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FAUNAL DIVERSITY: STATUS, THREATS AND MANAGEMENT OF KEDARNATH VALLEY, GARHWAL HIMALAYA, INDIA

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Abstract

The present study was conducted in the Kedarnath Valley located in the Garhwal Himalayan region of Uttarakhand. This valley is a rich repository of unique wildlife resources. Wildlife resources are represented in four vertebrate classes, 100 species belonging to 103 genera and 53 families, 26 species belonging to 21 genera and 14 families of mammals and 56 species belonging to 49 genera and 26 families of avian are present. However, 13 species belonging to 13 genera and 7 families of reptilians and 5 species belonging to 3 genera and 2 families of amphibians are also present in Kedarnath Valley. 17 species belonging to 17 genera and 4 families of butterflies are present in the Valley. Some vertebrates have been listed as threatened in IUCN RED List and are listed in different Schedules of Wildlife (Protection) Act, 1972 of India. The present study finds many natural and anthropogenic activities to threaten biodiversity and finds future strategies for the better conservation and management of the wildlife and improvement of the habitat of the wildlife species in the Kedarnath Valley.

Keywords: Biodiversity; Garhwal Himalaya; IUCN; Kedarnath Valley; Wildlife

Introduction

The Himalaya is a rich repository of unique biodiversity. The Himalaya is well recognized for its rich biological, ecological, hydrological, aesthetical and socio-cultural values [1]. The Uttarakhand state has reported a recorded forest area of 38,000 km^2. It is contributed by reserve forest (69.86%), protected forest (26.1%) and unclassed forest (13%) to the recorded forest area. The state has 6 National Parks, 7 wildlife sanctuaries and 2 conservation reserves covering an area of 13,202,26 km^2 [2]. The substantial area that has been classified as Reserve Forest which is very rich in wildlife and such areas are contiguous to protected areas and, in most cases, act as buffer.

Wildlife composition and distribution patterns are primarily governed by the elevation, forest composition, climatic conditions, geography and human settlements. The elevation is the key factor, which is high particular in many ways. With a steady increase in altitude, the climate, landscape and forest composition are transformed gradually and influence the wildlife composition. The proposed study area extends from temperate to alpine zones; the faunal forms are adapted to alpine meadows, high altitude environment, inhabiting cliffs, forested slopes and valleys.

Uttarakhand Himalaya is well known for its faunal diversity and huge flora. It consists of six National Parks, seven wildlife sanctuaries and one Biosphere Reserve. More than 600 species of permanent and migrated birds are found in Uttarakhand. Hundreds of tree species and

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innumerable kinds of flowers, herbs and insects can also be seen. Kedarnath Musk Deer Sanctuary, Tungnath Meadow (*Bugyal*) and Madhmaheswar Meadow attract researchers, scientists, nature lovers and students from all around the world.

Uttarakhand Himalaya provides habitat for many rare and endangered species of mammals and birds like Snow Leopard, Musk Deer, Monal, Snow Cock and some pieces of Snow Partridge and Vultures. Many species of mammals and birds migrate to the alpine region because they can survive up to the temperate forest region. Jim Corbett National Park is famous for tigers in Terai (foothills) of Uttarakhand. Many species like Leopard, Bharal, Thar, Sambar, Beer, Blue Sheep, some species of deer are found in abundance.

Experimental part

The study area

The very beautiful and world-famous Kedarnath Valley is located in Ukhimath Tahshil of Rudraprayag district, Garhwal Himalaya, Uttarakhand. The Kedarnath Valley is located between coordinates of latitude 30°25' to 30°45' N and longitude 78°55' to 79°20' E (Fig. 1). The survey was carried out in 20 villages of the Kedarnath Valley, which are located at an elevation of 864 m above m.s.l to 4,000m above m.s.l and spread over an area of 1,248km^2 including 248 villages. The population of these villages is 87,024 including 44,410 females and 42,614 males [3]. Kedarnath Valley is famous for their forest, wildlife, wild edible plants, medicinal plants, bugyals (alpine grasslands), many religious places and world famous Kedarnath and Tungnath temple.

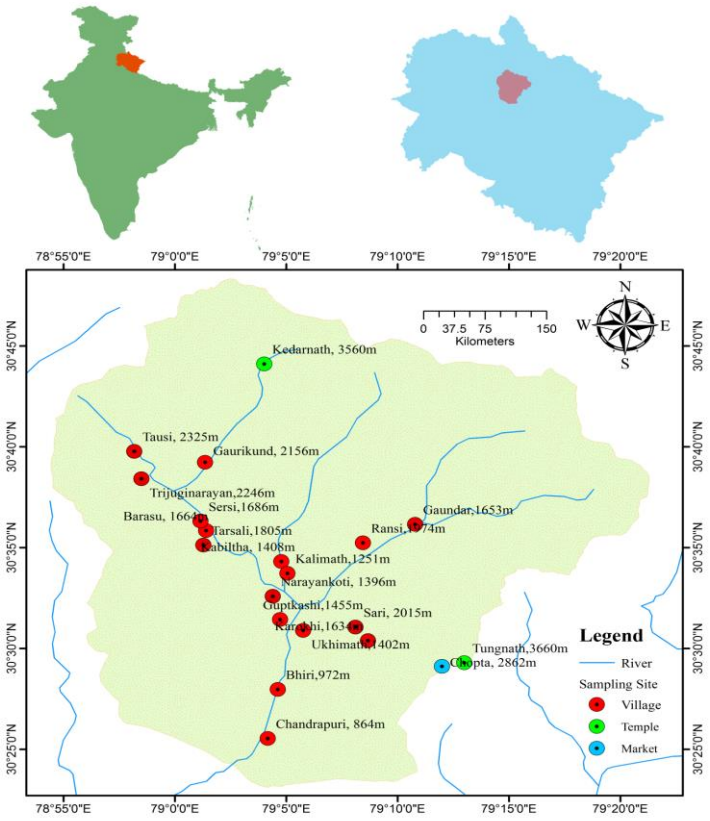

Fig. 1 Location Map of the Study Area: The Kedarnath Valley

Methodology

Wildlife resources will be studied with the help of methods standardized by the Wildlife Institute of India (WII). The strategies for the conservation and management of the Kedarnath Valley will be chalked out keeping in view every component of the ecosystem and applying the ecosystem approach. The conflict in resource exploitation will be minimized for the success of the conservation and management strategy of natural resources of the Kedarnath Valley.

The wild animals were identified by direct observation during the field survey and signs of their pellets, scats, pugmarks and claw marks were also considered. A binocular (10X-50X) was used for bird watching and the important features were noted. The identification of avian fauna was made on the basis of available literature [4]. Interviews with the villagers and local people were also made to generate information about wild mammals, aves, reptiles, amphibians and butterflies. The secondary data and reported list of wildlife were also consulted.

To collect information on the wildlife resources (mammals, birds, reptiles, amphibians and butterfly) in the Kedarnath Valley, primary as well secondary sources were used. Primary surveys were carried out for three seasons. The ecological status of the wild animals was categorized following IUCN Red Data Book, 2001 and Wildlife Protection Act (WPA) [5]. The following methods were adopted during the survey of fauna:

- The Forest Working Plans of the district Rudraprayag falling in the village were referred to for secondary information on the wildlife of the Kedarnath Valley.
- Interviews of local villagers for the presence and the relative abundance of various animal species within each locality.
- In order to assess the awareness of local people regarding the mammalian diversity of the area and interviews and informal discussions [6] were conducted in 20 villages of Kedarnath Valley.
- Data collection of habitat conditions, animal presence by direct sighting and indirect evidence.
- Direct sighting with photographs and indirect evidence such as calls, treks, signs and pallets of mammals were recorded along with the survey sites following Prater (1980).
- Manuals of Ali & Ripley [7] were consulted for identification of birds
- The criteria of IUCN [8], Zoological Survey of India (1994) and Wildlife Protection Act [5] were followed to describe the conservation status of the species.
- A detailed survey was carried out for mammals, birds, reptiles, amphibians and butterflies.

Results and Discussion

Rudraprayag district in Uttarakhand state is rich in wildlife and their habitats. It has Kedarnath Wildlife Sanctuary (KWS), three forest divisions, namely Kedarnath Wildlife Division, Rudraprayag Forest Division and Augustmuni Forest Division. Ecologically, the Kedarnath Valley is a unique ecosystem due to its varied physiographic and climatic conditions. The Kedarnath Valley is very rich in its biodiversity.

Wildlife resources are represented four vertebrate classes, 100 species belonging to 103 genera and 53 families, 26 species belonging to 21 genera and 14 families of mammals and 56 species belonging to 49 genera and 26 families of avian are present. However, 13 species belonging to 13 genera and 7 families of reptilians and 5 species belonging to 3 genera and 2 families of amphibians are present in Kedarnath Valley. 17 species belonging to 17 genera and 4 families of butterflies are present in the Valley.

Mammalian Diversity

India is very rich in biological diversity. Mammalian diversity is one of the main attributes of this diversity. *Wilson and Reeder* [9] studied the mammalian fauna of the world and represented 4,629 species belonging to 1,135 genera, 136 families and 26 orders.

According to State Environmental Report 2009 about 397 species of mammals are found in India, of which 10.8 % are threatened and 18.4% are endemic. *Rickefs and Schluter* [10] studied on Information of species diversity pattern and distribution is crucial for understanding the ecological and evolutionary determinants of spatial heterogeneity in biodiversity. *Gomez et al.* [11] and *Oertli et al.* [12] studied on Spatial congruence of species distributions in several taxa but it remains poorly understood in Mammals community, particularly in herbivores.

There are about 241 mammalian species (65%) recorded from the Himalaya and as many as 29 (37%) of mammalian species listed under Schedule I of Indian Wildlife Protection Act (WPA 1972) occur in the Himalaya [13]. A total of 28 mammalian species are reported from Kedarnath wildlife sanctuary [14, 15].

The knowledge about the Indian mammals is very old. Descriptions of some mammals are available in the Vedas and in the Pre-Vedic edicts. There are ethical, social, mythological and economic relationship between man and wild mammals. Some species of mammal are associated with different Hindu gods or goddesses in the Indian mythology and are worshiped. The mammals of Uttarakhand are unique and beautiful. The mammalian fauna of Uttarakhand has attracted the attention of different workers in the past. Important workers who have studied the mammalian fauna are Prater [16]; *Kumar and Chopra* [17]; *Saharia* [18]; *Osmaston and Sale* [19]; *Tak and Kumar* [20]; *Sathyakumar* [21]; *Uniyal* [22]; *Maheswari and Sharma* [23] and *Maheswari et al.* [24].

A total 26 species of mammals belonging to 21 genera and 14 families have been reported from Kedarnath Valley. Some mammalian species have been listed as threatened in IUCN RED List, ZSI categories and are listed in different Schedules of Wildlife (Protection) Act 1972 (Table 1). Six species are listed as Vulnerable followed by one species as Near Threatened, and one species as endangered. 18 species are listed as least concern in IUCN categories. Four species are listed as endangered and two species as vulnerable in ZSI categories. Nine species are listed in Schedule I followed by six species in Schedule II, two species in Schedule III and only one specie is listed in Schedule IV in Wildlife (Protection) Act 1972 (Table 1).

Distribution of Mammals

Hystrix indica (Indian Porcupine) is widely distributed in the forest of Kedarnath Valley. Indian Porcupine is distributed up to the **upper elevation limit** of 2,400m. *Hystrix indica* inhabits forest, grassland and caves and in the Kedarnath Valley. Hanumam Langur (S*emnopithecus entellus*) is widely distributed in Kedarnath Valley (Fig. 2). S*emnopithecus entellus* is distributed up to 3,500m. S*emnopithecus entellus* moves in troops of variable size. Hanuman Langur inhabits open areas and near settlements and raid agricultural and horticultural crops. The Hanuman Langur (S*emnopithecus entellus*) has a wide range of distribution from the plains to 3,660m above m.s.l. in the Himalaya and from relatively dry tropical forests, scrub jungles to arid rocky areas [24].

Macaca mulatta (Bandar) is also widely distributed in Kedarnath Valley. *Macaca mulatta* is distributed between 2,000-3,000m. *Moschus chrysogaster* also inhabits open areas and near settlements in the Kedarnath Valley. Wild boar *(Sus scrofa) Moschus chrysogaster* (Musk deer), *Muntiacus muntjak* (Barking deer), *Naemorhedus goral* (Goral, Ghurad or *Ghwed*) and *Rucervus duvauceli* (Barasingha) are also common in Kedarnath Valley. The niches of Goral and Barking Deer are between 2,100 – 3,000m and 1,500 – 2,400m, respectively. They inhabit forest, grasslands, open areas and raid agricultural fields. Gaston et al. (1981) found that the Goral altitudinal range is between 1,800 and 3,700 m, with abundance between 2,200 and 3, 400m above m.s.l. *Sathya Kumar et al.* [26] reported the range between 2,000 and 3,800m above m.s.l. in Eastern Himalayan habitats. The *Hemitragus jemlahicus* (Himalayan Tahr) is adapted to life in a cool climate with rocky terrain, which allows them to be found in mountainous regions. *Hemitragus jemlahicus is* also known as the Wild Goat. Himalayan Tahr

is distributed between 2,500-5,000m, they are mainly found on slopes. Himalayan Tahr feeds on wide variety of plants. They most frequently inhabit locations, where vegetation is exposed for grazing and browsing. During the winter season (when snow covers vegetation at higher elevations), they move to lower-altitude slopes [27].

Table 1. Mammals and their conservation status in Kedarnath Valley

S.No.	Zoological Name	Local Name	English Name	Conservation status		
				IUCN Category	ZSI	WPA (1972)
Bovidae						
1.	*Hemitragus jemlahicus* (Smith, 1826)	Himalayan Thar	Himalayan Thar, Wild Goat	Near threatened	-	I
Hystricidae						
2.	Hystrix indica(Kerr, 1792)	Solu	Indian Porcupine	Vulnerable	-	II
Cercopithecidae						
3.	*Macaca mulatta* (Zimmermann, 1780)	Bandar	Monkey	Least Concern	-	II
4.	*Semnopithecus entellus* (dufresne, 1797)	Goni	Hanuman Langoor	Least Concern		II
Cervidae						
5.	*Muntiacus muntjak* (Zimmermann, 1780)	Kakar	Barking Deer	Least Concern	Endangered	I
6.	*Rucervus spp.*	Jaray	Barasinga	Vulnerable		
Felidae						
7.	*Panthera pardus* (Linnaeus, 1758)	Bagh, Tendua	Leopard	Vulnerable	Vulnerable	I
8.	*Felis chaus* (Schreber, 1777)	Ban Biralu	Jungle Cat	Least Concern	-	I
9.	*Panthera uncial* (Schreber, 1775)	Him Tendua	Snow Leopard	Vulnerable	Endangered	I
10.	*Felis bengalensis* (Kerr 1792)		Leopard Cat	Least Concern	-	I
Canidae						
11.	*Canis aureus* (Linnaeus, 1758)	Syal	Jackal	Least Concern	-	II
12.	*Vulpes vulpes* (Linnaeus, 1758)	Red Fox	Red Fox	Least Concern	-	II
Suidae						
13.	*Sus scrofa* (Linnaeus, 1758)	Jungali Suwar	Wild Boar	Least Concern	Endangered	III
Muridae						
14.	*Mus musculus* (Linnaeus, 1758)	Chuha	Indian Mouse	Least Concern	-	-
Pteropodidae						
15.	*Pteropus giganteus* (Brunnich, 1782)	Chamgadar	Indian Flying Fox	Least Concern	-	-
16.	*Rhinolophus ferrumequinum* (Schreber. 1774)	Chamgadar	House Shoe Bat	Least Concern	-	-
Mutellidae						
17.	*Martes flavigula* (Boddaert, 1785)	Titriyal	Yellow-Throated Marten	Least Concern	-	II
Bovidae						
18.	*Moschus leucogaster* (Hodgson, 1839)	Kasturimrig	Himalayan Musk Deer	Endangered	Endangered	I
19.	*Nemorhaedus goral* (Hamilton Smith, 1827)	Ghwed	Deer , Ghurad	Least Concern	-	III
20.	*Capricornis sumatraensis* (Bechstein, 1799)	Serow	Serow	Vulnerable	Vulnerable	I

S.No.	Zoological Name	Local Name	English Name	Conservation status		
				IUCN Category	ZSI	WPA (1972)
Soricidae						
21.	*Suncus murinus* (Linnaeus, 1766)	Chakchunder	House Shrew	Least Concern	-	-
Muridae						
22.	*Rattus rattus* (Linnaeus, 1758)	Chuha	House Rat	Least Concern	-	-
23.	*Mus musculus* (Linnaeus, 1758)	Chuha	House Mouse	Least Concern	-	-
24.	*Mus buduga*	Chuha	Indian Field Mouse	Least Concern	-	-
Oechotonidae						
25.	*Ochotona roylei* (Ogilby, 1839)	Chuha tunanath	Royle's Pika	Least Concern	-	IV
Ursidae						
26.	*Selenarctos thibetanus* (G. Cuvier, 1823)	Bhalu, Richh	Black Bear	Vulnerable	-	I

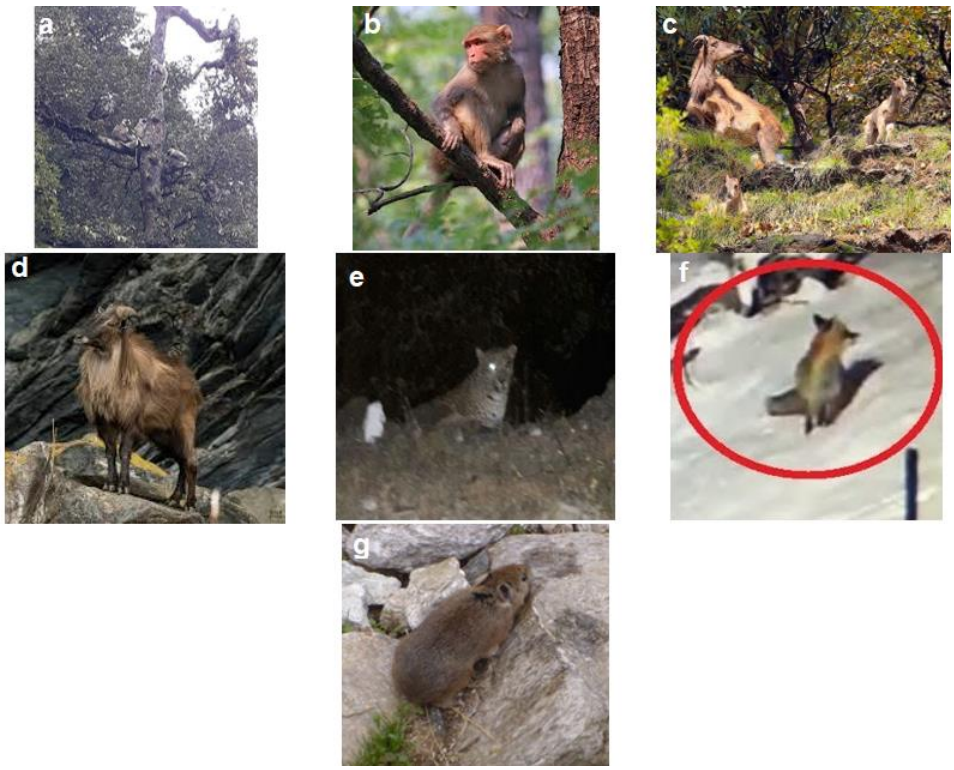

Fig. 2. Observed mammals: a- Hanuman Langur (S*emnopithecus entellus*) in Kedarnath Valley; b - Monkey *(Macaca mulatta)* in Tarsali Village; c - Ghoral (*Nemorhaedus goral*) sited at Chota -Tungnath trek; d - Himalayan Thar (*Hemitragus jemlahicus*) sited at Tungnath-Chandrashila trek; e - Common Leopard **(***Panthera pardus*) trapped in camera at Tarsali village; f - Red Fox (*Vulpes vulpes*) captured in closed circuit camera near Kedarnath Temple area; g - Himalayan Pika (Ochotona roylei) sited at Tungnath;

Musk Deer (*Moschus chrysogaster*) is distributed between 3,000 – 4,000m. Kedarnath Valley including Kedarnath wildlife Sanctuary. Kedarnath wildlife sanctuary is a well-known habitat of Musk Deer. *Maheshwari and Sharma* [23] reported the distribution of the Alpine Musk Deer between 3,600-3,700m above m.s.l. with the mean altitude of 3,650m. *Green* [1]

and *Satyakumar* [14] have also reported the status, distribution and abundance of this species in Kedarnath Wildlife Sanctuary. *Sathyakumar et al.* [28] reported the presence of Alpine Musk Deer between 3,700-4,500m, while *Bhattacharya et al.* [29] reported the presence of the Musk Deer at more than 3,700m in the Indian Himalaya. *Rucervus duvauceli* (Barasingha) distribution has been reported from 2,000 m to 3,000m in Kedarnath Wildlife Sanctuary [14, 30].

Panthera pardus pardus (Common Leopard) is very common in the region. It is distributed between lowermost reaches to 3,000m. They sometimes, enter in human habitation and kill domestic livestock. *Panthera uncia* (Snow Leopard) inhabits the upper part of the basin (above 3,000m.). It lives in the caves of stunned forest lying near the snow line. Habitat of Snow Leopard is characterized by cold and arid and semi-arid shrub land, grassland and barren areas [31]. Snow leopards' prey on deer, Himalayan marmot and the wild goat. Snow Leopard also feeds on wild prey Himalayan marmot (*Marmot* spp) in the alpine meadows. Domestic livestock (mule, goat and sheep) are also killed by the Snow Leopard as his food [24]. Snow Leopard spotted in Kedarnath for the first time. Snow leopard was captured in the camera trap by the forest department. To know the presence of the Snow Leopard, Kedarnath Wildlife Division had installed close circuit cameras in place in November 2016. Ms. Neetu Lakshmi M. DFO (Kedarnath Wildlife Sanctuary Gopeswar, Chamoli) has confirmed the presence of Snow Leopard. *Felis bengalensis* (Leopard Cat) is distributed between 2,500 to 3,240m in the Valley. The ecological information on Leopard Cat from the high-altitude Himalayan landscape is rare [32]. *Sathyakumar et al.* [28] reported the distribution range Leopard Cat from 1,750 to 2,750m above m.s.l. in the Indian Himalayan region. *Felis chaus* (Jungle cat) is distributed up to 2,000m. in the Valley. *Felis chaus* feeds mainly on small mammals' birds, frogs, lizards and snakes. Eggs are also a significant component of the diet of Jungle cat. Jungle Cat captures captured prey on the ground, but they are able to climb and leap well.

The dog family includes *Canis. aureus* (Asiatic Jackal) and *Vulpes vulpes* (Red Fox). *Canis. aureus* can ascend up to 3,500m. in the Valley. It comes out in search of food at dusk and returns to the shelter at dawn. *Vulpes vulpes* are not very common in the Valley. They inhabit high altitudes over 2,500m to trans-Himalayan tracts. Before the Kedarnath disaster, it has been seen many times in the Kedarnath area, but after the June 2013 disaster, Red Fox disappeared, then wildlife experts argued that possibly this animal would have ceased after the natural disaster. But on January 11, 2016 and on January 2, 2018, this animal was captured in the closed circuit camera near the Temple area. Mayank Shekhar Jha, DFO Rudraprayag has confirmed the presence of Red Fox. The Red Fox (*Vulpes vulpes*) is an opportunistic and generalist omnivore [33]. Red foxes are available even above the tree line as they are known to cross alpine passes upto 4,500m above m.s.l. [33]. The Red Fox feeds on rodents, Pika and beetles.

Sus scrofa (Wild Boar) is distributed up to 1,500m in Kedarnath Valley. *Sus scrofa* inhabits open forest areas and raids agricultural fields. Bear family is represented by *Ursus thibetanus* (Asian Black Bear). *Ursus thibetanus* is altitudinal migrant and move to elevations over 3,500m. near the snow line in summer season. In winter season, they can descend up to 1,500m. *Sus scrofa* inhabits open forest areas and raids agricultural crops in the Kedarnath Valley. Himalayan Brown Bear (*Ursus arctos isabellinus*) is distributed in and around Kedarnath Wildlife Sanctuary [34]. However, the Himalayan Brown Bear is thought to occur at very low densities in the alpine regions of the Greater and Trans Himalayan regions [35].

Family Musteliade is represented by *Martes flavigula* (Yellow Throated Marten). *Martes flavigula* is distributed between 1,200 – 2,700m. They normally live in the pair and avoid human habitation in Kedarnath Valley.

Rattus rattus (House Rat), *Mus musculus* (House Mouse) and *Mus buduga* (Indian Field Mouse) are common species in the Kedarnath Valley. Distribution of Himalayan Marmot has been reported in the altitudinal range of 4,000-4,600m above m.s.l. [23, 26].

Royle Pika (*Ochotona roylei*) is distributed in only Tunganath and Kedarnath at the elevations of 3,500 to 3,700m in Kedarnath Valley. Sathyakumar et al. [26] have reported the altitudinal distribution of Himalayan Pika between 3,000m to 5,200m above m.s.l. *Suncus murinus* (House Shrews) are widely distributed between 1,800 m to 3,600 m in the Valley. Bat family includes only two species *Pteropus giganteus* (Indian Flying Fox) and *Rhinolophus ferrumequinum* (Horse Shoe Bat) in Kedarnath Valley, former niches up to 2,100m. and later above 2,500m.

Capricornis sumatraensis (Serow) is distributed between 900 and 3,000m in Kedarnath Valley. It inhabits forest, grassland, open areas and raids agricultural crops.

Avian Diversity

Birds are a group of bipeds, feathered, warm-blooded animals whose body temperature remains more or less constant and independent of the surrounding temperature. Class Aves of the Phylum Chordata includes the fascinating warm-blooded vertebrate creatures, which are known as birds. The Himalaya is the home of thousands of species of birds. They are found in all continents, seas and islands penetrating the Arctic beyond 80º N and the Antarctic region. They range from the sea level to over 6,400m altitude on Mount Everest [36]. Amongst the larger birds found in the Himalaya are kites, eagles, vultures, and pheasants. The medium sized birds include fowls, cocks, woodpeckers, and swallows. White tits and warblers are some of the smaller birds of the Himalaya (Fig. 3 and 4).

Fig. 3. Birds spotted in Kedarnath Valley: a - Motacilla alba; b - Eumyias thalassinus (male); c - Horornis fortipes; d - Niltava macgrigoriae; e - Cettia castaneocoronata; f - Tarsiger chrysaeus; g - Mycerobas icteriodes; h - Trochalopteron lineatum; i - Dendrocopos himalayensis; j - Enicurus maculates; k - Pomatorhinus erythrogenys; l - Procarduelis nipalensis.

Birds are a good indicator species for good habitats and a healthy environment. The community structure of the avian fauna depends on habitat functions and physical structure. Avian community is a consortium of species population occurring together in space and time Distribution of each bird species is basically dependents on access to the place, nesting grounds, food availability and shelter together with other environmental factors. Since, there has been change in various degrees in ecology and geographical pattern features conected with many anthropogenic activities, there has been a change in distribution pattern of several bird's species.

Patterson et al. [37], *Stotz*, [38], *Blake and Loiselle* [39] studied on altitudinal distribution patterns of birds have tended to focus on variation in species diversity and richness with altitude range size and species turnover rates. *Khan et al.* [40], *Price et al*. [41], *Safiq et al.* [43] and *Sultana et al.* [43] documented the bird communities of the Western part of Himalayan region.

Fig. 4. Birds spotted in Kedarnath Valley; a - Pucrasia macrolopha; b - Arborophila torqueola; c - Lophophorus impejanus (Female); d - Lophophorus impejanus (Male); e - Corvus macrorhynchos; f - Acridotheres tristis; g - Steptopelia orientalis; h - Treron sphenurus(Female); i - Treron sphenurus (Male); j - Psittacula krameri; k - Urocissa erythroryncha; l - Dendrocitta formosae/

The total numbers of avian species are known so far about 9,000 of which India accounts for about 1,250 species 13 percent of the world's total avifaunal diversity. India is prominently among the ten countries in the world having the largest number of threatened species of birds. The hill state of Uttarakhand has great diversity of birds. More than 50% of the 1,263 bird species recorded from India [44] are found in Uttarakhand. Garhwal Himalaya as a part of the Western Himalaya is wealthy for its habitat diversity and bird species richness due to its single position between the Indo-Chinese and Palaearctic line and great altitudinal variations from 400m to 7,817m (Nanda Devi Peak-II) [45]. *Mohan and Sinha* [46] published the first checklist of birds of Uttarakhand listing 623 species. Mohan and Sondhi [47, 48] have published two updated checklists of the birds of Uttarakhand listing 693 species.

Naithani and Bhatt [49] have reported birds from Pauri Garhwal. A total of 56 species belonging to 49 genera, 26 families of Aves has been reported in Kedarnath Valley under the present study (Fig. 3). Some avian species have been listed as threatened in the IUCN RET List, ZSI categories and listed in Schedule IV in Wildlife (Protection) Act 1972. *Gyps himalayensis* (Giddh) is listed as Near Threatened and 55 species listed as least concern in IUCN categories. *Lophophorus impejanus* (Monal) is listed in endangered species in ZSI categories. Only two species, *Gyps himalayensis* (Giddh) and *Aquila chrysaetos* (Garud) are listed in Schedule I and 54 bird species are listed in Schedule IV in Wildlife (Protection) Act 1972 (Table 2).

Table 2. Birds and their conservation status in Kedarnath Valley

S.No	Zoological Name	Local Name	English Name	Conservation status		
				IUCN Category	ZSI	WPA (1972)
Phasianidae						
1.	*Arborophila torqueola* (Valenciennes, 1826)	Titar	Hill Patridge	Least Concern	-	IV
2.	*Lerwa lerwa* (Hodgson, 1833)		Snow Partridge	Least Concern	-	IV
3.	*Lophura leucomelana* (Latham, 1790)	Jugli Murga	White Creasted Kaleej Pheasant	Least Concern	-	-
4.	Lophophorus impejanus (Latham, 1790)	Monal	Himalayan Monal	Least Concern	Endangered	IV
5.	*Pucrasia macrolopha* (Lesson, 1829)		Koklass	Least Concern	-	IV
Columbidae						
6.	*Columba livia* (Gmelin, 1789)	Kabuter	Rock Pigeon	Least Concern	-	IV
7.	*Steptopelia orientalis* (Latham, 1790)	Ghuguti	Rufous Turtle Dove	Least Concern	-	IV
8.	*Treron sphenurus* (Vigors, 1832)	Malyo	Wedge Tailed Green Pigeon	Least Concern	-	IV
Cettiidae						
9.	*Horornis fortipes* (Hodson, 1845)		Brown-Flanked Bush Warbler	Least Concern	-	IV
10.	*Cettia castaneocoronata* Burton, 1836		Chestnut-Headed Tesia	Least Concern	-	IV
Dicruridae						
11.	*Dicrurus leucophaeus* (Vieillot, 1817)	Kala Lampuchh	Ashy Drongo	Least Concern	-	IV
Accipitridae						
12.	*Gyps himalayensis* (Hume, 1869)	Giddh	Griffin Vulture	Near Threatened	-	I
13.	*Aquila chrysaetos*	Garud	Himalayan	Least Concern	-	I

S.No	Zoological Name	Local Name	English Name	Conservation status		
				IUCN Category	ZSI	WPA (1972)
	(Linnaeus, 1758)		Golden Eagle			
Emberizidae						
14.	*Emberiza cia* (Linnaeus, 1766)		Rock Bunting	Least Concern	-	IV
15.	*Melophus lathami* (Gray, 1831)		Crested Bunting	Least Concern	-	IV
Fringillidae						
16.	*Carpodacus erythrinus* (Pallas, 1770)		Common Rose Finch	Least Concern	-	IV
17.	*Procarduelis nipalensis* (Hodgson, 1836)		Dark-Breasted Rose Finch	Least Concern	-	IV
18.	*Mycerobas icterioides* (Vigors, 1831)		Black-and-Yellow Grosbeak	Least Concern	-	IV
Muscicapidae						
19.	*Myophonus caeruleus* (Scopoli, 1786)		Blue Whistling Thrush	Least Concern	-	IV
20.	*Phoenicurus frontalis* (Vigors, 1832)		Blue Fronted Redstart	Least Concern	-	IV
21.	*Chaimorrornis leucocephalus* (Vigors, 1831)		White Caped Redstart	Least Concern	-	IV
22.	*Eumyias thalassinus* (Swainson, 1838)		Verditer Flycatcher	Least Concern	-	IV
23.	*Enicurus maculates* (Vigors, 1831)		Spotted Forktail	Least Concern	-	IV
24.	*Ficedula superciliaris* Jerdon,		White-Browed Blue Flycatcher	Least Concern	-	IV
25.	*Phoenicurusfuliginosus* (Vigors, 1831)		Plumbeous Water Redstart	Least Concern	-	IV
26.	*Tarsiger chrysaeus* (Hodgson, 1845)		Golden Bush Robin	Least Concern	-	IV
27.	*Niltava macgrigoriae* (Burton, 1836)		Small Niltava	Least Concern	-	IV
Motacillidae						
28.	*Motacilla caspica* (Tunstall, 1771)		Grey Wagtail	Least Concern	-	IV
29.	*Motacilla alba* (Linnaeus, 1758)		White Wagtail	Least Concern	-	IV
30.	*Anthus roseatus* (Blyth, 1847)		Vinaceous Breasted Pipit	Least Concern	-	IV
Nectariniidae						
31.	*Aethopyga siparaja* (Raffles, 1822)		Crimson Sunbird	Least Concern	-	IV
Phylloscopidae						
32.	*Phylloscopus trochiloides* (Sundevall, 1837)		Greenish Leaf Warbler	Least Concern	-	IV
Cerambycidae						
33.	*Pseudhammus occipitalis* (Lameere, 1893)		Crowned Leaf Warbler	Least Concern	-	IV
Passeridae						

S.No	Zoological Name	Local Name	English Name	Conservation status		
				IUCN Category	ZSI	WPA (1972)
34.	Passer montanus (Linnaeus, 1758)	Ghiduri	Tree Sparrow	Least Concern	-	IV
35.	*Passer domesticus* (Linnaeus, 1758)		House Sparrow	Least Concern	-	IV
Prunellidae						
36.	*Prunella collaris* (Scopoli, 1769)		Alpine Accentor	Least Concern	-	IV
Pycnonotidae						
37.	*Pycnonotus cafer* (Linnaeus, 1766)	Bulbul	Red Vented Bulbul	Least Concern	-	IV
38.	*Pycnonotus leucogenys* (Gray, JE, 1835)	Bulbul	White Checked Bulbul	Least Concern	-	IV
Psittacidae						
39.	*Psittacula krameri* (Scopoli, 1769)	Tota	Parrot, Rose-Ringed Parakeet	Least Concern	-	IV
Strigidae						
40.	*Glaucidum cuculoides* (Vigors, 1831)	Ulloo	Himalayan Spotted Owl	Least Concern	-	IV
Laniidae						
41.	*Lanius schach* (Linnaeus, 1758)		Long Tailed Shrike	Least Concern	-	IV
Leiothrichidae						
42.	*Trochalopteron lineatum* (Vigors, 1831)	Musbheguru	Streaked Laughing thrush	Least Concern	-	IV
43.	*Trochalopteron erythrocephalum* (Vigors, 1831)		Chestnut-Crowned Laughingthrush	Least Concern	-	IV
Picidae						
44.	*Dendrocopos himalayensis* (Jardine & Selby, 1835)	Kathphorwa	Himlayan Wood Pecker	Least Concern	-	IV
Prunellidae						
45.	*Prunella collaris* (Scopoli, 1769)	Burfili Ghinduri	Alpine Accentor	Least Concern	-	IV
Sturnidae						
46.	*Acridotheres tristis* (Linnaeus, 1766)	Myana	Indian Myana	Least Concern	-	IV
Corvidae						
47.	*Corvus macrorhynchos* (Wagler, 1827)	Kawwa	Jungle Crow	Least Concern	-	IV
48.	*Garrulus glandarius* (Linnaeus, 1758)		Eurasian Jay	Least Concern	-	IV
49.	*Urocissa erythroryncha* (Boddaert, 1783)	Lampuchh	Red Billed Blue Magpie	Least Concern	-	IV
50.	*Dendrocitta formosae* (Swinhoe, 1863)	Brown, black color lambpuchh	Himalayan tree Pie	Least Concern	-	IV
51.	*Nucifraga caryocatactes* (Linnaeus, 1758)		Nutcracker	Least Concern	-	IV
52.	*Pyrrhocorax graculus* (Linnaeus, 1766)		Yellow Billed Chough	Least Concern	-	IV
Timaliidae						
53.	*Pomatorhinus erythrogenys* (Vigors, 1832)		Rusty-Cheeked Scimitar Babbler	Least Concern	-	IV

S.No	Zoological Name	Local Name	English Name	Conservation status		
				IUCN Category	ZSI	WPA (1972)
54.	*Heterophasia capistrata* (Vigors, 1831)		Black-Caped Sibia	-	-	IV
Upupidae						
55.	*Upupa epops* (Linnaeus, 1758)	Bulbul	Hoopoe	Least Concern	-	IV
Zosteropidae						
56.	*Zosterops palpebrosus* (Temminck, 1824)		Oriental White-Eye	Least Concern	-	IV

Reptilian Diversity

Reptiles are cold-blooded vertebrates. Therefore, they go for aestivation during very hot temperatures and in winter they go for hibernation. The Reptilian fauna of India is unique in its diversity, which has the greatest affinity to the Oriental region, and the Indo-Malayan region. Reptiles in India are found in diverse habitats ranging from deserts to the rain forests, from the brackish water and marine waters fringing the coasts of plains, hills and dense forest. Reptiles are the most vital group of predators, the interaction of which maintains the natural balance in the deserts, rivers, lakes, plains, forests and high mountains of India. A great number of living reptiles are slowly disappearing mainly due to the increasing human interference. Not only Reptiles deprived of their habitats, but their direct persecution and slaughter are intensified by the rapid growth of industrialization and land exploitation.

The Reptilian diversity of Uttarakhand is represented by 72 species belonging to 48 genera, 14 families and three orders, which constitutes 15% of Indian reptilian faunal diversity (460). One species, *viz.*, *Python mrulus bivittatus* has recently been reported from Uttarakhand state by *Nawab and Srivastawa* [50], while another species, *viz.*, *Pangshura tentoria circumdata* is reported herewith for the first time from the state. *Waltner* [51] gave a general account of the geographical and altitudinal distribution of Reptiles in the Himalaya. 13 species belonging to 13 genera and 7 families of Reptiles have been reported from Kedarnath Valley (Fig. 5). No reptilian species has been listed as threatened in the IUCN categories. *Xenochrophis piscator* and *Gloydius himalayanus* are listed in Schedule II and IV respectively in Wildlife (Protection) Act 1972 (Table 3).

Fig. 5. Reptiles spotted in Kedarnath Valley: *Agama tuberculate and Naja naja*

Table 3. Reptiles and their conservation status in Kedarnath Valley

	Zoological Name	Local Name	English Name	IUCN Category	WPA (1972)
Colubridae					
1.	*Platyceps ventromaculatus* (Gray, 1834)	Saanp	Gray Rat Snake	Least Concern	-

	Zoological Name	Local Name	English Name	IUCN Category	WPA (1972)
2.	*Ptyas mucosus* (Linnaeus, 1758)		Oriental Rat Snake	Not evaluated	-
Natricidae					
3.	*Herpetoris platyceps* (Blyth)		Himalayan Keelback	Not evaluated	-
4.	*Xenochrophis piscator* (Schneider, 1799)		Checkered Keelback	Not evaluated	II
Viperidae					
5.	*Trimeresurus albolabris* (Gray, 1842)	Saanp	Green Pit Viper	Least Concern	-
6.	*Gloydius himalayanus* (Günther, 1864)		Himalayan Pit Viper	Not evaluated	IV
Elapidae					
7.	*Bungarus caeruleus* (Schneider, 1801)	Saanp	Common Krait	Least Concern	-
8.	*Naja naja* (Linnaeus, 1758)	Nag	Indian Cobra	Least Concern	-
Lumbricidae					
9.	Lumbricus terrestris (Linnaeus, 1758)	Kenchua	Common Earthworm	-	-
Agamidae					
10.	*Agama tuberculata* (Gray, 1827)	Chhipkali	Common Lizard	Least Concern	-
11.	*Calotis versicolor* (Daudin 1802)	Chipkali	Indian Garden Lizard	Least Concern	-
12.	*Japalura major* (Jerdon, 1870)		Garhwal Mountain Lizard	Not evaluated	-
Scincidae					
13.	*Scincella himalayanum* (Greer 1974)		Himalayan Ground Skink	Not evaluated	-

Amphibian Diversity

Amphibians are a group of animals that include toads, frogs, salamanders and caecilians. Amphibians first colonized land in the mid-Devonian, some 350 million years ago. Amphibians are cold-blooded vertebrae. Due to their smooth skin, they can live comfortably on water and land. They are widespread because they have a model indicator group. Amphibians live mostly in terrestrial and freshwater (except marine environments, Antarctic and deep Arctic). Amphibians have developed significant diversity in the vertebrate group due to their habitat in both water and land. Amphibians are found in different ecological conditions in mountains, plains, ponds, less rainy places and deserts. Many of its species live in bushes, boulders, rocks and stones. Some amphibians like to live in cracks of rocks, trees, litters and plant leafs. The Northeastern region and the Western Ghats have the most diversity of amphibians.

India harbors 209 species of amphibians out of 5,150 species of the world *Chanda* [52]. Amphibians form an important link in the evolutionary history of vertebrates in India. Amphibians are represented by all the three orders – Gymnophiona, Apoda and Caccillians; Caudata/Urodela; and Salientia/Anura. The Anurans, to which frogs and toads belong, are the prominent one. Uttarakhand embraces almost all types of amphibian habitats. On account of its varied climatic, topographical, altitudinal and vegetation conditions, the Amphibian fauna of Uttarakhand have not been adequately studied. Important contributions on the amphibians of Uttarakhand were made by *Anandale* [53], *Boulenger* [54], *Waltener* [55] *and Chopra* [56]. *Tilak and Ray* [57], and *Ray and Tilak* [58], *Ray* [59] made contributions on the amphibians of Nanda Devi Biosphere.

In the Kedarnath Valley, 5 species of amphibians belonging to 3 genera and 2 families have been reported under the present study. No RET (rare, endangered and threatened) species have been recorded in the Kedarnath Valley. All the species are listed in Schedule IV of Wildlife (Protection) Act 1972 (Table 4).

Table 4. Amphibians and their conservation status in Kedarnath Valley

S.No.	Zoological Name	Local Name	English Name	IUCN Category	WPA (1972)
Bufonidae					
1.	*Duttaphrynus himalayanus* (Gunther, 1864)	Medhak	Himalayan Toad	Least Concern	IV
2.	*Duttaphrynus melanostictus* (Schneider, 1799)	Medhak	Asian Common Toad	Least Concern	IV
Ranidae					
3.	*Amolops spp* Cope, 1865		Cascade Frogs	-	IV
4.	*Rana (Paa) annandolii*		Boulerger	-	IV
5.	*Rana dhakuriensis*		Boulerger	-	IV

Butterflies

Butterflies play a very important role in the ecosystem, there is a co-evolutionary relationship between plants and butterflies and their lives are interlinked. Butterflies are also known as flying flowers, displaying their beauty. The butterfly is an insect, diverse of many sizes and colours. They are highly sensitive to environmental alterations, so much that they have been considered as excellent bioindicators of climate [60-64] and can be used as surrogates to assess the conservation threat of biodiversity [65] and the abundance of butterflies usually indicate healthier ecosystem [66]. Worldwide, there are more than 28,000 species of butterflies, with about 80% in tropical regions [67]. The Indian subcontinent hosts about 1,504 species of butterflies [68]. Butterflies were abundant from late April to September (Table 5). Bi-spot Royal (*Ancema ctesia ctesia* Hewitson), and the Powdery Green Sapphire (*Heliophorous tamu tamu* Kollar) were recorded in the west of Kumaon, the earlier western limit of the distribution of these species in the Himalaya [69-71].

Table 5. Diversity of butterfly in Kedarnath Valley

S.No.	Zoological Name	English Name
Nymphalidae		
1.	*Acreae issoria* (Hubner, 1819)	Hubner
2.	*Aglais cashmerenisis* (Kollar, 1848)	
3.	*Argyreus hyperbius* (Linnaeus, 1763)	Linnaeus
4.	*Aulocera swaha* (Kollar, 1844)	Kollar
5.	*Danaus genutia* Cramer, (1779)	Cramer
6.	*Issoria lathonia* (Linnaeus, 1758)	Linnaeus
7.	*Junonia iphita* (Cramer, 1779)	Cramer
8.	*Neptis zaida* (Fabricius, 1807)	Doubleday
9.	Vanessa cardui (Linnaeus, 1758)	Linnaeus
10.	*Venessa indica* (Herbst, 1794)	Herbst
Papilionoidea		
11.	*Callerebia annada* (Moore 1857)	Moore
12.	*Graphium nomius* (Esper, 1793)	Esper
Pieridae		
13.	*Catopsilia Pomona*	Fabricius
14.	*Gonopteryx rhamni* (Linnaeus, 1758)	Linnaeus
15.	*Pieris brassicae* (Linnaeus, 1758)	Linnaeus
Lycaenidae		
16.	*Lycaena pavana* (Kollar 1848)	Kollar
17.	*Udara akasa* (Horsfield, 1828)	Horsefield

In the Kedarnath Valley, 17 species of butterflies belonging to 17 genera and 4 families have been reported. *Acreae issoria* (Hubner), *Argyreus hyperbius* (Linnaeus), *Aulocera swaha* (kollar) , *Callerebia annada* (Moore), *Cynthia cardui* (Linnaeus), *Danaus genutia* (Cramer), *Issoria lathonia* (Linnaeus), *Junonia iphita* (Cramer), *Neptis zaida* (Doubleday), *Venessa indica* (Herbst), *Catopsilia pomona* (Fabricius), *Gonopteryx rhamni* (Linnaeus), *Pieris brassicae* (Linnaeus), *Graphium nomius* (Esper), *Lycaena pavana* (Kollar) and *Udara akasa* (Horsefield) species have been spotted in Kedarnath Valley (Table 5). *Singh* [72] has also reported 147 species belonging to 102 genera, five families and 19 subfamilies of butterflies in Kedarnath Musk Deer Reserve, Garhwal Himalaya.

Threats to Vertebrate Diversity

In Kedarnath valley are several threats to faunal diversity. In addition to their natural activities (ecodisaster, landslide, hailstorm and heavy rainfall) and anthropogenic activities like making of the hydroelectric power project, road construction, all-weather road widening, helicopter services, hunting, poaching and human intervention of wild animal by the local inhabitants will have direct and indirect impact on the wild animals. The main threats detailed in below:

Habitat loss, degradation and fragmentation

Habitat loss, degradation and fragmentation are important threats to faunal diversity. The major cause of degradation and depiction of wildlife are natural and anthropogenic activities. In Kedarnath Valley, natural activity like ecodisasters, landslides, hailstorm and heavy rainfall main cause of degradation, depletion and fragmentation of the wildlife habitat. July, 2012 ecodisaster in Ukhiamath village and June, 2013 Kedarnath ecodisaster is example of this.

Poaching and Hunting

Illegal poaching of hunting and killing of wildlife by the people is one of the major threats to wildlife resources in Kedarnath Valley. Porcupines, rats, snakes and birds and sometimes common leopards are killed by trekkers, and by the collision of heavy vehicles. During the field visit in 2016, one leopard was found killed by the collision of bus and leopard near Bhiri NH 109 (Fig. 6). Illegal extraction of medicinal plants is also common in Kedarnath Valley.

Fig. 6. Leopard killed by Bus-animal collision near Bhiri on NH 109

Forest Fire

Forest fire in the Kedarnath Valley has greatly damaged the forests, fauna, medicinal plants and human livelihood. Some local people put fire in the near forest intentionally. Young plants are also damaged by forest fires. Mammals, reptiles, amphibians and butterfly are also charred by forest fire or they migrate from there.

Human Wildlife Conflicts

The wildlife involved in conflicts with humans was the common leopard, black bear and monkey in Kedarnath Valley. Livestock *(*buffalos, sheep, goats, horses and mules) are killed by the common leopard in the Kedarnath Valley. The black bear has been reported to attack the human beings. Two women have killed by the black bear in 2017 in Rampur Nyalsu. *Maheswari and Sharma* [23] reported that there is depredation of livestock (sheep and goats) of shepherds during summers, when these shepherds visit the higher ranges of Snow Leopard habitats in Uttarakhand.

Biotic Interferences

The high influx of pilgrims, movement of buses, trekkers and helicopter service may exert biotic pressure on the animal diversity in the Kedarnath Valley. These biotic interferences are causing environmental degradation and depletion of natural resources.

Road Construction and All-Weather Road Widening

Road construction and their widening are the major anthropogenic drivers causing environmental degradation and depletion of natural resources in Kedarnath Valley. Poor implementation of all-weather road widening and road construction causing environmental problems. Road constructions are causing dust pollution, traffic jams, contamination of natural freshwater springs, massive soil erosion, landslides and blocking of natural water seepages.

Poor Implementation of Hydropower Projects

Poor development of hydropower projects in the Kedarnath Valley is also a threat to wildlife. The construction of LANCO Hydro Power Projects, L&T Power Project and other small HEPs are threats to the wildlife in the Valley. Making tunnels and road for hydropower projects in the Kedarnath Valley have an adverse impact on the movement of wild animals. Sometimes, the blasting for road construction and digging of tunnels for HEP has severe impact on the behavior of wild animals.

Helicopter Services

In the Kedarnath Valley, 13 helicopter services take off in 40km distance. They fly at very low altitudes. Thereby, there is a negative impact on wild animals, domestic animals, humans, plants and the atmosphere and in the Kedarnath Valley. Wild animals are migrating from the Valley due to helicopter's noise and fear of vibrations. During the survey, the villagers have reported that the children born there are getting deaf from birth. People have difficulty in communicating with each other due helicopter noise.

Conservation and Management of Wildlife

No threatened biodiversity component including the prominent species of Snow Leopard, Leopard, Musk Dear and other wild animals are likely to be affected by the dam construction, road widening, construction and noise and vibration of helicopters the existing natural mountain ecosystem in Kedarnath Valley needs to protected protection the following suggestions have been made.

During the construction period, different activities like construction of approach roads, dumping of muck, excavation for tunnels, quarrying (excavated materials) and human population pressure on land are probable to exert pressure on the natural resources of the Valley.

Keeping in view the above impacts, a comprehensive Biodiversity Conservation and Management Plan has been suggested for the Kedarnath Valley. The following actions are recommended.

- Ecological balance should be maintained through preservation, conservation and restoration of an ecosystem whenever; it has been degraded due to development projects.
- Natural habitats of wild animals should be protected in the Kedarnath Valley.
- Rehabilitation of important species (endangered, rare and threatened species) of any with provision for *in-situ* and *ex-situ* conservation of critical important animal and plant species has been suggested.

- Creating all-around awareness on conservation and management for ensuring public participation in the conservation and management efforts and minimizing man and animal conflict is very much essential.
- Providing incentives to local communities in supporting the cause of protection of Wildlife is very much needed in Kedarnath Valley.
- Developing local involvement and a good intelligence network in protection task forces.
- Make stronger the ability of local forest and wildlife staff in terms of their numbers training and equipment.
- Encourage local people in self-regulation regarding illegal hunting.
- Helicopters flying in the Kedarnath Valley should also be given strict instructions that they cannot fly below 600 meters, if the helicopter flies below 600m, the helicopter should be seized and the license of the company should cancelled. The government should also reduce the number of Helicopters Company and their rounds in the Kedarnath Valley.
- In order to prevent forest fire, a special forest fire task force should be created in every forest post, which can control forest fire immediately as soon as the forest fire erupts.
- Agencies underworking the works of road constructions, all-weather road widening and hydro power projects should be instructed to construct without the use of dynamite and should be given strict instructions for disposal of muck at the identified sites only. Retaining walls should be constructed along the streams and rivers sides.

Conclusions

The present study on wildlife resources of Kedarnath Valley concluded that the mammalian diversity is represented by 26 species belonging to 21 genera and 14 families. Avian diversity is represented by 56 species belonging to 49 genera and 26 families, Reptilian diversity is represented by 13 species belonging to 13 genera and seven families. However, the Amphibian diversity is represented by five species belonging to three genera and two families in the Kedarnath Valley. Seventeen species belonging to seventeen genera, seven families of butterflies have also been reported from the Kedarnath Valley. The flagship species of the Kedarnath Valley is Musk Deer (*Moschus chrysogaster*).

There are many natural and anthropogenic pressures that are contributing to the depletion of the wildlife of Kedarnath Valley. Helicopter service operating in the Kedarnath Valley has been a major factor in disturbing the behavior, movement and daily life of wild animals. Kedarnath Disaster of June 2013 has also impacted adversely the wildlife of the Kedarnath Valley. Thus, remedial measures including regulating the helicopter service in Kedarnath Valley are urgently required.

Natural disasters cannot be stopped, but these can be reduced. In the Kedarnath Valley, illegal poaching, hunting, killing of wild animals, forest fire and over-grazing should be controlled. New road construction, developmental projects and helicopter services should be conducted based on the carrying capacity of the Kedarnath Valley.

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