academicJournals

Vol. 6(7), pp. 495-501, July 2014
DOI: 10.5897/IJBC2013.0630
Article Number: 706E7F346197
ISSN 2141-243X
Copyright © 2014
Author(s) retain the copyright of this article
http://www.academicjournals.org/IJBC

International Journal of Biodiversity and Conservation

Review

Biodiversity in Khajjiar Lake of Himachal Pradesh, India: Threats and conservation

Vikram Singh* and H. S. Banyal

Department of Biosciences, Himachal Pradesh University, Shimla-171 005 (HP), India.

Received 28 August, 2013; Accepted 23 May, 2014

Faunal resources of Kalatop-Khajjiar sanctuary, which is one of the oldest preserved forests of the state are under severe anthropogenic pressure and need urgent attention of the field biologists as it is one of the most favoured tourist destinations in Himachal Pradesh. Biodiversity of Khajjiar area of Himachal Pradesh has 223 species of different faunal groups (invertebrates and 100 vertebrates), comprised of 93 genera, 79 families and 32 orders. Out of these, 3 species of butterflies are placed under Wildlife Protection Act (1972) and 13 mammals have been placed under Indian Wildlife Protection Act 1972. While nine species of mammals has been listed as threatened in Convention in Trade of Endangered Species (CITES). Two critically endangered birds, Indian White-backed Vulture and Red-headed Vulture are also recorded. Ecological equilibrium of the study area is no more in a balanced state due to increased development and human intervention.

Key words: Khajjiar Lake, ecological imbalance, faunal diversity, pollution.

INTRODUCTION

Biodiversity, encompasses variety and variability of all life on earth. It has been generally defined as the 'full variety of life on Earth'. More specifically, biodiversity is the study of the processes that create and maintain variations. It is concerned with the variety of individuals within populations, the diversity of species within communities, and the range of ecological roles within ecosystems. Biological diversity or biodiversity refers to the diversity of life. Biodiversity is the result of evolutionary plasticity of living organisms, and increased geometrically through perhaps 3.5 billion years, proliferating by trial and error, controlled by natural selection, filling almost every one of the habitable ecological niches created in a likewise evolving world environment. The variability among living organisms from all sources includes terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.

The word biodiversity which is the abbreviated from the word biological diversity appears to have come into prominence around 1980, when Norse and McManus (1980) first defined it. Its abbreviation into 'biodiversity' was apparently made by Walter (1985) during the first planning meeting of the 'National Forum on Biodiversity' held at Washington DC in September 1986 (UNEP, 1995). The book entitled biodiversity (Wilson and Peters, 1988) introduced the notion of biodiversity and popularized this word among the scientific community as well as the

*Corresponding author. E-mail: proliterate@yahoo.com. Tel: +91 9418484418.

Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

public. Since then, not only the number of publications on biodi-versity, but also people interested in the subject for one reason or the other has steadily increased. United Na-tions General Assembly has declared 2011-2020 as "Uni--ted Nations Decade of Biodiversity" and 22nd May of every year is celebrated as International Day for Biodiversity.

India is situated at the tri-junction of the Afro-tropical, the Indo-Malayan and the Paleo-Arctic realms, which display significant biodiversity. Being one of the 17 identified mega diverse countries; it is home to 8.58% of mammalians, 13.66% of avians, 7.91% of reptilians, 4.66% of amphibians, 11.72% of fish, and 11.80% of plant species documented so far. From the biodiversity standpoint, India has some 59,353 insect species, 2,546 fish species, 240 amphibian species, 460 reptile species, 1,232 bird species and 397 mammal species, of which 18.4% are endemic and 10.8% are threatened (Varughese et al., 2009). Among species found in India, only 12.6% of mammals and 4.5% of birds are endemic, as against 45.8% of reptiles and 55.8% of amphibians. India has 172 (2.9%) of the IUCN designated threatened species. It has been estimated that at least 10% of the country's recorded wild flora, and possibly the same percentage of its wild fauna, are on the threatened list, many of them are on the verge of extinction (Varughese et al., 2009).

Traditional and substantial dependence on biodiversity and faunal resources for fodder, fuel wood, timber and minor forest produce has been an accepted way of life for the rural population that accounts for nearly 74% of India's population. With radical demographic changes, the land to man ratio and forest to man ratio has rapidly declined. The lifestyles and the biomass resource needs having remained unchanged, the remnant forests have come under relentless pressure of encroachment for cultivation, and unsustainable resource extraction, rendering the very resource base unproductive and depleted in its biodiversity. Today, this diversity of life is threatened by human activities, although the exact rate of species loss is difficult to ascertain. These activities are unabated human population growth, overexploitation of resources, pollution and global climatic change. Disappearance of species is not an aberrant process in the course of time. Biologists estimated that natural rate of extinction is about one per one million species in a year which is also referred as 'background' rate of extinction. In the deep past, species were also wiped out in large scales due to extrinsic factors that were beyond normal environment regime. Species evolution and extinction are very much part of evolutionary history of biotic world. But the concern on the alarming rate at which species are going to extinction today due to reckless alteration and degradation of environment quality and putting the very future at risk. The current rate of species extinction is about 1000 times faster, while the evolution of new species is limited by evolutionary constrains (Saikia et al., 2010).

As per the IUCN Red List, 2008, India has 413 globally threatened faunal species, which is approximately 4.9% of the world's total number of threatened faunal species. These include 53 species of mammal, 69 birds, 23 reptiles and 3 amphibians (Varughese et al., 2009). India has globally important populations of some Asia's rarest animals, such as Asiatic Lion, the Bengal Tiger, and the Indian White-Rumped Vulture.

If the present rate of decline continues, half of the world's species will get extinct in 21st century. It has been predicted that 20% of the world's species would get extinct within next 30 years and at least 50% in the decades that follow. Presently, biodiversity on the earth is being impoverished at an alarming rate, just at the time when man needs it most for sustaining its own life. It is now well recognised that the well-being of human beings and biodiversity are more interdependent than ever before. Virtually all governments, organisations and communities have responded to this situation in several ways.

The faunal and floral diversity in Himachal Pradesh is also very rich and diversified, primarily due to varied climatic conditions ranging from tropical in the foothills to arctic environment in the Trans-Himalayan region. Rich diversity of animals in Himachal Pradesh is reflected by the presence of 2,542 faunal species belonging to different groups as compared to 89,500 animal species of the country (Mehta, 2005). Himachal Pradesh has a small geographical area of 55,673000000 square meters which is only 1.7% of India but it harbours more than 7% of the total fauna of the country. Invertebrates constitute 88.4% and vertebrates 11.6% of the fauna in Himachal Pradesh. Insects and other arthropods form a predominant group (4,641 species) among invertebrates, whereas vertebrates are dominated by birds comprising about 447 (610, revised) species (Mehta, 2005).

Keeping in view, comprehensive studies were conducted from July, 2008 to June, 2012 on enumeration of different faunal groups in Khajjiar Lake and surrounding areas. Based on the above, field based conservation measures have also been elucidated for betterment of the biodiversity of Khajjiar Lake area. The lower animal groups were collected, preserved, identified and studied strictly following the wildlife conservation provisions. However, direct observations were made on large animals in their natural habitats and no individual was caught or hurt during the observations. So, different methods like hand picking, sweeping, aerial netting, aspirator and light trap have been employed for study of lower (invertebrate) animal groups. Methods employed for vertebrate fauna included visual sighting, trapping with net and photography. Quantification of indirect evidences in mammals was done with standardized methods such as pellet groups, scats, pug marks and hoof marks.

STUDY AREA AND METHODOLOGY

Khajjiar Lake "The Mini Switzerland of Himachal

A

B

Plate 1. A: Khajjiar Lake area in winter; B: Khajjiar Lake area in summer.

Pradesh" is present in the western part of Chamba district of Himachal Pradesh (Plate 1). Khajjiar Lake has a clump of reeds and grasses exaggeratedly called an island in it. Fed by slim streams, this small lake rests in the centre of large glade of Khajjiar. This glade is greenish in its turf and contains in its centre a small lake having approximate area of 4180 square metres. The glade is surrounded from all sides by a thick forest of deodar (*Cedrus deodara*), fir (*Abies pindrow*) and spruce (*Picea smithiana*) (Plate 1).

Khajjiar Lake lies at 32°26´ north and 76°32´east at an altitude of about 6300 ft (1920 m) above sea level between Chamba and Dalhousie. The average depth of this lake is stated to be thirteen feet as per district gazetteer. This lake remains full of water in all seasons. It requires no rain water for survival. There is a 'golden' domed temple at the edge of this meadow, dedicated to the deity 'Khajjinag', from whom the area derives its name. Khajjiar Lake is situated in the centre of Khajjiar-Kalatop wildlife sanctuary. This small sanctuary lies in the catchments of the Ravi River, located in western part of Chamba district. It is one of the oldest preserved forests of the state (noti-

fied on 01.07.1949) (Singh and Banyal, 2012). Total area of sanctuary is 2,026.89 hectares (20.69 sq. km.) Geographically, it is situated at the Northwest termination of Dhauladhar range in the middle Himalayas. Its mean annual rainfall is 800 mm. Temperature varies from -10 to 35°C.The climate of Khajjiar is alpine. Summers (April-June) are mild and winters (November-February) are cold and bitter (Plate 1). It experiences south-western monsoon rains in July-September.

Despite a few studies on biodiversity of birds in Chamba district of Himachal Pradesh, this area has not been sufficiently explored. Similarly, only some of the faunal elements like birds and beetles have been enlisted from Kalatop-Khajjiar sanctuary and no information is available on other faunal groups of this sanctuary. Moreover, faunal resources of Kalatop-Khajjiar sanctuary which is one of the oldest preserved forests of the state (notified on 01.07.1949) are under severe anthropogenic pressure, need urgent attention of the field biologists as it is one of the most favoured tourist destinations in Himachal Pradesh.

Faunal diversity of Khajjiar Lake area

Biodiversity of Khajjiar area of Himachal Pradesh is represented by 223 species of different faunal groups (123 invertebrates and 100 vertebrates), comprised of 193 genera, 79 families and 32 orders. Analyses of data shows that class Aves dominated the fauna of Khajjiar with 77 species, followed by Lepidoptera (49 species), Orthoptera (29), Mammalia (16), Coleoptera (15), Odonata (10), Hymenoptera (7), Hemiptera and Diptera (5 each), Reptilia (4) and Amphibia (2 species). It is further analyzed that Mollusca, Oligochaeta, Homoptera and Pisces are least represented groups of fauna with a single species each in Khajjiar area.

These 123 species of invertebrates belongs to 110 genera, spread over 30 families and 10 orders from Khajjiar area. Of these, Lepidoptera (49 species) is the most dominant invertebrate order in the present study area, followed by Orthoptera (29 species), Coleoptera (15 species), Odonata (10 species), Hymenoptera (7 species), Hemiptera and Diptera (5 species each), and Mollusca, Oligochaeta and Homoptera (1 species each). Comparison of number of species of invertebrates recorded presently and known from Himachal Pradesh (Mehta, 2005) reveals the presence of 6.6% of the invertebrate fauna of the state in Khajjiar area. Similarly, invertebrates constitute more than 55% of the total fauna of Khajjiar area. A total of 121 species of insects belonging to 108 genera comprised of 28 families and 8 orders also present in Khajjiar area. It forms about 55% of the total fauna of the study area and 98% of the invertebrates.

Ten species belonging to 8 genera comprising of 5 families of odonates are present in Khajjiar lake area. Khajjiar area supports a total of 29 species of Orthoptera belonging to 28 genera, under 5 families. Orthopterans of Khajjiar area represent more than 17% of the state fauna and form more than 23% of the total invertebrate fauna of the present study area. Only 5 species of hemipterans belong to 4 genera and 2 families and single species of Homoptera (*Platylomia saturate* Walker, 1858) belonging to family Cicadiae is present in Khajjiar area. 15 species of beetles belonging to 15 genera and 7 families are present in Khajjiar and surrounding area of Chamba district. It corresponds to 12% of the invertebrate and 7% of the total fauna of Khajjiar area. A total of 49 species of butterflies belonging to 41 genera and 10 families are recorded from the study area Khajjiar area of Himachal Pradesh. It constitutes about 39% of the invertebrate and about 22% of the vertebrate fauna of the Khajjiar area. Categorization of the species further revealed that of these 49 species, 5 were very common, 32 common, 5 uncommon and 7 were rare. Moreover, 3 species were placed under Wildlife Protection Act (1972). These included *Lethe scanda* and *Lampides boeticus* placed under scheduled II and *Castalius rosimon* under scheduled IV of the Act.

Presently, 5 species of dipterans belonging to 5 genera, 3 families are in Khajjiar area of Chamba. It constitutes about 4% of the invertebrate and 1.7% of the total fauna of Khajjiar area. A total of 7 species of hymenoptera belonging to 6 genera and 5 families have been recorded from Khajjiar area of Himachal Pradesh. It forms about 6% of the invertebrate and 3% of the total fauna.

A total of 100 species of vertebrates belonging to 83 genera, spread over 49 families and 22 orders, representing about 45% of the total fauna have been recorded from Khajjiar area. The present investigations revealed the presence of 77 species of birds belonging to 62 genera, 12 orders and 31 families. Birds represent 77% of the vertebrate and 34.5% of the total fauna of the Khajjiar. Khajjiar Lake and surrounding area supported 20 species of birds which are local and rest 57 are seasonal-local and long range migrants. The birds placed under resident category included critically endangered Indian White-backed Vulture and Red-headed Vulture. Of the 57 species, 35 are seasonal-local migrants, 4 are winter visitors and 10 are summer visitors. Moreover, Khajjiar Lake supports 8 of such species which shows winter and summer influx. Of these, 6 shows summer influx, whereas, winter influx is shown by 2 species only. Analyses of data on relative abundance shows that 25 species of birds are very common, 30 are common, 21 are uncommon and 1 is rarely seen in the area under investigation. Further analysis of residential status and relative abundance reveals that of the 20 resident species, 10 are very common, 8 are common and 2 are uncommon. Of the 57 seasonal-local migrants, 15 species are very common, 24 are common, and 17 are uncommon and only 1 species is rare. Categorization of 4 winter visitors reveals that 2 are uncommon, 1 each is common and rare. Moreover,

analysis of data on relative abundance of summer migrants shows that of the 10 species, 1 species is very common, 5 are common and 4 are uncommon. Grouping of the species among winter and summer influx reveals that of the 2 species which shows winter influx, 1 each is common and uncommon , whereas, out of 6 species that shows summer influx 1 is very common and 5 are common in the Khajjiar lake area.

Moreover, 16 species of mammals belonging to 14 genera, 12 families and 6 orders are also present in the Khajjiar wildlife sanctuary. Nine species has been listed as threatened in Convention in Trade of Endangered Species (CITES) under different schedules. Five species namely *Semnopithecus ajax*, *Ursus thibetanus, Panthera pardus, Naemorhedus sumatraensis* and *Naemorhedus goral* have been placed in schedule I, *Macaca mulatta* in schedule II and *Vulpes vulpes, Martes flavigula* and *Mustela sibrica* under schedule III. Out of a total of sixteen species thirteen have been placed under Indian Wildlife Protection Act 1972. Two species *P. pardus* and *N. sumatraensis* have been kept under schedule I. Same species have been considered as vulnerable species according to National Red Data.

Threats and conservation of biodiversity

Biodiversity has three important categories of values viz., productive use value, consumptive use value and indirect values. Productive use value is a value assigned to products that are commercially harvested for exchange in formal markets and is, therefore, the only value of biological resources that is reflected in national income accounts. On the other hand, consumptive use value is the value placed on natural products that are consumed directly. The value of such goods can be considerable. Indirect values are related primarily to the functioning of ecosystems, do not normally appear in national accounting systems, but they may far outweigh consumptive and non-consumptive values (Alfred et al., 1998). The biodiversity in Khajjiar lake area, like other parts of Himachal Pradesh is very rich and diversified, but, in recent years, area of Khajjiar in particular and the state in general have come under a strong threshold of development. Natural ecosystems/habitats have been over-exploited and even destroyed by the rapidly increasing human population and tourist inflow. A number of endemic and restricted range species found in the area/region are facing threat of their existence (Vedwan and Rhodes, 2001).

There already exist many programmes/acts which if strictly followed, can play an important role in the preservation of bio-diversity of not only urbanized areas but in rural and forested areas too. Wildlife Protection Act (1972), National Wildlife Action Plan (1983), National Biodiversity Strategy and Action Plan (NBSAP) etc., all envisage objectives which aim at all active protection and development of forest resources, conserving nation's biodiversity and strengthening efforts to protect wild species and varieties. Convention on Biological Diversity (1992) emphasizes various objectives all of which have one fact in common, that is, protection of nature and natural resources. Moreover, India has a well developed Protected Area Network (PA's) comprising 89 National Parks (covering an area of 37,530.76 km^2 or 1.14% of the country's geographical area) and 489 Wildlife Sanctuaries (1,17,042.04 km^2 or 3.56% of the country's geographical area). Khajjiar Lake is also one of the richest and oldest preserved wildlife sanctuaries of the country. Put together, the 578 PA's cover about 4.70% of the country's geographical area (Rodgers et al., 2002).

Ecological equilibrium of the study area is no more in a balanced stage due to developments and human interventions. With the passage of time natural food plants of Monkeys and Langurs have decreased in the forest and these animals have came out of their natural habitat and forced to live near or around human population. Similar observations have been made in some studies conducted in different parts of country in recent past. Southwick and Siddiqi (1994) reported that in the northern parts of our country, normally 86% of rhesus monkey population depends entirely upon human settlements for their food, however; only 14.4% of the rhesus macaques live in isolation from humans and do not rely on them at all for food. It is observed that leopard prefers easily available food in the form of domestic animals and stray cattle, therefore, natural check on monkey is not there. Feeding habits of monkeys and langurs in present study area have also changed. Now they have become more dependent on human left outs like baked or cooked food available near the human population, offered by tourists and leftover of the hotels. In the recent past, it has been recorded that Rhesus and Langurs usually raid the crops of the natives and cause huge economic losses to them. A new kind of conflict has developed between the ecology of these animals and local farmers. Various incidences of violence of monkeys against tourist are also commonly recorded in Khajjiar area (Singh and Banyal, 2012).

Similarly, with increasing intervention of man into forest incidences of encounters between man and bear has also increased in Kalatop-Khajjiar area. Most of the places are remote and there is no access to the vehicle so local people have been using the forest path and sometime it gives rise to bear-human interface. With decreasing food resources bears are forced to raid maize and other crops of farmers. It is observed that the amount of the destruction of the crop was much higher than they actually eat. Earlier when the food resources were available in the forest this kind of raids of crops were rarely observed as informed by people. Although monkeys, langurs and bears are in conflict with humans but no incidences of their killing was recorded from the area.

Another important concern of ecology which is noticed is of domesticated cattle and cows (Plate 2). These are in

Plate 2. Different tourist games and grazing of domestic animals in Khajjiar Lake.

huge numbers and can be seen grazing in and around the Khajjiar lake. Further, population of these stray animals is increasing day by day. This leads to increased addition of faecal matter in the lake which is leading to eutrophication of lake (Plate 3). Many times these stray animals enter forest for grazing and destroy undergrowth of forest. With ever increasing number of tourists reaching Khajjiar every year the number of hotels in the area is increasing. This is good for general socio economic development of the area but has adverse impacts on ecological health. Many tourists visit deep in the forests and enjoy tracking in the hills. Hotels and tourists produce a large quantity of non degradable garbage which accumulates in and around the lake and also deep into the forest. This non degradable garbage also interferes with the rejuvenation of forest organic mass which impacts floral and faunal diversity.

Khajjiar area of Himachal Pradesh has seen a tremendsdous increase in population in the last decade, due to which natural habitats are in great pressure. The future of the unique Himalayan Wildlife found in the present study area of Khajjiar, therefore, requires immediate involvement of scientific inputs, political will and collective public participation in saving biodiversity from imminent danger of appalling extinction. Keeping in view the imminent dangers of extinction to bio-diversity following measures can be adopted.

There is huge number of stray animals which can be seen grazing around the lake. This leads to increased addition of faecal matter in the lake which is leading to eutrophication of lake. So entry of domesticated animals should be restricted to the meadow. For this a barbet wire fencing the lake and meadow can serve the purpose. Additionally, immediately around the meadow number of horses can be seen which are used for horse ring by the tourist. These horses add to the economy of people but have adverse impact on health of lake through their dung. So proper management of horse dung is immediately needed. As discussed earlier increasing hotel industry is adding huge quantities of non-biodegradable as well biodegradable wastes like plastics and bottles, which is disturbing natural growth of vegetation in the forest as well as in meadow. Proper management of this waste is required.

Khajjiar is one of the favorite tourist destinations for tourists and huge population of tourists is visiting the meadow every year so there should be some check on the entry of tourists to this place. Various types of tourist sports take place in the Khajjiar meadow. These disturb the normal growth of meadow grass and limiting the activities of many small fauna and insects. Surprisingly, forest officials as well as tourist department do not have any check on these tourism sports activities. So appropriate guidelines for tourism sports in Khajjiar meadow

Plate 3. Threat of Khajjiar Lake.

should be prepared. Tourists come to visit Khajjiar Lake through private vehicles and taxies because very little bus service is available to this area. Keeping in view, the disturbance created to the wildlife by vehicles in the form of horn, air pollution, noise pollution, etc. traffic laws should be strictly be implemented on all the vehicles entering the sanctuary area.

Stray animals enter the deep forests which affects the undergrowth of forest. Sometimes tourists also enter the forest and carry plastic materials with them. Entry of stray animals and of tourists into the forest patches should be restricted.

Khajjiar area has various endangered faunal species. Multiplication and breeding of threatened species of fauna through modern techniques of tissue culture and biotechnology should be encouraged. Also, conservation pockets for the rare and endemic faunal species found in Khajjiar area should be established. There should be documentation of local resources and support for threatened species. There should be inventorisation and monitoring of processes adversely impacting biodiversity. As a complement to *ex situ* approaches, *in situ* measures for biodiversity conservation can be developed. There should be efforts for restoration of degraded habitats and recovery of endangered species. All these measures can be implemented by promoting scientific and technical cooperation among Himalayan researchers. Various researchers are working on different aspects of ecology and biodiversity in isolation, there should be a convergence of this work.

When we implement all these conservation measures, there will be impact on the life of the local villages of the area. This lake is one of the income sources for the people as they cannot access forest produce in the wild life sanctuary. So a proper redressal of grievances should be put in place. To start with, there should be educational and public awareness programmes with respect to conservation and sustainable use of biodiversity. Economically and socially, sound measures should be adopted that act as incentives for conservation and sustainable use of components of biodiversity. These programmes should be undertaken among rural people, farmers and shepherds. Alternate grazing ground should be developed to help the poor rural people and shepherds.

REFERENCES

Alfred JRB, Das AK, Sanyal AK (1998). Faunal diversity in India. Zoological Survey of India, Kolkata, p 495.

IUCN (2008). IUCN Red List of Threatened Species. IUCN Species Survival Commission. Gland, Switzerland (www.iucnredlist.org).

Mehta HS (2005). Fauna Western Himalaya (Part-2). Zoological Survey of India, Kolkata. p. 359.

Norse EA, McManus RE (1980). Ecology and living resources biological diversity. In: Environmental Quality 1980. 11th Annual report of the council on environmental quality, Washington DC, 31-80.

Rodgers WA, Panwar HS, Mathew VB (2002). Wildlife Protected Areas Network in India: A Review (executive summary). Wildlife Institute of India, Kolkatta. p. 43.

Saikia U, Sharma N, Dass A (2010). Vanishing species: The planet in crisis. Resonanace 321- 336.

Singh V, Banyal HS (2012). Diversity and Ecology of Mammals in Kalatop-Khajjiar Wildlife Sanctuary, District Chamba (Himachal Pradesh), India. Int. J. Sci. Nat. 3: 125-128.

Southwick CH, Siddiqi MF (1994). Primate commensalisms: the rhesus monkey in India . Rev Ecol (Terre Vie). 49: 223-31

UNEP (1995). Global biodiversity assessment. Cambridge University Press, Cambridge.

Varughese GC, Vijyalakhhmi K, Kumar A, Rana N (2009). State of environment report, India. ENVIS, Ministry of Environment and Forestry, Government of India. pp.1-73.

Vedwan N, Rhodes, RE (2001). Climate change in the Western Himalayas of India: a study of local perception and response. Clim. Res. 19: 109-117.

Wilson EO, Peters FM (1988). Biodiversity. National Academy Press, Washington DC.