of hunting site from the villages, (b) the number of animals killed each year and the number of individuals involved in it. Age group of the persons involved in hunting was also recorded and analyzed for identifying the age group intensively involved in hunting. Extracted species were identified with the help of vernacular names of animals provided by the villagers and later identified and confirmed with the help of reference books on relevant species. Indirect evidences of animals hunted like skull, horns, trophy, skin, and their numbers were collected from the households.

RESULTS

157 hunters responded to our queries on the different aspects of hunting. Male persons are exclusively involved in hunting and the age of the participants ranges from 16–57 years. The mean age of the hunter is 35.5 (± 12.3) years. The age group of hunter between 26 to 35 years is most common. However, the various age groups are not the same in all the tribes, the age group between 16 to 25 years is recorded in all the Nyishi, Monpa and Apatani tribes, whereas the age group of 26 to 35 years is recorded only in the Nyishi and Apatani tribes. The results indicate that the most active age of hunters is between 26 to 35 years where the section of experienced hunters associated with active group is up to the age of 55 years. Thus the experienced group shares their expertise and carries on field training to the younger groups.

Animal categories extracted: All the tribal groups under the study extracted the mammals. The details of the mammals extracted are given below.

41 mammal species are recorded to be extracted from their natural habitat (Table 1). Different mammalian groups harvested and their percentages in harvested lots are given in Figure 2. Among the mammalians the major groups extracted are carnivores (39%), ungulates (25%), rodents (15%), and primates (8%). Different intensity of hunting is recorded in all the three tribal groups. The Nyishi have extracted maximum mammals (44%) followed by the Apatani (34%), and the Monpa (22%).

However, the Nyishi tribe extracted 35 mammalian species, the Monpa and the Apatani tribes have extracted 38 species of each. Extracted mammaliam species of the Nyishi tribe consists of carnivores 37.14%, ungulates 22.9%, rodents 17.14%, primates 8.6%, bear 5.8%, pholiodota 2.9 % and chiropteran species 5.8%. Extracted of mammalian groups of the Apatani tribe is composed of 42.1% carnivores, 18.42% ungulates, 15.8% rodents, 13.16% primates, 2.7% bear and pholiodota of each and 5.27% chiropteran. The Monpa tribe has extracted carnivores 39.45%, ungulates 26.31%, rodents 15.8%, primates 7.9%, bear and pholiodota 2.7% of each, and chiropteran species 5.26%. The pattern of groups of mammals harvested, predominantly carnivores, ungulates, rodents and primates is uniform in all the tribal groups. But the amount of harvest is not uniform in all the tribes. Extraction of carnivorous species by the Apatani tribe is highest.

Extraction of ungulates is carried out more by the Monpa, rodents and primate species by the Apatani. However more number of bear, pholiodota and chiropteran species are extracted by the Nyishi which is followed by the Monpa and the Apatani tribes. Majority of animal species extracted belong to the threatened categories as per IUCN classification. More than half of the harvested species belongs to the vulnerable category and one fourth to the endangered category. The details of categories of the harvested species are given in Figure 3.

Hunting season and tools : Hunting is intensive during 'jhuming' and after harvesting of the crops mainly in the month of October-December and April-May. September and October are the suitable months for group hunting for all the tribes. However, hunting time and seasons vary with species to species. Capturing and killing of bear, larger cats particularly leopards are carried out during night by the Monpas and the Nyishis.

Hunting tools used by hunters : Tribal people have used various types of indigenously designed mechanical trap for hunting.

(a) Bows and arrows: It is a common hunting technique practiced by all the tribes. Different tribes call them differently in their own dialect. Bows and arrows are made from bamboo. The sharp metallic triangular tip on an arrow is smeared with root tuber of *Aconitum ferox*, which is poisonous in nature and immobilizes the animal fast and ultimately kills it. (b) Mechanical Traps: Different types of mechanical traps are traditionally used to capture and kill different types of animals such as tigers, deer, rodents and birds. (c) Guns: Guns are the modern weapon of hunting owned by persons who are politically strong, economically sound and often literate and used by most people of the "basti" in addition to the owner. Both air gun and cartridge gun are used in killing birds and other wild animals.

Table 1. Average number of mammals extracted by the Nyishi, Monpa and Apatani tribes (2002-2005). (Number of hunters, 0-species not hunted)

Animal	Common name	Scientific name	Number of animals Categories		
			Nyishi	Monpa	Apatani
Carnivores	Tiger	*Panthera tigris*[E]	1.10 ± 0.10 (10)	0.0 (0)	1.20 ± 0.18 (5)
	Leopard	*Panthera pardus*[V]	1.14 ± 0.09 (14)	1.20 ± 0.18 (5)	1.13 ± 0.13 (8)
	Clouded leopard	*Neofelis nebulosa*[V]	1.16 ± 0.17 (15)	1.43 ± 0.19 (7)	1.30 ± 0.16 (10)
	Leopard cat	*Felis bengalensis*	1.33 ± 0.14 (12)	2.00 ± 0.20 (7)	1.30 ± 0.16 (10)
	Marbled cat	*Felis marmorata*	1.38 ± 0.18 (13)	1.80 ± 0.13 (8)	1.60 ± 0.16 (10)
	Jungle cat	*Felis chaus*	1.25 ± 0.10 (19)	2.10 ± 0.09 (10)	1.70 ± 0.14 (12)
	Large Indian civet	*Viverra zibetha*	1.20 ± 0.08 (25)	1.33 ± 0.12(15)	1.80 ± 0.13(20)
	Himalayan palm civet	*Paguma larvata*	1.20 ± 0.08 (25)	1.33 ± 0.12 (15)	1.60 ± 0.12 (22)
	Yellow throated marten	*Martes flavigula*	2.18 ± 0.17 (17)	1.70 ± 0.20 (12)	2.12 ± 0.21 (17)
	Yellow bellied weasel	*Mastela kathiah*[V]	2.17 ± 0.20 (18)	1.50 ± 0.14(12)	1.80 ± 0.19 (17)
	Siberian weasel	*Mastela sibirica*[V]	0.0(0)	2.0 0± 0.22 (10)	2.40 ± 0.25 (10)
	Beak striped weasel	*Mastela strigidorsa*[V]	0.0(0)	1.50 ± 0.19 (10)	1.90 ± 0.07 (15)
	Beach marten	*Martes foina*	0.0(0)	1.70 ± 0.14 (12)	1.90 ± 0.07 (15)
	Common mongoose	*Herpestes edwardsi*	1.39 ± 0.08 (37)	1.70 ± 0.14 (12)	2.10 ± 0.19 (10)
	Small Indian mongoose	*Herpestes javanicus*	1.80 ± 0.12 (26)	1.80 ± 0.15 (14)	2.50 ± 0.25 (10)
	Otter	*Lutr lutra*[V]	2.24 ± 0.14 (30)	2.20 ± 0.20 (20)	2.40 ± 0.18 (25)
Ungulates	Barking deer	*Muntiacus muntjac*	2.52 ± 0.17 (29)	2.00 ± 0.13 (20)	1.90 ± 0.05 (30)
	Sambar	*Cervus unicolor*	2.52 ± 0.20 (29)	1.80 ± 0.16 (25)	1.80 ± 0.09 (30)
	Moschus	*Moschus moschiferus*[V]	1.75 ± 0.25 (4)	1.33 ± 0.12 (15)	0.0 (0)
	Hog deer	*Axis porcinus*[L]	1.88 ± 0.11 (32)	0.0(0)	2.20 ± 0.13 (20)
	Serow	*Capricornis sumatraensis*[V]	1.50 ± 0.10 (30)	1.80 ± 0.09 (20)	1.60 ± 0.10 (25)
	Goral	*Naemorhedus goral*[L]	1.88 ± 0.09 (34)	1.60 ± 0.15 (15)	2.05 ± 0.04 (20)
	Bharal	*Pseudois nayaur*[L]	0.0(0)	1.70 ± 0.09 (20)	0.0(0)
	Takin	*Budorcas taxicolor*[E]	0.0(0)	1.03 ± 0.07 (15)	0.0(0)
	Yak	*Bos grunniens*	0.0(0)	2.50 ± 0.22 (20)	0.0(0)
	Mithun	*Bos frontalis*	6.73 ± 0.26 (72)	5.60 ± 0.22 (10)	6.60 ± 0.40 (32)
	Wild boar	*Sus scrofa*	2.39 ± 0.09 (38)	2.00 ± 0.17 (15)	2.70 ± 0.17 (27)
Rodentia	Porcupine	*Hystrix indica*	2.67 ± 0.29 (24)	2.00 ± 0.12 (15)	2.70 ± 0.11 (20)
	Malayan giant squirrel	*Ratufa bicolor*	2.31 ± 0.17 (13)	2.40 ± 0.24 (10)	2.70 ± 0.20 (15)

	Red-bellied squirrel	*Callosciurus erythraeus*	2.50 ± 0.13 (14)	1.90 ± 0.14 (18)	1.90 ± 0.40 (20)
	Giant flying squirrel	*Petaurista pitaurista*	2.21 ± 0.11 (14)	1.90 ± 0.16 (18)	1.90 ± 0.04 (18)
	Himalayan striped squirrel	*Tamiops macclellandii*	2.13 ± 0.13 (15)	1.70 ± 0.13 (20)	2.20 ± 0.11 (18)
	Bamboo rat	*Cannomys badius*	5.03 ± 0.47 (29)	1.80 ± 0.13 (20)	9.80 ± 0.77 (20)
Primate	Assamese maccaque	*Macaca assamensis* [V]	2.49 ± 0.19 (39)	2.06 ± 0.14 (18)	2.50 ± 0.15 (20)
	Rhesus macaque	*Macaca mulatta* [L]	2.95 ± 0.24 (39)	1.70 ± 0.11 (18)	2.80 ± 0.15 (20)
	Slow Loris	*Nycticebus coucang* [DD]	0.0(0)	0.0(0)	1.20 ± 0.18 (5)
	Caped langure	*Trachypithechus pileatus* [E]	2.70 ± 0.20 (40)	2.50 ± 0.25 (10)	2.33 ± 0.23 (15)
	Hoolock gibon	*Bunopithicus hoolock* [E]	0.0(0)	0.0(0)	1.20 ± 0.18 (5)
Bear	Himalayan Black Bear	*Selanactos thibetanus* [V]	2.33 ± 0.11 (18)	2.50 ± 0.25 (10)	2.13 ± 0.17 (15)
	Sloth bear	*Ursus ursinus* [V]	1.55 ± 0.11 (21)	0.0(0)	0.0 (0)
Pholiodota	Chinese pangoline	*Manis pentadactyla* [L]	1.74 ± 0.13 (18)	1.60 ± 0.12 (15)	1.90 ± 0.05 (30)
Chiroptera	Flying fox	*Pteropus giganteus*	1.73 ± 0.19 (11)	2.70 ± 1.30 (10)	3.10 ± 0.41 (10)
	Short nosed Bat	*Cynopterus sphinx*	3.29 ± 0.28 (21)	1.60± 0.120 (15)	1.90 ± 0.05 (30)

Species categories as Endangered (*E*), Vulnerable (*V*) Lower Risk/ Near threatened (*L*) and Data deficient (*DD*) respectively, (2003 IUCN Red List)

Hunting frequency of different tools used by the Nyishi, Apatani and Monpa tribes have been shown in the Table 2. All four different hunting tools viz., gun, bow and arrow, spear and mechanical traps are more effective tools. The gun is the most effective hunting tool. Hunting frequency of the most effective tool, gun is: 41.3% per year by the Nyishi, 51% by the Apatani and 50% by the Monpa tribe.

Hunting frequency and site distances : The distance between village and hunting sites in forest is one of the major factors that influence the frequency of hunting. The distances of villages from their hunting arena have shown negative relationship with hunting frequency. The regression analysis between the hunting frequency and the distance of hunting area in forests from villages shows a significant negative correlation for mammal ($R^2 = 0.79$, $P < 0.001$, $df = 29$, Figure 4) by the Nyishi tribe. The Apatani tribe also shows similar tendency ($R^2 = 0.72$, $P < 0.001$, d.f = 22, Figure 5). However, the regression analysis is not significant in case of the Monpa tribe ($R^2 = 0.048$, $P < 0.001$, df =50, Figure 6).

Frequency of hunting: Hunting frequency is classified into four categories namely very often, often, sometimes and rarely. The hunters who claim to hunt one to three times per week come under the category of very often. It was found that 30% hunters undertake hunting very often, 21% often, 18.4% hunters sometimes, and 18.4% rarely. Chi-square analysis of hunters motivation in hunting shown significant results, $X^2(4) = 2.89$, $P < 0.05$. The rate of hunting mammals is high among the Nyishi and the Apatani i.e. 2.5 animals/hunter/year as compared to Monpa, 1.9 animals/hunter/years. Thus, the rate of killing is more among the Nyishi. Apatani tribe hunts mammals more frequently than Monpa people (Table 1).

Reasons cited for hunting : An attempt is made to identify the various causes of hunting of wild animals by the ethnic people. The study reveals that 44% respondents cited utilitarian reasons for hunting such as economic benefit and for food supplements, 18% cited cultural reasons and 18% hunted for enjoyment. But, 19% respondents do not hunt wild animals for personal reason and 1% do not hunt owing to moral or ethical reasons. Chi square analysis of response (positive and negative, yes/no) on hunting of wild animals has been done ($X^2 = 13$, $P < 0.05$, d.f. = 4).

DISCUSSION

Hunting of wild animals is common all over the world in tribal inhabiting countries like China, Vietnam, Yunnan, Indonesia, South America, West and Central Africa (Eudey, 1999). This practice is also not un-common in Indian counterparts; northeastern region shows a prominence

Table 2: *Details Hunting tools and animal kills (2002-2005)*

Hunting tools	Nyishi		Apatani		Monpa	
	No. of kill	% of kill	No. of kill	% of kill	No. of kill	% of kill
Gun	191.5	41.3	197.0	51.0	157.0	50.0
Mechanical trap	121.5	26.1	140.0	36.3	110.0	35.0
Spear	75.00	16.1	23.5	6.1.0	23.5	7.1
Bow and arrow	75.00	16.1	25.0	6.4.0	23.5	7.0

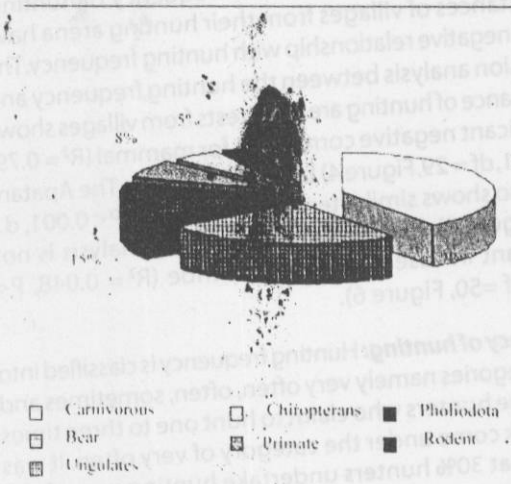

Fig. 2 : *Compositions of mammalian groups extracted*

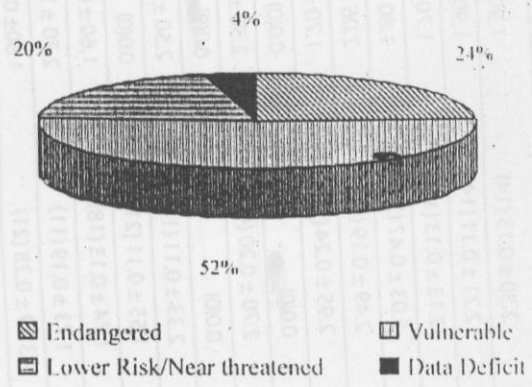

Fig. 3 : *Categories of threatened mammals extracted*

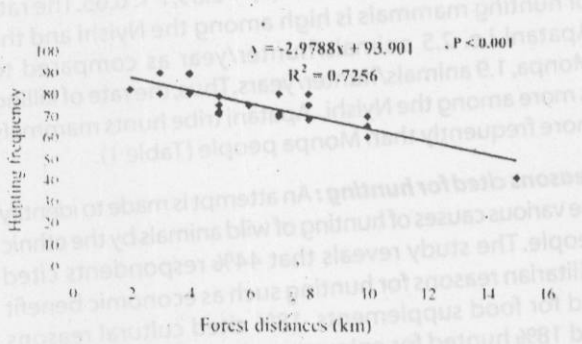

Fig. 4: *Relationship between hunting frequency of mammals and distance of village from hunting area in Nyishi tribe*

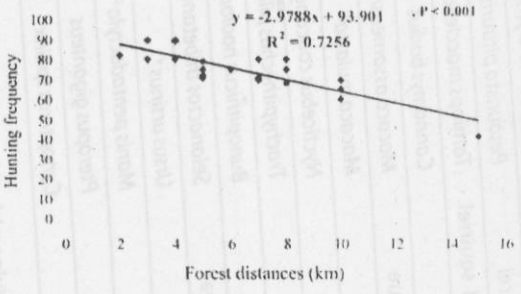

Fig. 5 : *Relationship between hunting frequency of mammals and distance of village from hunting area in Apatani tribe*

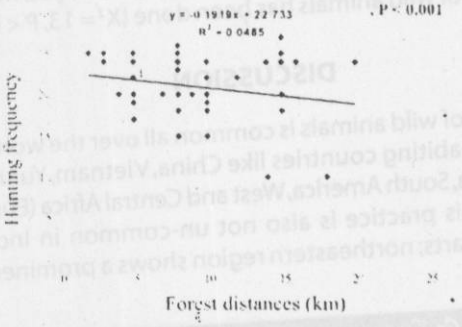

Fig. 6 : *Relationship between the hunting frequency of mammals and the distance from the village from hunting area in Monpa tribe*

in it (Garit, 2002; Borang, 1996; Solanki and Chutia, 2004). Arunachal Pradesh encompasses large ethnic diversity (Solanki, 2002) and all ethnic groups hunt wild animals for food and for their body parts which they use in different socio-cultural, magical and religious practices and also traditional medicines practice. Hunting and poaching is found to be seasonal activity, maximum numbers of animals are extracted in winter and pre monsoon season. The agricultural pattern i.e. jhum cultivation, appears to be the deciding factor in hunting intensity. Before the start of agricultural operation, the hunters remain free from other engagements. Categories of animals hunted also depend on season. The hunting frequency of non-human primate, bear and hornbill mainly increases during agricultural operation. Among all the three tribes, the Nyishi tribe is the more extensive jhum cultivator than the Apatani and the Monpa. Therefore, the total number of animals killed by the Nyishi per year is more as compared to that of the Apatani and the Monpa tribes (Table. 1). The Monpa tribe extracts more animal species than the other two tribal groups as more animal species diversity exist in their region but the frequency of extraction of animals is more in case of the Nyishi and that is due to intensive hunting practices than the others (Table 1). Hunting of wild animal for trading of bushmeat and their body parts is the prime activity among the local people and has become a way of life in many ethnic groups. Anadu *et al.* (1988) has recorded the species of mammals including primates that are sold for cash money in the local market of South-Western Nigeria. Illegal trade of bushmeat and animal body parts of primates have frequently been recorded in African countries (Anadu *et al.*, 1988; Auzel and Wilkie, 2000), the situation is not different in north-eastern region in India. Such practices are also frequently observed in Arunachal Pradesh (Dutta, 1998; 2000; 2002; Solanki *et al.*, 2002; Solanki and Chutia, 2004). Madhusudan and Karanth (2000) have studied the local hunting compatibility with large mammal conservation in Western Ghat, India. During the slash and burn cultivation (jhum cultivation) the selling of wild animals mainly wild boar, deer, porcupine, sometimes civet, primates and bear meat is frequent in local markets of Arunachal Pradesh. Studies of hunting in the Peruvian Amazon have shown that hunters prefer large bodied mammals and mammals with high economic value (Cowlishaw and Dunbar, 2000). In Arunachal Pradesh all the Nyishi, the Apatani and the Monpa tribes have selected medium-sized animal, preferably ungulates for meat. The rate of loss of mammals estimated due to these practices in the tribal groups is 1653 per year. The contribution of the Nyishi for loss of animal diversity is maximum i.e., 722 mammals /year followed the Apatani and the Monpa, where the loss of species is 568 individuals/year and 363 individuals/year respectively. Various other factors associated with life style and their use values in tribal communities in Arunachal Pradesh also plays a pivotal role. The socio-cultural, magical and religious and therapeutic activities prevailing in the ethnic groups and the use values of particular animal categories are most common reasons for hunting. Sacrifice of animals in graveyard, bride prize of marriage ceremonies are the common example of cultural practices of both the Nyishi and the Apatani tribes. The Monpas have different cultural and religious back-ground because of their belief in Buddhism. They are different from the other two groups in the use pattern of animals and their body parts. Therapeutic uses of particular animals and their body parts such as the musk of musk deer, the gall bladder of bear and non-human primates used by all the Nyishi, the Apatani and Monpa tribes are common probably due to indigenous knowledge system. These factors lead to the hunting of wild animals in the regions.

A large number of mammals and birds mainly Galliformes are hunted in the western Himalaya and many of these are of conservation concern (Fuller *et al.* 2000; IUCN 2003). Out of the 43 mammalian species hunted by the tribal communities in Arunachal Pradesh, twenty-four (56%) species fall under the Endangered, the Vulnerable, the Lower Risk/Near threatened and the Data deficient category as per IUCN Red List (IUCN 2003). Therefore the species under these categories deserve more conservation concern. The Endangered and the endemic species, like Takin (*Budorcas taxicolor*) are recorded to be hunted in nearly 50% of the Monpas in Tawang. The gun, bow and arrow, and some mechanical traps are the most widely used method of hunting. Alvard (1995) has stated that the change over the technical weapon like shot guns in place of traditional hunting tools has often been proved as one of the factors contributing to over-hunting. Changing technology and its easy access with no accountability imposed on the user is one the major threats for wild animals (Halford *et al.*, 2003). Jhuming activities are not only causing loss of habitat but also altering living environment hence forcing animals to come out in open where they become easy prey to hunter. Eyo *et al.* (2002) in their studies in Congo Basin have reported that habitat loss is the primary cause of wildlife extinction, while hunting for commercial purposes has become the immediate threats to the future of wildlife in Congo Basin. Ellis (1999) has also recorded that hunting of primates for food poses the greatest threats to Gorilla species of West and Central Africa.

Ecological impact of hunting : Redford (1992) has described the empty forest syndrome as a complete phenomenon of habitat depletion as well as hunting of large animals. It is applied in both forest as well as terrestrial ecosystem. The

role of frugivorous animals in seed dispersal as herbivory in pollination and prey predation relationship is also well studied. In the present study it is observed that various kinds of herbivorous animals mainly the deer group and the frugivorous such as non-human primates, chiropteran are mostly hunted. The removal of such species will have a serious impact on genetic diversity, regeneration of tree species and ecosystem as a whole. The genetic variability of trees in the habitat where primates are found will be significantly higher than the habitat where the primates have been eliminated by hunting with other animals (Vo Halle 2002). Thus, hunting of animals, particularly primates will have greater impact on the animal genetic diversity and population structure of plants in the ecosystem at large and the survival of the species as such on long term basis. As has been predicted, when any link in the food chain is eliminated, the whole system will collapse in course of times.

Extraction of herbivorous animals such as deer has another ecological impact. This group of animals has been providing a prey-predator relationship with top carnivorous animals mainly tiger, leopard etc. Species being hunted are the main prey to wild predators. So the reduction of prey base will reduce the survival possibility of natural predator. The improper prey predator ratio leads to conflict with human being. These carnivores resort to domestic animal for food and hence get exterminated. The negative impacts of hunting on animal populations are greatly increased when other anthropogenic activities like deforestation and habitat fragmentation bring addition pressure on animals. Animals become more vulnerable to hunting when available habitat is reduced and access by hunters to forest increases (Mittermeier and Coimbra-Filho 1977; Cormier 2000).

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REFERENCES

Auzel, P. & Wilkie, D. S. 2000. Wildlife Use in Northern Congo: Hunting in a commercial Logging Concession. In: *Hunting for sustaining for sustainability in Tropical Forests.* (Robinson, J. G. & Bennett, E. L. eds.), Columbia University Press. 413.

Baille, J. & Groombridge, B. 1996. *1996 IUCN Red List of Threatened Species*. Gland and Cambridge, IUCN.

Baille, R. C. & Aunger, R. 1989. Net hunters vs. archers: Variation in womens's subsistence strategies in the Ituri forest. *Hum. Ecol.*, 17: 273-297.

Bakarr, M. J., da Fonseca, G. A. B., Mitterneier, R., Rylands, A. B. & Paenenilla, K.W. 2001. *Hunting and Bushmeat utilization in the African rain forest: Prospective towards a blueprint for conservation action*. Applied Biodiversity. Series 2. Washington, USA.

Bennett, E. L. & Robinson, J. G. 2000. *Hunting of Wildlife in Tropical Forests. Implications for biodiversity and forest peoples*. Biodiversity Series 6. Washington.

Bennett, E. L. & Rao, M. 2002. Wild meat consumption in Asia tropical forest countries: Is this a glimse of the future for Africa? In: *In Links between Biodiversity Conservation, Livelihoods and Food Security: The sustainable use of wild species for meat.* (Mainka, S. & Trivedi, M. eds.), Gland Switzerland, Cambridge.

Bird Life International. 2000. *Threatened Birds of World*. Bird Life International, Cambridge, U.K.

Bodmer, R. E. 1995. Susceptibility of mammals to overhunting in Amazonia. In: *Integrating people and wildlife for a sustainable future.* (Bissonette, J. & Krausman, P. eds.). 292-295.

Bodmer, R. F., Eisenberg, J. & Redford, K. 1997. Hunting and livelihood of extinction of Amazonian mammals. *Cons. Biol.*, 11: 460-466.

Borang, A. 1996. Studies on Certain Ethno zoological Aspects of Adi Tribes of Siang District, A.P. India. *Arunachal Forest News*. 14:1-5.

Colell, M., Fa, J. & Mate, C. 1994. Hunting among Moka Bubis in Bioko: dynamics of faunal exploitation at the village level. *Biol. Cons.*, 3: 939-950.

Cormier, L. 2000. Cultural practices benefiting primate conservation among the Guaja of Eastern Amazonia. *Neotropical Primates*. 8: 144-146.

Eudey, A. A. 1999. Asian Primate Conservation-my perspective. In: Dolhinow P. and Fuentes A. (eds.), *The Non-human primates*. Mayfield Publishing company. Mountain View, California. 151-158

Eves, H. E., Robinson, J. G. & Wilkie, D. S. 2002. Why is eating bushmeat a biodiversity crisis? *Cons. Practice*. 3: 28-29.

Foster, D. J., & Machilis, G. E. 1996. Modeling human factors that affect the loss of biodiversity. *Cons. Biol.*, 10: 1253-1264.

Harcourt, A. H. & Park, S. A. 2003. Threatened primates experience high human densities: Adding an index of threat to the IUCN Red List criteria. *Biol. Cons.*, 109: 137-149.

Hart, D. N. 2001. Zoo therapeutic use of Animals in Health Care in Mizoram India, *J. Nat. Con.*, 13: 117-122.

Hart, D. N. 2002. Reports on Porcupine in Mizoram, India. *Him. Env. Zool.*, 16: 27-29.

IUCN. 2003. *Summary statistics for globally threatened species*. 2002 IUCN Red List of Threatened Species.

Kumar, A. & Solanki, G.S. 2004. Ethno-sociological Impact on Capped langur (*Trachypithecus pileatus*), and suggestions for conservation: A Case Study of Reserve Forest in Assam, India. *J. Nat. Cons.*, 16: 107-113.

McKinney, M. L. 2001. Role of human population size in raising bird and mammal threat among nations. *Animal Conservation*. 4: 45-57.

Mittermeier, R. A. & Coimbra-Filho, A. F. 1977. Primate conservation in Brazilian Amazonia. In: *Primate Conservation*. (Prince, N. H. & Bourne, G. H. eds.) Academic Press. New York. 177-166.

Mittermeier, R. A. 1997. Effect of hunting on rain forest primates. In: *Primate Conservation in Tropical Rain Forest*. (Alan, R. eds.) New York. 109-146.

Reid, W. V. 1992. How many species will there be? In: *In Tropical Deforestation and Species extinction*. (Whitemore, T. C. & Sayer, J. A. eds.). 55-73.

Robinson, J. G. & Redford, K.H. 1994. Measuring the sustainability of hunting in tropical forests. *Oryx.*, 28: 249-256.

Robinson, J. G. & Bennet, E. L. (eds.) 2000. *Hunting for Sustainability in Tropical Forests*. Columbia University Press. New York.

Sethi, P & Hilaluddin. 2001. Structural financial empowerment for localized development with joint Forest management: examples from Madhya Pradesh. India. *Sust. Develop.*, 9: 87-102.

Solanki, G. S., Kumar, A. & Chutia, P. 2002. *Impact of ethnic diversity on primates and their conservation in Arunachal Pradesh*. Paper presented in *National* Conference On zoology vision for 21 century, held at Banglore 28-31 December.

Solanki, G. S. 2002. Socio-cultural and faunal diversity of Arunachal Pradesh. *Him. J. Env. Zoo.*, 16: 159-170.

Solanki, G. S. & Chutia, P. 2004. Ethno zoological and socio-cultural aspacts of Monaps of Arunachal Pradesh. *J Hum. Ecol.*, 15: 251-254.

Solanki, G. S., Chutia, P. & Singh, O. P. 2004. Headgear- A cultural artifact and its impact on biodiversity in Arunachal Pradesh, *Aru. Univ. Res. J.*, 7: 35-44.

Solanki, G.S., Chutia, P. & Singh, O. P. 2005. Ethnozoology of Nhishi tribe and its impacts on Biodiversity. *Arun. Univ. Res. J.*, 8: 89-100.

Srivastava, A., Chetry, D., Bujarbarua, P., Das, J. & Sarkar P. 2001a. Status of Primates in Gibbon Wildlife Sanctuary. *Biol. Cons.*, 4: 43-49.

Sunder, S. F.W. & John-Singh, A. J. T. 2001. Impact of Biotic Disturbances of Nilgiri Langur Habitat, Demography and group Dynamics. *Curr. Sci.*, 80: 428-436.

Von Halle, B. O. 2002. Preliminary assessment of the environmental and socio-economic impacts of wild meat harvesting in South America. *The sustainable use of wild species for meat*. TRAFFIC International.61-69.

Wilkie, D. S. & Carpenter, J. F. 1999. Bushmeat hunting in the Congo Basin: an assessment of impacts and option for mitigation. *Biol .Cons.*, 8: 927-955.