# Assessment of Community Perception and Threats on Indian Giant Flying Squirrel Population in Central Gujarat

**Dissertation submitted in partial fulfilment of**

**Master Degree in Wildlife Conservation Action**

**By**
**Krishna Pithva**

Under the guidance of

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**and**
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**Institute of Environment Education and Research**
**Bharati Vidyapeeth Deemed University**
**Pune, Maharashtra, India**

**2021-2022**

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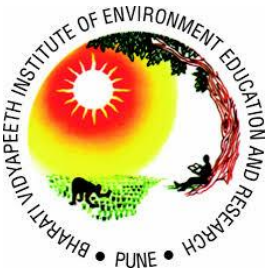



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**2021-2022**

# CERTIFICATE

This is to certify that **Ms. Krishna Pithva**, final year student at the Bharati Vidyapeeth (Deemed to be University) Institute of Environment Education and Research, Pune has successfully completed the dissertation titled, '**Assessment of Community Perception and Threats on Indian Giant Flying Squirrel Population in Central Gujarat'** under the guidance of **Dr. Nishith Dharaiya**, and **Dr. Kranti Yardi** in partial fulfilment of the Master Degree in Environment Science And Technology during the academic year 2021-22.

The work has been completed to our satisfaction and standards. The said dissertation has not been submitted for any other degree or diploma and any such material which has been obtained from other sources has been duly acknowledged in the dissertation.

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# Abstract

Central Gujarat is known for the high population of Indian Giant Flying Squirrel (IGFS) due to favourable habitat, however it was observed that people living around the IGFS habitat are not aware about the presence of the species. This study aims to understand peoples' level of knowledge on the species and their perception towards the presence of the species in the area using semi-structured questionnaire and Q-methodology respectively. The study categorised threats to the species based on available literature and forest department reports. The threats have been identified and same were confirmed through field observation. Two flying squirrel habitats from central Gujarat were selected for this study in which 108 people were interviewed for questionnaire survey and 53 people were interviewed for Q-methodology belonging to 10 villages. The study reveals that people lack knowledge in roosting, biology/ecology and hunting of the species however it was observed that 66 people appreciate presence of IGFS. However, peoples' perception was categorised into 3 factors that are i) Economic impact, ii) Aesthetic, spiritual and conservation values and iii) Lack of awareness. The findings suggest that people highly like IGFS as it do not cause any economic loss and it is aesthetically pleasing with compared to other animals. According to available literature ecological and anthropological threats were listed and during field work only some anthropological threats were observed. Flying squirrel is patchily distributed in the state of Gujarat and the habitat degradation has been identified as one of the major threats to the species. For successful conservation of remaining flying squirrel habitat, it is very important to conduct long term study to monitor population of IGFS habitat. Based on this study people living in and around the IGFS habitat need to be educated through species specific conservation education program.

**Keywords:** Level of knowledge, Peoples' perception, Q-methodology, Ecological and anthropological threats

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# Chapter 1
# Introduction

# Chapter 1. Introduction

## 1.1 Indian Giant Flying Squirrel

Indian Giant Flying Squirrel *(Petaurista philippensis, Elliot 1839)* is a nocturnal, solitary and arboreal animal having wide distribution in South Asia, Southeast Asia, Central and Southern China. It is a rodent belonging to the Sciuridae family[(1)]. As the name suggests flying but *P. philippensis* does not fly instead it glides between the tall trees and canopies with help of patagium which is a fold of skin between forelimbs and hindlimbs on both side of the body, it is aerial locomotion without beating of wings but when the animal at high altitude glides down to move forward from one tree canopy to another[(2)]. Also, gliding takes less energy than flying[(2)]. Eleven different species of flying squirrel are found in India and 44 species in all over the world from 15 different genera, Indian Giant Flying Squirrel (IGFS) is most widely distributed in India covering evergreen forests, mixed moist and dry deciduous forests, the Himalayan ranges, north part of Maharashtra, Rajasthan and Gujarat[(2)]. It has been recorded in cardamom plantations in some parts of south India[(3)]. According to the book, Indian Mammals a field guide by Vivek Menon published in 2014, Indian Giant Flying Squirrel (IGFS) is a dabber cousin of Red Giant Flying Squirrel. The book also describes its coat which varies from coffee-brown to grey, grizzled with white, it also has white or pale grey underside and rufous patagium, head having same color as rest of the body with ears having radish brown margins. The tail is uniformly brown-grey but in some individuals the tip is darker. Since the species is nocturnal it comes out from its hide during dusk and goes back before dawn. It has been reported in a previous study that the squirrel may sleep on its back with legs and parachute outspread to cool down and maintain its body temperature due to hot weather[(4)]. The average home range size of *P. philippensis* is about 2.8 ha, an adult female has up to 2.2 ha, an adult male has up to 4.4 ha and sub-adults have about 0.8 ha Kuo and Lee (2012)[(5)]. The study also shows that the size in the home range of the species may vary with changes in seasons and environment in search for resources like food availability, finding mates and may adapt to different strategies to cope with changes[(5)]. Nandini and Parthasarathy (2008) have described their diet mainly frugivorous and folivores in some parts of the fragmented rainforest of Western Ghats[(6)]. The diet of Indian Giant Flying Squirrel also consists of fruits and leave but they have seen eating other parts of plants too. Since it is herbivores *P. philippensis* also feeds on flowers, fruits, leaves, bark, pith, lichens, shoot and nuts, some were seen to feed on beetles, larvae and termites[(7)]. The study done in Rajasthan shows that *Madhuca longifolia* commonly

known as Mauha is highly consumed plant species throughout the year by IGFS along with Diospyros melanoxylon, Terminalia Bellirica, Terminalia tomentosa and Ficus religiosa[6]. Study in Taiwan suggests that *P. philippensis* may prefer to rest often on tree branches while feeding on mature leaves during winters than actively search for higher quality food resources to conserve its energy[5]. The study done in Western Ghats is the first to report high consumption of fruits by squirrels, though fruits like Ficus are very good source of easily assimilated energy, contains low fat and good source of protein, calcium and necessary minerals[3]. According to IUCN, the spices is in Least Concerned category and it is protected under Indian Wildlife (Protection) Act, 1972 in Schedule II (Part II) although some studies in south India shows population decline due to deforestation, anthropogenic activities, forest fragmentations, agricultural activities, hunting and myths[6]. This indicates that if not protected and attention given on this species, soon it may push to vulnerable category.

### 1.2 Indian Giant Flying Squirrel in Gujarat

A study in Gujarat have reported results from online questionner survey on IGFS which releaved the need of more scientific study focusing on different aspects of the species[8]. Also, the specie is mostly limited to mature decideous woodlands and forests dominated by Mahua (Madhuca latifolia) trees which mentiones the species's distribution from Sabarkantha (Vijaynagar and Polo forest range) in North Gujarat and Kewadi forests, Ratanmahal Sanctuary in Central Gujarat, Dang forest in south Gujarat and Vansada National Park in South-East Gujarat[9]. The quetionner survey study done by Nisha and Dharaiya (2016) revealed that the species is reffered with different local names depending on the different region of Gujarat such as it is called as Udan Gilhari, Udati Khiskoli in Central Gujarat, Haruva alilu, Parukkum Anil, Shekroo, Rajpankhi Lokharke, Pankha/ Pakhi in Dangs, Mor Chitri in North East Gujarat and etc[1].

### 1.3 Threats to Indian Giant Flying Squirrel

The squirrel population in many parts of India could be declining locally due to hunting practices, habitat loss, forest logging, shifting cultivation, increase in anthropogenic activities, development, forest degradation, and deforestation[8]. Hunting of the species by local communities for meat consumption and so called ethnomedicinal purposes in South Asia and

China.[10]. Forest fragmentation may restrict the distribution of IGFS which may result in less or finding difficulty to breed. It may increase in competition for resources like food and territory. This may force the species to co-exist in human settlements and may decline the population of the species or lead to local extinction of the species[8]. Hunting practices for illegal commercial and personal purposes on western border because use of medicinal beliefs of animals parts, especially some primates species like lion-tailed macaques from Western Ghats gets sold for good amount of money[11]. Although, some local or tribal communities like Vokkaliya Gowda caste did not hunt flying squirrels where Hakki Koramaru tribe mainly hunted small mammals[11]. Density of small and large mammals may differ from place to place due to difference beliefs in and hunting practices[11]. Increase in habitat destruction and deforestation may result into losing their nesting sites which can lead to decline in the population of Indian Giant Flying Squirrel. In some part of the country squirrel species find threat from forest fire, mining activities, timber collection and etc. Some squirrel species are hunted because of bushmeat and socio-cultural practices as sacrifices in marriage ceremonies for good will[7].

### 1.4 Justification and significance of the study

Being a least concerned (IUCN Redlist®) and Scheduled II (Indian wildlife protection act-1972) the species of IGFS get very little attention by researchers, policy makers and local community and this may be reason that at present we do not know the actual status of this species in its distribution range. Coupe of PhD thesis on IGFS from Rajasthan and Gujarat are the only scientific information from the western India, which is the western most limit of their distribution. The studies conducted in Rajasthan, Gujarat and Western Ghats explaining its ecology, feeding habits, calling, activity budget, gliding behavior, status, distribution and sleep out behavior etc[3][12][1]. It is very difficult to take conservation actions, when the species is not conservation concerned at global level. In such circumstances, local community can play a major role. However, there is need to understand the peoples' dimension and to study their perception towards Indian Giant Flying Squirrel, thereby understanding the threats caused due into various reasons. The purpose of this study is to carry out the same so that we could acquire authentic and traditional first-hand data that would help us interpret the persisting threats to the Indian Giant Flying Squirrel in two regions of Gujarat. The study will be conducted in northern and southern parts of Gujarat as these two regions vary from each other by their geography,

climatic condition and culture. These differences may lead to develop holistic understanding about community based conservation that can be useful to initiate the community stewardship for conservation of this species in Gujarat. The study can also be used as a model for other states of India and may for other understudied fauna. Being a short-term study as a part of master's dissertation, following objectives will be addressed in detail during the period of July, 2020 to October 2020 months.

# Chapter 2

# Aim and Objectives

# Chapter 2. Aim and Objectives

## 2.1 Aim

Understanding the perception of local people towards Indian giant flying squirrel with reference to first-hand knowledge and threats to the species.

## 2.2 Objectives

1. To document the first-hand knowledge about Indian Giant Flying Squirrel among the local people

2. To assess the perception of locals towards the Indian Giant Flying Squirrel

3. To analyze ecological and anthropological threats on the Indian Giant Flying Squirrel in Gujarat

Research Questions

1. Is perception of local people towards IGFS based on their level of their first-hand knowledge?

2. What are the anthropogenic and ecological threats to Indian Giant Flying Squirrel and its habitat?

# Chapter 3

# Literature Review

# Chapter 3. Literature Review

Indian Giant Flying Squirrel (*P. philippensis*, Elliot 1839) is listed as Least Concerned (LC) species by IUCN having wide spread distribution in India in some parts of Rajasthan, Western Ghats, Gujarat and etc. In Gujarat Indian Giant Flying Squirrel found in south Gujarat, North-East Gujarat, Central Gujarat, and North Gujarat[(1)]. In Jambughoda Wildlife Sanctuary, Central Gujarat, the first indirect evidence like eaten pith, fallen twigs and pellets of Indian Giant Flying Squirrel were found under trees[(9)]. A virtual survey study was done using survey monkey to see the presence of the IGFS in North-East to Central to South Gujarat, the result also revealed the trees species on which the squirrel is seen and awareness amongst people[(1)]. The study carried out in some part of Gujarat on feeding patterns of IGFS shows that the species consumed 23% pith, 21% fruits, 16% bark, 14% twigs, 10% flowers, 6% seeds, 6% leaves and 4% buds but the increase or decrease in percent of some food items may vary from season to season such as during summer season the species may consume more flowers, young leaves and fruits due to more water intake and more nutrition[(8)(3)]. Very less scientific study has been carried out on the threat of *Petaurista philippensis* in the state of Gujarat so there is very little data available on the same. Despite of these studies in Gujarat, in my opinion there should be continuous monitoring done with minimum three to five years of gap to understand changes occur due to many aspects such as change in climatic conditions, variation in seasons and temperature, increase or decrease in human disturbance, increase in development and infrastructure and etc. this may show variations in threats faced by the species. This may show some behavioural changes and ecological changes in the species over years of monitoring.

## 3.1 Seed Dispersal by the squirrels

Mammals are very important part of the ecosystem for balancing and for functioning as they help in seed dispersal and pollination of floral species[(13)]. Some squirrels from oriental region has vast diversity in their diet but some has been observed to eat more flesh of fruits and seeds they contain while some studies suggests that some species seem to destroy most of seeds, sometimes discarding the flesh of the fruit and some reported that the only pulp is consumed in some fruits and that seeds are dropped[(14)]. As squirrels have large home range this may result into faster the dispersal rate and also may help in balancing floral density in the forest, especially in fragmented forest areas. There can be many ways of seed dispersal by animals,

firstly, seeds could be swallowed by the squirrel and extracted out as faeces though there is no direct evidence which may seem that squirrel is very less likely to destroy all the seeds in the fruits like fig[14]. Secondly, seed dispersal may occur due to when squirrel transports a seed or fruit away from the plant it picked in the mouth, this is very common dispersal behaviour in some species which may result into dispersal if the seeds afterwards dropped intentionally or accidentally[14].

### 3.2 Threats

Specially in human-carnivore conflict local people have often negative attitude towards the species due to low level of tolerance and in a lot of scenario negative attitudes may have been seen because not enough compensation are given to locals for their damage[15]. Sometimes when large-bodied animals, especially carnivores, become more threatened when local people or communities who live in the proximity of forest areas start taking actions to solve the problem on their own by poisoning then or shooting them. A lot of time places where there is presence of large animals such as carnivores, the tolerance of local communities sometimes get influenced by subjective psychological factors including beliefs and perception[16].

Historically, extinction of certain large animals has been correlated with the presence of humans and due to hunting practices[17]. Hunting only meets the short term economic need in tropical forests in today's developing world[17]. Sustainable hunting is very important for local communities otherwise resources will start depleting and people will have to spend more time in search for proper nutrition and may have to travel long ways in search for wild animals species[17][18]. Also, this may lead to imbalance in ecosystem that local communities and tribal rely on for their livelihood and may face scarcity of natural resources. Excessive hunting of some animal species may result into disturbance in food chain. Understanding local ecological knowledge can play a major role in promoting and supporting the improvement of scientific research and management of ecosystems although, not all tradition practices and belief systems are ecologically adaptive but in some cases they can change with time[19].

Kebung (Ratufa bicolor) and other squirrel species from morang forest hunted by Adi tribe in Arunachal Pradesh study have mentioned ethnomedicinal values which are dried meat of kebung when cooked with various edible plants and given to lactating mothers for about 1-2

months for birth recovery[20]. Also, some women reported, kebung's abdomen, along with its gallbladder can help treat malaria and fever[20]. For Fathers of the Adi tribe used a poisonous plant emo which is a type of wolfbane, Aconitum ferox for hunting wild animals such as deer and boars[20].

### 3.3 Hunting

In Asia, the data on hunting is limited and mainly restricted to trading whereas in other countries like South Africa and South America the data is available on livelihood of hunting by indigenous communities[21]. Although, there is some data available on other species of flying squirrels, small mammals and other animals from different parts of the country and the world. In some states of India have recorded hunting of Indian Giant Flying Squirrels for bushmeat, socio-cultural activities and many more.

The state of Arunachal Pradesh, has many indigenous tribes who hunt for food, culture, trade and leisure. Arunachal Pradesh located in north-east of India, it is considered as one of the biocultural diversity hotspots of the country having tribe diversity and enormous flora and fauna diversity. Local communities and tribes who live in proximity to forest are mostly dependent of native wildlife species for food, cultural purposes and trade, also it is their major source of income in the house[21]. Sometimes the species is hunted beyond its sustainable limit due to increase in market demand for wild meat[21]. In one of the studies, bushmeat was ranked higher than domestic meat; 96% of all respondents preferred to eat wild meat because for the taste and perceived meat purity[18]. Small scale hunting can result in specific species population decline in large birds and mammals which may eventually affects tropical forest dynamics[22]. Study was conducted in Indo-Tibetan Buddhist tribe in Arunachal Pradesh says, most common reason for hunting were for recreation, provision of meat and for commercial purposes but some cattle species like Gaur (Bos gaurus) are not hunted for recreational activities because the species may have some religious beliefs[18]. To control of imprudent hunting requires information on hunting patterns and understanding on the factors that encourages local hunting. In one of the study it is mentioned that the squirrels are hunted from successional forests including morang and jhum lands as a part of Adi people of Arunachal Pradesh, sociocultural, economic and livelihood system[20]. In India hunting is naturally associated with rapidly increase human population[18]. Himalayan Black bear (Ursus thibetanus) is intensively hunted

for its gallbladder and traded or sold for around 10,000-25,000 INR for each to people in Bhutan and Assam[18]. In one of the study from Arunachal Pradesh shows that it is taboo to kill some species like primates, gaur, hornbills, squirrels and tiger but some people from local tribal community would kill taboo species such as primates and squirrels when they raid crops, as per them it was only taboo when they eat their meat[18]. To meet conservation goals and sustainable hunting practices there should be understanding between local communities or tribal communities amongst themselves otherwise they should be provided with alternative source for their needs. Sometimes communities may have positive attitudes because they were given compensation but sometimes negative attitudes towards killing the species when they raid their crops and eat their cattle. Most of the study in modern hunting reported recent decline in lard-bodied animal species, with increasing hunting practices only few survivors left[23].

Hunting is not the only threats to animals but trading of animals which can be kept as pet are also captured and traded to other countries. China has been one of the major markets for imported pet trade and trading of luxurious animal parts like rhino horn, ivory, tiger skin and bone and etc. Many animals like primate, shrews, pangolins, bats are trades and killed for their meat. This may increase in disease transmission from animals to humans. Seven species of squirrels were found in Madan (the capital of North Sumatra Province) wildlife trade market where unusual or attractive species are sold as novelty pets and very commonly found species sold for their meat or food[24].

### 3.4 Natural Threats

Habitat loss, degradation, deforestation and other threats are huge and visible threats to biodiversity, especially in rainforests, which is why sometimes in some places hunting is considered a secondary threat to wildlife species[23]. Sometimes hunting can be easily controlled by engaging communities into alternative sources of income such as tour guides for tourists, making of jewelleries, with the help of forest department hunter can be converted to forest guides by doing so some of their cultural values are respected and can also bring economic values. Along with this they will be able to conserve their first-hand tradition knowledge and pass it on to the upcoming generation. The study of local traditional first -hand knowledge has been growing in the field of science since past many years due to recognition of such first-hand knowledge can contribute in the management of various aspects of

ecosystem, ecological processes and sustainable use and cultural practices in the conservation of biodiversity and threatened species[19].

### 3.5 Anthropogenic threats

Human activities like mining, construction, road development, grazing and many more are highly discourages in and around protected areas due to which it many cause disturbance in animal's daily routine[13]. Due to construction activities, forest areas get fragmented which result into roadkill of many animals' species. With proper study and sufficient research corridors can be made to connect forest fragments which can help to reduce roadkill incidents. Anthropogenic disturbance can cause increase in environmental heterogeneity which may result into reducing the effect of intra-specific competition over getting better resources and may find difficult to co-exist with other animal species[13]. Excessive using of natural resources from forest area for fuelwood, timber, bamboo for building houses and oak Quercus sp. Leaf litter for manure, use of herbs and shrubs for medicinal purposes which gives economic benefit to local communities[25]. Excessive use of natural resources may result into over exploitation of available resources and may lead to forest fragmentation, degradation and habitat loss for animals. There should be sustainable use of natural resources from forest areas to avoid natural disasters.

# Chapter 4

# Methodology

# Chapter 4. Methodology

## 4.1 Study Area

Gujarat is rich in fauna species having many endemic species and variety of ecosystems such as grassland, dry deciduous forests, marine ecosystem and wetlands. The state is unique variety of flora and fauna such as Asiatic Lions (*Panthera leo persica*) and Indian wild ass (*Equus hemionus khur*). The state is divided into three major habitat types which are the Indian dessert in north, semi-arid region and Western Ghats in the south of Gujarat. Mahi, Sabarmati, Narmada and Tapi are four major rivers and have longest coast line (Arabian sea) in Gujarat. The state has Aravalli Mountain ranges in north-east and Vindhyas and Satpuda ranges in east.

The state has total 18,927 sq km which is approximate 9.66% of forest cover[(26)]. As tropic of cancer passed through Gujarat which gives it sub-tropical climate. The climate is classified into three seasons which are monsoon (June to September), winter (November to February) and summer (March to May), temperature varies from 4°C to 46°C having annual rainfall around 400 to 2000 mm[(27)]. Gujarat has different forest types ranging from dry deciduous, dry teak and mixed deciduous forest in central part of Gujarat, thorn forest and grassland in Kutch, moist deciduous forest in south part of Gujarat which also includes Dangs. Gujarat has 101 mammal species belonging to 68 genera, 33 families and 12 orders from which two species are endemic to Indian subcontinents[(28)]. It has 22 sanctuaries, four national parks and two biosphere reserves to protect flora and fauna species in the state. (www.forests.gujarat.gov.in)

The state has major timber producing forests such as Teak (*Tectona grandis*) is the dominant sp. associated with Sadad (*Terminalia tomentosa*), Haldu (*Adina cordifolia*), Mahua (*Madhuca indica*), Biyo (*Pterocarpus marsupium*), Kalam (*Mitragyna parvifolia*), Timbru (*Diospyros melanoxylon*), Manvel bamboo (*Dendrocalamus strictus*).

The study area focuses mainly on the only local community where Indian giant flying squirrel (IGFS) *(P. philippensi*s Elliot 1839) is found in North and Central parts of the state. The study area is in Ratanmahal Sanctuary in Central and North Gujarat and Kewadi forests. These two area are well known for spotting for IGFS where human population seen living around the habitat of the species. These two areas have hilly terrain and mostly wel known for timber

production. The flora species found are *T. tomentosa* (Sadad), *M. longifolia* (Mahua), *T. grandis* (Saag) and etc. The fauna species are Leopard (*P. pardus*), hyena (*Hyaena hyaena*), jackal (*Canis aureus*) and etc. Both the area has suitable habitat for Indian Giant flying Squirrel consist of large tall tree with good canopy cover and availability of necessary resources.

### *4.1.1 Kevdi Forest*

Kevdi is situated in north Gujarat connecting route between two sanctuaries which are Jambughoda Wildlife Sancturay and Ratanmahal Wildlife Sanctuary. The area is rich in biodiversity having frequent visitors and resident such as sloth bear, hyena, Indian giant flying squirrel. It's tribal communities highly depend on forest resources for their livelihood. Its main attraction is due to spotting of Indian Giant Flying Squirrel and sloth bear which creates a lot of disturbance in animal's habitat. Sometimes people from city area often come to visit Kevdi as tourists. Kevdi comes under chhota Udepur forest division. (https://forests.gujarat.gov.in/index.htm)

### *4.1.2 Ratanmahal Wildlife Sanctuary*

Ratanmahal Wildlife Sanctuary is very famous for sloth bear situated in Central Gujarat, Dahod district located very close to Baria tribal town. The forest consists of fry teak forest, bamboo on periphery and mixed deciduous forest. The sanctuary has high density of Mahuda (*Madhuca longifolia* var *latifoloia*), it proved to be suitable habitat for Indian Giant Flying Squirrel along with other tree species. Ratanmahal is like plateau hilly from the bottom and flat at the top which is locally called mal means Mahal. There are eleven villages located in the sanctuary out of which five are inside the sanctuary and six are on the periphery. The study site will be in villages in the sanctuary. (https://forests.gujarat.gov.in/index.htm)

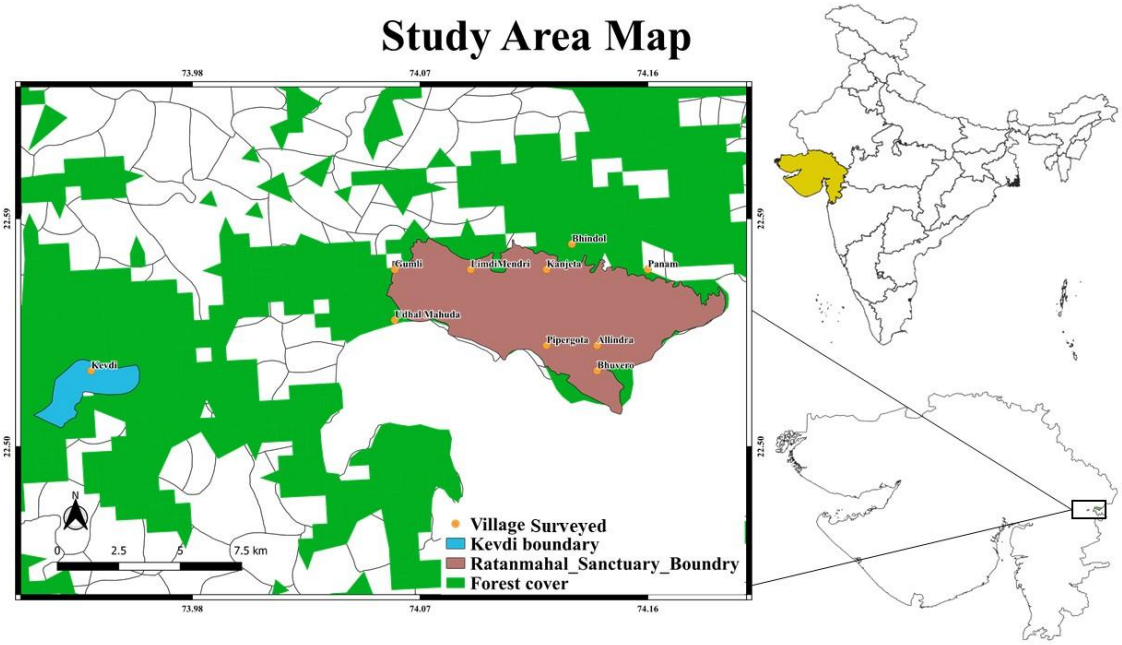


*Figure: 4.1: Map of the study area*

*Table 4.1: Geo Locations of both study sites*

| Sr No. | Study area | Geo Location |
|---|---|---|
| 1 | Kevdi forest and Eco Tourism Site | Lat: 21°20’17.92” N<br>Long: 73°24’42.61” E |
| 2 | Ratanmahal Wildlife Sanctuary | Lat: 22°32’59.61” N<br>Long: 73°6’47.89” E |

## 4.2 Methods

In order to achieve mentioned objectives different approach are used. All the objectives have different methods apply to it which are explained in detail in following chapters. Using different scientific approach for every mentioned objectives helps to address the gap in better way. To document the first-hand knowledge on Indian Giant Flying Squirrel amongst local people semi-structured questionnaire will be used which will not restrict them to answer in detail and about the species. In the second objective to know the local’s perception Q-method will be used. To fulfil third objective ten tree method will be used describing its parameters to identify anthropogenic threats.

### *4.2.1 Documenting first-hand knowledge*

A questionnaire based survey was used to document the first-hand knowledge about Indian Giant Flying Squirrel in both the study sites. The interviews were made to identify the squirrel using colored photograph of the species. Then questionnaire interviews were followed to collect further information mentioned below. The semi structured interviews were conducted of local people in villages along with local forest staff to document how much knowledge they have about the species which is described in Annexure I. The respondents for the survey were selected on random basis without any bias.

Chi-square test of independence is non-parametric test also known as Pearson chi-square test or chi-square test. This test was introduced by Karl Pearson in 1900 which made big contribution to the field of science. It is most useful statistical test that deals with nominal and ordinal data. It tests the null hypothesis about the relationship between two variables. In this study, chi-square test was employed to test the hypothesis that the villager's knowledge level that is categorized in high and low about IGFS on its feeding, roosting, nesting, biology/ecology and hunting proving or rejecting the null hypothesis. The chi-square test compares predicted frequencies, assuming the null is true, with the determined frequencies from the study. When obtaining a significant chi-square result, calculate percentages in a table to summarise in which the variations among the groups are[29].

### *4.2.2 Q – Methodology*

It is a photo-based method used to get detailed information from locals' stakeholder about Indian Giant Flying Squirrel and its presence in human dominate area. This method allows qualitative and quantitative data on perception of the person being interviewed. It allows the participant to explain and justify the answer in detail and to explain their perception without any restriction. In Q-methodology the response variable is the participant in the study, not the participants' answers to a series of questions[30].

The Q-set is consisted of 16 photographs of various wildlife species found in the study area. Although this study is mainly concerned with Indian Giant Flying Squirrel, a more comprehensive approach to local wildlife was taken to assess the attitudes and opinions

towards IGFS relative to other wildlife. Photographs were chosen in local language which is known to participants and found in and around the area if not they may be able to identify from the photos provided. The chosen species includes mammals and belonging to IUCN Red List. A full list of all species is included with the results in Table 4 in the next chapter.

In total 10 villages will be surveyed for this method. Participants will be asked to sort the 16 given photographs into three category of species they liked, did not like, or were neutral them. Later, they were asked to place photographs into a forced normal distribution, ranging from the most positive association at the right, to the most negative association at the left (Figure 4). As shown in the figure, the distribution is divided into multiple layers on basis of participant's increasing and decreasing level of positive or negative association. With pre fixed number in top row of spots defining for each column, forcing participants to sort all the provided photos from positive or negative association. After the participants were done sorting then asked if they want to make any change. When final arrangement was done, they were asked to provide explanation for their placement of the photographs shown in Annexure II. These explanations were recorded for further data analysis.

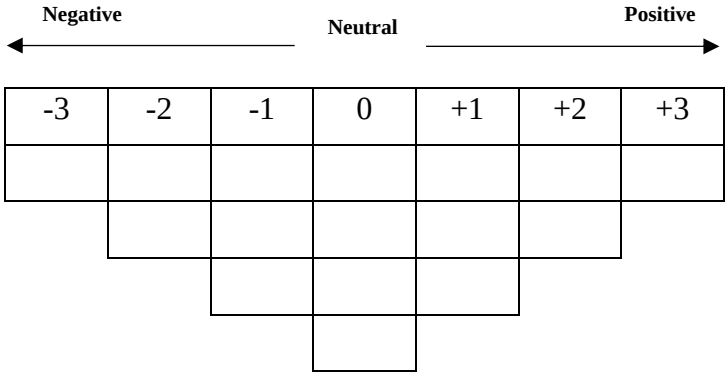


*Figure 4.2: A demostrative of Q-sort worksheet*

*Table 4.2: List of animals selected for Q-methodology*

| **Common name** | **Scientific name** | **Local name (Gujarati)** |
|---|---|---|
| Wild boar | *Sus scrofa* | Jangli Bhund |
| Hanuman langur | *Semnopithecus entellus* | Vanar |
| Indian cobra | *Naja naja* | Nag |
| Indian giant flying squirrel | *Petaurista philippensis* | Udati khiskoli |
| Small Indian civet | *Viverricula indica* | Vaniyar |
| Sloth bear | *Melursus ursinus* | Rinchh |
| Indian hare | *Lepus nigricollis* | Saslu |
| Indian python | *Python molursus* | Ajagar |
| Barn owl | Tyto alba | Andhali Chakan |
| Grey francolin | *Francolinus pondicerianus* | Tetar |
| Red-wattled lapwing | *Vanellus indicus* | Titodi |
| Rhesus macaque | *Macaca mulatta* | Mankdu |
| Black kite | *Milvus migrans* | Samdi |
| Common krait | *Bungarus caeruleus* | Kalotaro sap |
| Indian crested porcupine | *Hystrix indica* | Shahudi/ Shedhadi |
| Blue bull | *Boselaphus tragocamelus* | Nilgai/ Roz |

### *4.2.3 Ecological and anthropological threats*

The ecological and anthropological threats are selected on the base of ecology and habitat type of Indian Giant Flying Squirrel. There are various parameters taken in consideration to measure ecological and anthropological threats. To measure these threats parameters are 1) Presence of predators of *P. philippensis*, predators active at night such as owls, leopard and other nocturnal animals. 2) Distance to human settlements to see human pressure[31]. 4) the distance to roads, district and national roads and highways[32]. 5) Activity of tourists in and around population of the squirrel. 6) Construction activities if there is any. 7) Other disturbances will be noted down such as logging of forest, forest resource use by locals and etc. The threat study will be conducted in both the study area to fulfill objective three.

## 4.3 Analysis

### *4.3.1 Chi square analysis*

For objective 2 a semi structured questionnaire was used in both study site. Total 108 interviews were taken from 10 villages from both study area and recorded using mobile phone. Later they were translated and entered in excel datasheet. Respondents were randomly chosen for the interviews. As per responses of 108 people 66 people have seen and are aware about presence of flying squirrel in their surroundings. These 66 responses were mainly from villages that are close to the IGFS habitat and other 42 people who has not seen or heard of IGFS live in outer villages which are far (approx. 10 to 15 km) from the flying squirrel habitat.

While reporting chi-square test results, the statistic, degree of freedom (df) and observed significant value are necessary. A contingency table of observed frequencies, expected frequencies, and chi-square should be presented with definite cell[33]. The Pearson's Chi-square ($X^2$) follows following assumptions[34].

- The obtained data is through random selection
- The sample size should be large enough for $X^2$ calculation and mutually exclusive.
- The observations should be independent of each other.
- The data should be in form of frequency or counts.

Research hypothesis: there is relation between variables or they are dependent on each other. Null hypothesis ($H_0$) describes that the variables are independent or there is no association. Alternate hypothesis ($H_a$) says there is association between the variables or they are related to each other. The $X^2$ is calculated based on formula given below. Here $H_0$ is people have enough knowledge about IGFS and $H_a$ refers to people does not have enough knowledge about IGFS.

$$X^2 = \sum_i \frac{(O_i - E_i)^2}{E_i}$$

Where,

$X^2$ = chi-square value

$O_i$ = Observed value

$E_i$ = Expected value

Once the hypothesis is set, expected value is calculated for each cell assuming the null hypothesis is true. The expected value specifies each cell value in the table assuming there is no association between the variables. The data is arranged in contingency table consisting observed value and expected value. The contingency table explains villager's knowledge on IGFS feeding, roosting, nesting, biology/ecology and hinting on the scale of low and high.

The expected value in are the people who have seen and aware about Indian Giant Flying Squirrel in both the field site assuming that they contain all the knowledge about the species. Whereas the observed values are the number of people who knows about the specie in detail and categorised in their respective cells.

The contingency table for low scale knowledge shows expected value of people who has low knowledge and the observed value i.e. number of people recorded having low knowledge of the species and categorised in their respective cells. Once observed and expected values are placed in their respective cells, (O-E) value is calculated for further calculations followed by $(O-E)^2$ and $(O-E)^2/E$ to get the $X^2$ for both.

### *4.3.2 Q-methodology analysis*

For this study all the Q Sorts were analysed using PQMethod software (http://schmolck.org/qmethod/). This software is exclusively built for Q Methodology analysis, it is appropriate to use in a Q Study[35][36]. As per McKeown and Thomas, "data analysis in Q Methodology typically involves the sequential application of three sets of statistical procedures: correlation, factor analysis, and the computation of factor scores"[37]. A factor in this study represents group of people who have similar perspective[36]. The higher the factor loading, the more highly that sorter is correlated with that factor[38][39]. The major advantage of this method that recommends it to use, is it uses one of the most powerful statistic technique, with huge exploring valences: factor analysis, the approach of the method is that, structures of subjectivity gathered from individuals are subject to a factor analysis and results in factors that only represent segments of subjectivity[40].

For this study 53 sorts were collected having multiple stakeholders such as forest staff, local villagers (educated and uneducated), shop vendors, cooking staff and watchmen (field watchmen and gate watchmen). Total 16 photos of wild animals were selected that are locally

found in and around their village. From Q-sort data collection, 42 sorts were found completed which further analysed using PQ Method software. Q-sorts are the number of participants that took part in the survey. In this study, three factors were derived form 42 Q-sorts which describes all stakeholder's perception toward the animal's photos given to them. A factor in this study is a category representing the group of people who have similar perspective[36]. All these Q-sorts were entered in PQ software manually, first entering the number of Q-statements i.e., animal's photos in this case followed by participants organised Q-sorts. The participants were named as R1M_RM, R2F_K where R stands for respondent followed by serial number of participants, M/F stands for male/female, RM stands for Ratanmahal Wildlife Sanctuary and K stands for Kevdi ecotourism campsite.

#### 4.3.2.1 Correlation

A simple measure of association between the variables can be established using a correlation statistic. Correlations is generally used to measure 'the degree of agreement between two sets of scores gathered from the same individuals'[41]. The values of correlation can range from -1 through +1. Factor loadings show each participant's association with each of the identified opinion types[42]. A factor loading of +0.56, means that a person's statement array is highly correlated with factor 3.

#### 4.3.2.1 Factor Analysis

Factor analysis is a statistical technique widely used in many fields such as, psychology and social sciences to understand qualitative and complicated data in simple way and in organised manner. It is reduction of attribute space from a larger number of variables into smaller number of factors for better understanding of data. This analysis is usually applied to find correlation between variable. Factor loadings are defined as correlation between variables and factors.

#### 4.3.2.3 Q Factor Analysis

In Q factor analysis, the respondent's sorts are grouped based on how they arranged photos on the Q board. The set of variables that are highly inter related are called as factors and represents dimensions within the data sets. It provides tools to analyse interrelationships structure between large number variables. Correlation matrix is the starting point of factor analysis which is inter

correlated between the presented variables[43]. People who have given similar ranking to given photos will be loaded in the same factor. These factor loadings indicate how each Q sort correlates with each factor. Hence, respondents who share similar perception end up on the same factor.

Step 1: Entering statements

Statements/photo name are entered as line by line. For example, statement/photo name one is entered as line one and this is done for all the sixteen statements/photo. These statements are than saved in .STA file in project folder.

Step 2: Entering sorts

There is many information required to enter such as number of statements/photos (16), ranking values of each sort from -3 to +3. Each sort is given identification having 8 maximum letters as a software default. Once all the data is entered, it is than saved as .DAT file in project folder.

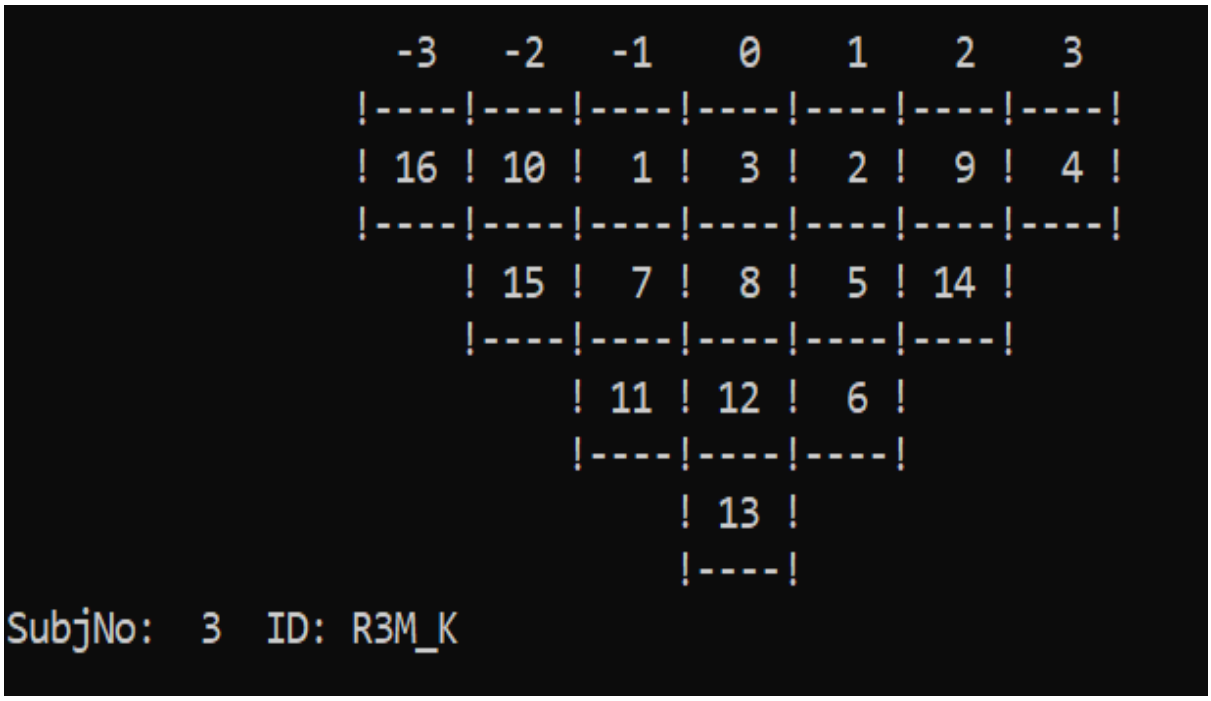


*Figure 4.3: Representative of Q-sort in PQMethod software*

Step 3: Factor extraction

Here, the factors were derived manually based on participants perception. Though, considering eigenvalues greater or equal to 1.00 was also considered for further analysis. Eigenvalues that are less than 1.00 were considered as insignificant as they generally show too little interest for further analysis. The first step of the factor analysis is factor extraction method. The software PQMethod® offers two choices for factor extraction are principal component and centroid[35]. The centroid method is the most preferred for factor extraction because of uncertainty of its the solution and there can be many possible solutions for the same.[34][40]. As per recommendations, the centroid method for factor extraction was employed.

Once all the 16 statements (animals photo name) and 53 Q-sorts are entered, centroid factor analysis is used to extract factors. To perform this step QCent command is given in the PQMethod software. A centroid factor refers to a large central average of the relationship between all the sorts as they are represented by their correlation coefficients[36][45]. The outcome of this factor extraction is factor loadings referring to the value expressing each sort's relationship with the centroid.

Step 4: Factor rotation

The software offers two choices for factor rotation: Varimax and hand rotation. Varimax is preferred for this study as it allows to produce simple structure and maximising eigenvalue for each factor[46]. In Q methodology, the researcher is more focused on subjectivity including the subjective rotation of factors[36][47]. The command QVarimax is used in the PQMethod software to perform varimax rotation.

Step 5: Flagging factors

Followed by factor rotation, software's pre-flagging algorithm selects only pure cases of factors indicating with X next to the factor score[44]. Participants who are not flagged or placed X next to their factor score are not represented by any factor[35]. The X's indicates participants' viewpoint. The flagged score defines the factors which are used to determine representative sorts for each factor. All factors represent a unique perspective. Participants who did not load

significantly on any of the factors therefore they are not flagged or indicating X by the software[48]. These unflagged sorts are not included in further analysis. It is necessary to flag sorters before the analyses produce a report that involves a variety of tables[39].

Step 6: Analysing factors

This is the final step in Q study involves analysing the results of factor analyses. The final report is saved in from of .LIS file. The report contains tables that are developed statistically using PQMethod®. These tables help in better understanding of the process and easy interpretation. While making decision on final set of factor that are used in analysis suggested as simplicity, clarity, distinctness and stability[49].

Simplicity: It is better to have fewer factors as it makes view point easier to understand without losing important information.

Clarity: Trying to minimise the number of people who load on multiple factor and people who do not load on any factor.

Distinctness: Lower correlations between factors are better, as highly correlated factors are saying similar things.

Stability: Certain groups of people cluster together which indicates individuals have similar thinking and sharing similar perception.

# Chapter 5

# Results

# Chapter 5. Results

## 5.1 To document the first-hand knowledge about Indian Giant Flying Squirrel among the local people

Once the *Chi*-square value is calculated from both the contingency table, degree of freedom (df) is calculated to get the critical *Chi*-square value based on calculated Chi-square table 5.1.

*Table 5.1: Representation of knowledge level*

| | Feeding | Roosting | Nesting | Biology/Ecology | Hunting |
|---|---|---|---|---|---|
| **Low** | 66 | 10.24 | 66 | 11.87 | 0.54 |
| **High** | 0 | 36.37 | 0 | 21.87 | 54.54 |

Based on table 5.1. degree of freedom is calculated shown below.

df = (# rows - 1) * (# columns – 1)
= (2-1) * (5-1)
= (1) * (4)
= 4

The critical value at 5% level of significance is 9.49 obtained from *Chi*-Square table. The critical value is marked in red box in figure 5.1. Villagers from both the study sites have much knowledge on the specie's feeding habits which is confirmed by the *Chi*-square test. *Chi*-square test score for people having low knowledge on feeding habits is 66 which is much higher than the critical value ($X^2$ = 66 > 9.49; $H_0$ rejected for low scale) therefore it rejects the null hypothesis but the test score of high knowledge is 0 which is less than critical value ($X^2$ = 0 < 9.49; $H_0$ accepted for high scale) therefore it proves, people from both study site has enough knowledge on specie's feeding habit. For roosting, the test rejects null hypothesis for both the scale knowledge of people as the test value is higher than the critical value ($X^2$ = 10.24 > 9.49; $H_0$ rejected for low scale, $X^2$ = 36.37 > 9.49; $H_0$ rejected for high scale).

| Degree of Freedom | Probability of Exceeding the Critical Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0.99 | 0.95 | 0.90 | 0.75 | 0.50 | 0.25 | 0.10 | 0.05 | 0.01 |
| 1 | 0.000 | 0.004 | 0.016 | 0.102 | 0.455 | 1.32 | 2.71 | 3.84 | 6.63 |
| 2 | 0.020 | 0.103 | 0.211 | 0.575 | 1.386 | 2.77 | 4.61 | 5.99 | 9.21 |
| 3 | 0.115 | 0.352 | 0.584 | 1.212 | 2.366 | 4.11 | 6.25 | 7.81 | 11.34 |
| 4 | 0.297 | 0.711 | 1.064 | 1.923 | 3.357 | 5.39 | 7.78 | 9.49 | 13.28 |
| 5 | 0.554 | 1.145 | 1.610 | 2.675 | 4.351 | 6.63 | 9.24 | 11.07 | 15.09 |
| 6 | 0.872 | 1.635 | 2.204 | 3.455 | 5.348 | 7.84 | 10.64 | 12.59 | 16.81 |
| 7 | 1.239 | 2.167 | 2.833 | 4.255 | 6.346 | 9.04 | 12.02 | 14.07 | 18.48 |
| 8 | 1.647 | 2.733 | 3.490 | 5.071 | 7.344 | 10.22 | 13.36 | 15.51 | 20.09 |
| 9 | 2.088 | 3.325 | 4.168 | 5.899 | 8.343 | 11.39 | 14.68 | 16.92 | 21.67 |
| 10 | 2.558 | 3.940 | 4.865 | 6.737 | 9.342 | 12.55 | 15.99 | 18.31 | 23.21 |
| 11 | 3.053 | 4.575 | 5.578 | 7.584 | 10.341 | 13.70 | 17.28 | 19.68 | 24.72 |
| 12 | 3.571 | 5.226 | 6.304 | 8.438 | 11.340 | 14.85 | 18.55 | 21.03 | 26.22 |
| 13 | 4.107 | 5.892 | 7.042 | 9.299 | 12.340 | 15.98 | 19.81 | 22.36 | 27.69 |
| 14 | 4.660 | 6.571 | 7.790 | 10.165 | 13.339 | 17.12 | 21.06 | 23.68 | 29.14 |
| 15 | 5.229 | 7.261 | 8.547 | 11.037 | 14.339 | 18.25 | 22.31 | 25.00 | 30.58 |
| 16 | 5.812 | 7.962 | 9.312 | 11.912 | 15.338 | 19.37 | 23.54 | 26.30 | 32.00 |
| 17 | 6.408 | 8.672 | 10.085 | 12.792 | 16.338 | 20.49 | 24.77 | 27.59 | 33.41 |
| 18 | 7.015 | 9.390 | 10.865 | 13.675 | 17.338 | 21.60 | 25.99 | 28.87 | 34.80 |
| 19 | 7.633 | 10.117 | 11.651 | 14.562 | 18.338 | 22.72 | 27.20 | 30.14 | 36.19 |
| 20 | 8.260 | 10.851 | 12.443 | 15.452 | 19.337 | 23.83 | 28.41 | 31.41 | 37.57 |
| 22 | 9.542 | 12.338 | 14.041 | 17.240 | 21.337 | 26.04 | 30.81 | 33.92 | 40.29 |
| 24 | 10.856 | 13.848 | 15.659 | 19.037 | 23.337 | 28.24 | 33.20 | 36.42 | 42.98 |
| 26 | 12.198 | 15.379 | 17.292 | 20.843 | 25.336 | 30.43 | 35.56 | 38.89 | 45.64 |
| 28 | 13.565 | 16.928 | 18.939 | 22.657 | 27.336 | 32.62 | 37.92 | 41.34 | 48.28 |
| 30 | 14.953 | 18.493 | 20.599 | 24.478 | 29.336 | 34.80 | 40.26 | 43.77 | 50.89 |
| 40 | 22.164 | 26.509 | 29.051 | 33.660 | 39.335 | 45.62 | 51.80 | 55.76 | 63.69 |
| 50 | 27.707 | 34.764 | 37.689 | 42.942 | 49.335 | 56.33 | 63.17 | 67.50 | 76.15 |
| 60 | 37.485 | 43.188 | 46.459 | 52.294 | 59.335 | 66.98 | 74.40 | 79.08 | 88.38 |
| | *Not Significant* | | | | | | | *Significant* | |

*Figure 5.1: Critical value table for chi-square test*

Similarly, for nesting, $X^2 = 66 > 9.49$; $H_0$ rejected therefore people do not have low knowledge viz. the test score rejects hypothesis but the test accepts null hypothesis for people containing much knowledge on nesting of the species ($X^2 = 0 > 9.49$; $H_0$ accepted for high scale). The score for the knowledge about the biology/ecology of the species ($X^2 = 11.87 > 9.49$) also suggests to reject $H_0$ low scale as well as high score i.e., $X^2 = 21.87 > 9.49$. For hunting of the species, the test accepts $H_0$ ($X^2 = 0.54 > 9.49$; $H_0$ accepted) for low scale but $H_0$ is rejected for high scale that explains people do not have much knowledge of hunting practice.

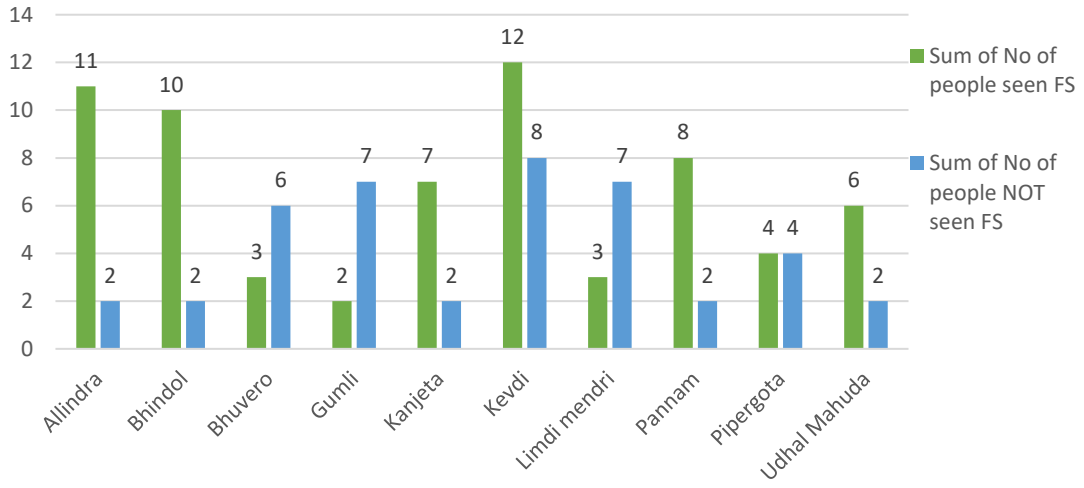


*Figure 5.2: Number of people who has seen and not seen flying squirrel*

As proved earlier that people living far from flying squirrel spot have no or less knowledge about the species which is clear from above graphical representation. In Ratanmahal, villages such as Gumli, Bhuvero and Limdi mendri are far from the flying squirrel is seen therefore very few people are aware about the species. The same data is shown in corelation with distance in below Figure 5.3.

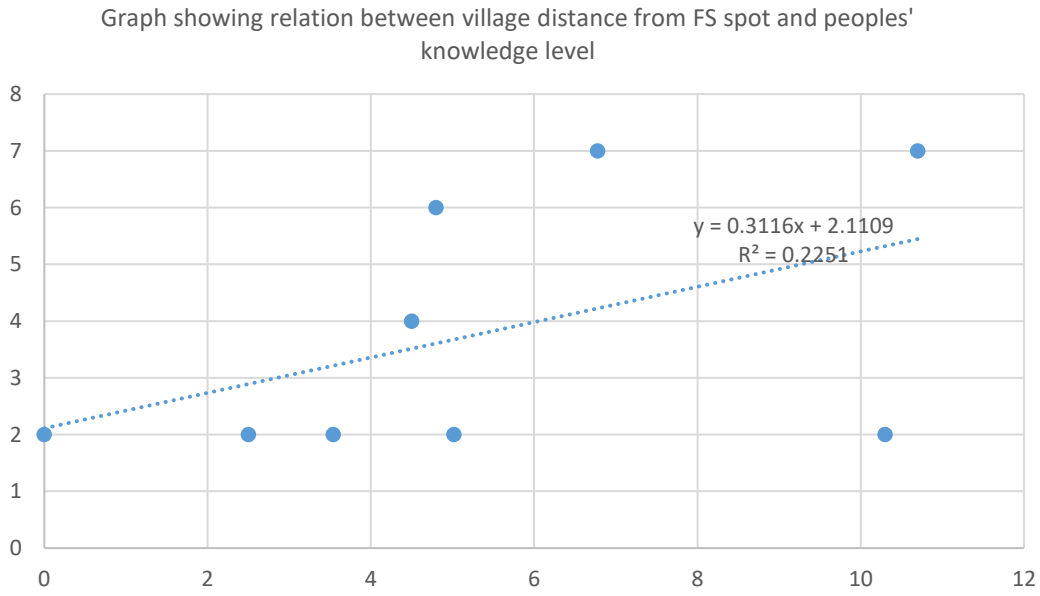


*Figure 5.3: Relation between village distance FS spot and peoples' level of knowledge*

Trend line is used to determine any patterns within a set of data. It is generally referred as a line of best fit. It is used in conjunction with a scatter plot to see if there is any relationship with data sets. It can be used in predicting future data points. In figure 5.4 the trend line shows the positive trend as with the increase in distance from the spot of IGFS, peoples' level of knowledge is reducing. The reason behind this is they live far from the spot where IGFS is seen therefore they did not come across the species.

## 5.2 To assess the perception of locals towards the Indian Giant Flying Squirrel

The three factors that emerged from the analysis are illustrated in table 5.2 with automatic pre-flagging. An 'X' next to factor loading, in bold denotes respondents belonging to a particular factor. For example, in table 5.2 person 2 having ID R2M_RM indicating factor 2 whereas person from 3 to 9 belong to factor 1 having similar perception. Each of three factors represent different perspective towards statements/animal photos provided to them. As mentioned earlier in step 5 participants who did not load significantly on any of the factors were not flagged by the software therefore, they are not marked with X. In this study all 53 sorts were entered out of which 42 sorts were significant and further analysed describing 59% variance which shows this Q study is acceptable.

*Table 5.2: Extracted table for Q-sorts*

| Q-Sorts | ID | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|---|
| 1 | R1M_RM | 0.149 | 0.4774 | 0.0182 |
| 2 | R2M_RM | 0.4051 | **0.5980X** | 0.2068 |
| 3 | R3M_K | **0.5914X** | 0.4735 | 0.1777 |
| 4 | R4M_K | **0.7211X** | -0.0601 | 0.3781 |
| 5 | R5M_K | **0.6929X** | 0.1299 | 0.1719 |
| 6 | R6M_K | **0.8338X** | 0.0359 | 0.1909 |
| 7 | R7M_K | **0.7494X** | 0.0743 | 0.0682 |
| 8 | R8M_K | **0.5930X** | 0.3523 | 0.2777 |
| 9 | R9M_K | **0.7972X** | 0.3242 | 0.2725 |
| 10 | R10F_K | 0.3605 | 0.2771 | 0.0663 |
| 11 | R11F_K | **0.5544X** | -0.008 | 0.3549 |

| | | | | |
|---|---|---|---|---|
| 12 | R12M_K | -0.1639 | **0.7489X** | 0.0415 |
| 13 | R13F_K | **0.8012X** | -0.0569 | -0.0214 |
| 14 | R14M_K | 0.4368 | **0.6488X** | 0.2463 |
| 15 | R15M_K | 0.5025 | 0.2465 | 0.484 |
| 16 | R16M_K | 0.2124 | 0.6066 | 0.5897 |
| 17 | R17M_RM | 0.2587 | 0.3074 | 0.1029 |
| 18 | R18M_RM | **0.7689X** | 0.2195 | 0.052 |
| 19 | R19M_RM | **0.6836X** | -0.1268 | 0.5604 |
| 20 | R20M_RM | **0.8091X** | -0.0131 | 0.1539 |
| 21 | R21M_RM | -0.1444 | **0.6144X** | 0.0056 |
| 22 | R22M_RM | **0.5960X** | 0.046 | 0.4324 |
| 23 | R23M_RM | 0.1297 | 0.175 | 0.1471 |
| 24 | R24M_RM | **0.6753X** | 0.1405 | 0.5139 |
| 25 | R25M_RM | 0.2748 | **0.5483X** | 0.2939 |
| 26 | R26M_RM | -0.0416 | 0.3487 | **0.6653X** |
| 27 | R27F_RM | 0.3708 | 0.2491 | **0.6509X** |
| 28 | R28M_RM | -0.0974 | 0.05 | **0.7715X** |
| 29 | R29M_RM | 0.0208 | 0.5085 | **0.6114X** |
| 30 | R30M_RM | **0.8641X** | 0.1384 | 0.0807 |
| 31 | R31M_RM | 0.16 | 0.3611 | **0.5797X** |
| 32 | R32M_RM | **0.8357X** | -0.0928 | 0.0582 |
| 33 | R33M_RM | -0.4617 | 0.364 | 0.455 |
| 34 | R34M_RM | 0.2747 | 0.4833 | 0.419 |
| 35 | R35M_RM | 0.3213 | 0.1696 | **0.6123X** |
| 36 | R36M_RM | **0.5423X** | 0.0071 | 0.4285 |
| 37 | R37M_RM | -0.106 | **0.7922X** | 0.018 |
| 38 | R38F_RM | -0.0204 | **0.7886X** | 0.1787 |
| 39 | R39M_RM | **0.7512X** | 0.1216 | 0.3164 |
| 40 | R40M_RM | 0.3386 | 0.5089 | **0.6255X** |
| 41 | R41M_RM | **0.7414X** | 0.2744 | 0.1941 |
| 42 | R42M_RM | 0.4852 | 0.0811 | **0.6883X** |
| 43 | R43M_RM | 0.2844 | **0.6103X** | 0.208 |
| 44 | R44M_RM | 0.3142 | 0.0705 | **0.5302X** |

| | | | | |
|---|---|---|---|---|
| 45 | R45M_RM | 0.5681 | 0.2279 | 0.5594 |
| 46 | R46M_RM | 0.483 | -0.1014 | 0.4445 |
| 47 | R47M_RM | 0.217 | **0.7967X** | 0.2948 |
| 48 | R48M_RM | 0.2727 | 0.4392 | **0.7304X** |
| 49 | R49M_RM | 0.6262 | 0.1243 | **0.6434X** |
| 50 | R50M_RM | -0.2965 | 0.4835 | 0.2895 |
| 51 | R51F_RM | 0.0008 | **0.9334X** | 0.0679 |
| 52 | R52M_RM | **0.5349X** | 0.1589 | 0.4895 |
| 53 | R53M_RM | 0.5258 | 0.1294 | **0.6553X** |
| **%** | **expl.Var.** | **26** | **16** | **17** |
| | **No. of sorts** | **20** | **10** | **12** |

In above table 5.2 there are 20 sorts representing factor 1 and their loading values ranging from 0.53 to 0.86. Factor 1 has 26% variance. Factor 1 categorised as “Economic impact” based on subjective perception of respondents which is explained later. This factor has 2 females from Kevdi field site and 18 males (9 from Kevdi field site and 9 form Ratanmahal WLS).

Factor 2 has 10 sorts and 16% variance and values ranging from 0.54 to 0.93. Based on participant’s descriptive response this factor named as “Aesthetic, spiritual values and Conservation aspects”. This factor has 2 females from Ratanmahal WLS and 8 males (3 from Kevdi and 5 from ratanmahal WLS).

There are 12 sorts that represent factor 3 having variance 17%. Factor loading values range from 0.53 to 0.77. As per participant’s subjective response, it is named as “Lack of Awareness”. It has 1 female from Ratanmahal WLS and 11 males from Ratanmahal WLS.

Once factor score calculated, two tables that are developed in this analysis are consensus and distinguishing factor statements, which allow the researcher to explore what is common among and different between the factors respectively[36][39][48]. In order to determine distinguishing statements, factor score is normalized weighed average statement score (Z-score) of respondents that define that factor. Consensus statement are that do not distinguishing between any of the factor[50]. Consensus statements that are common among pairs of factors.

*Table 5.3: Correlations between factor scores*

| **Factors** | **1** | **2** | **3** |
|---|---|---|---|
| 1 | 1.0000 | 0.2332 | 0.5671 |
| 2 | 0.2332 | 1.0000 | 0.4664 |
| 3 | 0.5671 | 0.4664 | 1.0000 |

Table 5.3 shows the correlation between all the factors. Here, Correlation coefficient refers to the strength of a relationship between two variables and runs along the same continuum of correlation[51]. A large positive correlation, say +0.23, indicates that persons who scored highly in relation to Variable 1 have tended to do similarly in relation to Variable 2. This suggests that high scores relative to Variable 1 are typically associated with low scores on Variable 2 (and vice versa). Here, the relation between factor 2 and factor 3 i.e., +0.46 is positively correlated therefore they are highly correlated with each other.

*Table 5.4: Factor values for each 16 photos*

| No. | Statement | Factor Arrays | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| 1 | Indian python | 0 | 0 | -1* |
| 2 | Hanuman langur | 1 | 1 | -2* |
| 3 | Monitor lizard | 0 | -2* | 0 |
| 4 | Red-wattled lapwing | 2 | 1* | 2 |
| 5 | Sloth bear | -2* | 3* | 1* |
| 6 | Indian hare | 3 | 1* | 3 |
| 7 | Indian leopard | -2* | 2* | 1* |
| 8 | Grey francolin | 1* | -1* | 2* |
| **9** | **Indian giant flying squirrel** | **2*** | **2*** | **1*** |
| 10 | Blue bull | 0 | 0 | -1 |
| 11 | Small Indian civet | -1* | 0* | -2* |
| 12 | Fruit bat (Flying fox) | 0 | -1* | 0 |
| 13 | Indian cobra | -1 | 0 | -1 |
| 14 | Barn owl | 1* | -1 | 0 |
| 15 | Indian chameleon | -1* | -2* | 0* |

| | | | | |
|---|---|---|---|---|
| 16 | Wild boar | -3 | -3 | -3 |

Note: Distinguishing Statements marked by *

Table 5.4 shows different factor score for each statement and depending on statistical significance the statement load to a specific factor. The above table contains 16 statements from the Q-samples and their grid position for all three factors as perception. Statements grid position has asterisk indicates distinguishing statements for that particular factor compared to other factors. Here Indian Giant Flying Squirrel is scored 2 for factor 1 and factor 2 whereas for factor 3 it is scored at 1 based on people's perception. A table of the distinguishing statements especially for every factor will be presented in the analyses for that factor, in the subsequent section, to resource the reader within the interpretation of each factor. A representative sort is made from the sorts of those who are represented by a specific factor. This representative sort is one sort that represents that factor/viewpoint[36][39]. An example of a representative sort from Factor 1 is show in Figure 5.4 below and contains the same information about Factor 1 contained in Table 5.4.

Negative ← Neutral → Positive

| -3 | -2 | -1 | 0 | +1 | +2 | +3 |
|---|---|---|---|---|---|---|
| 16 | 5 | 11 | 1 | 2 | 9 | 6 |
| | 7 | 13 | 3 | 8 | 4 | |
| | | 15 | 10 | 14 | | |
| | | | 12 | | | |

*Figure 5.4: Representative Sort for Factor 1*

The photos that are ranked as most liked and least liked provides perception represented by that factor. For further understanding of individual respondent's sort, post sort interview was conducted for respondents to explain why sort was arranged in the way it was. This can allow to gain confirmation of the analysis and may provide insight into factor's meaning[50][52].

For this study, the I requested post-sort questions about the sorting grid sheet and allowed the respondents to self report about the selection procedure used during the sorting process. These questions are mentioned in Annexure II.

Based on these responses of these questions, it was easy to identify the commonalities among sorters who were represented by the same factor as well as to help define and articulate the factors. Comments that help understand each factor interpretation will be included in the following sections with the description of each factor.

Factor 1: Economic impact

Factor 1 explains economic impact based on participants responses and their perception towards all the animals found in their surroundings.

Respondents of this factor are mainly villagers whose main occupation consist of farming and animal husbandry. The others include teacher, labours and local businessmen. They are positive as there is no direct or indirect harm done by the species. Indian Giant Flying Squirrel does not harm farmers or villagers in anyway therefore it contributes in positive 'attitude of some farmer towards the species living in wild. Most of the respondents does not see any see and conflict with flying squirrel due to its nocturnal characteristic though it consumes minor part of fruits and flowers and share some resources. Although some respondents have negative perception towards Indian giant flying squirrel due to its feeding habit of eating soft branches of many tree species like Mahua, Timbru and other trees of economic importance. According to participants, the flying squirrel's habit of eating soft branches restricts the growth, delays in fruiting and therefore it reduces fruit yield and sometime the slows the tree growth.

*Table 5.5: Factor 1 top most liked / disliked photos*

| No | Statements/Photos | Grid position for factor 1 | Z- scores |
|---|---|---|---|
| 6 | Indian hare | 3 | 1.677 |
| **9** | **Indian giant flying squirrel** | **2** | **1.594** |
| 4 | Red-wattled lapwing | 2 | 1.033 |
| 8 | Grey francolin | 1 | 0.756 |
| 14 | Barn owl | 1 | 0.668 |
| 2 | Hanuman langur | 1 | 0.525 |
| 12 | Fruit bat (Flying fox) | 0 | -0.032 |
| 1 | Indian python | 0 | -0.099 |

| | | | |
|---|---|---|---|
| 3 | Monitor lizard | 0 | -0.257 |
| 10 | Blue bull | 0 | -0.321 |
| 15 | Indian chameleon | -1 | -0.406 |
| 11 | Small Indian civet | -1 | -0.51 |
| 13 | Indian cobra | -1 | -0.524 |
| 7 | Indian leopard | -2 | -0.67 |
| 5 | Sloth bear | -2 | -1.539 |
| 16 | Wild boar | -3 | -1.895 |

The photos in table 5.5 represents the views on most liked and most disliked for factor 1. As per table 5.5, Indian Hare shows highest z-score indicating most liked by the participants. Whereas the most disliked Wild boar has the lowest z-score and the rank of -3 in q-sort. According to the participants Indian hare is harmless and causes no major economic loss but wild boar damages crop and causes a significant economic loss to the farmers. Comparing with Indian giant flying squirrel, stands at +2 in q-sort indicating much liked species by participants as they see no harm or no economic loss by the participants.

*Table 5.6: Distinguishing photos of animal for factor 1*

| No. | Statements/Photos | Grid position for Factor 1 | Z-score of Factor 1 | Grid position for Factor 2 | Z-score of Factor 2 | Grid position for Factor 3 | Z-score of Factor 3 |
|---|---|---|---|---|---|---|---|
| **9** | **Indian giant flying squirrel** | **2** | **1.59*** | 2 | 1.03 | 1 | 0.31 |
| 8 | Grey francolin | 1 | 0.76 | -1 | -0.52 | 2 | 1.13 |
| 14 | Barn owl | 1 | 0.67* | -1 | -0.39 | 0 | -0.11 |
| 15 | Indian chameleon | -1 | -0.41 | -2 | -0.93 | 0 | 0 |
| 11 | Small Indian civet | -1 | -0.51 | 0 | 0.05 | -2 | -0.96 |
| 7 | Indian leopard | -2 | -0.67* | 2 | 1.46 | 1 | 0.84 |
| 5 | Sloth bear | -2 | -1.54* | 3 | 1.78 | 1 | 0.58 |

This factor was described by 20 participants mainly concerning economic impact of all these animals living in and around their village. For this distinguishing animal table 5.6, the ranking of statement/animal number 9 i.e., Indian giant flying squirrel is most liked which explains that

IGFS does not do any harm or cause any economic loss. Whereas the leopard and Sloth bear is most disliked and given -2 score as they cause most economic loss by killing their livestock and also threatens their lives respectively.

Factor 2: Aesthetic, spiritual and Conservation values

This factor explains Aesthetic, spiritual values and Conservation aspects which includes appearance, tourist attraction, rehabilitation and religious belief. There are 10 responses in this factor.

Respondents are observed to have negative opinion towards animals which play major role in economic loss but positive towards animal's beauty and its natural charisma. On positive side they like to see Indian giant flying squirrel due to its unique gliding ability from one tree to another tree. A respondent has a religious belief towards all squirrels from the Indian mythology of Ramayan. People have positive attitude towards animals having aesthetic values as it attracts tourists in their area. The participant from the forest staff has liking towards the species as he took care of injured individual for about 4 months that's how he got a lot of knowledge of the species.

*Table 5.7: Factor 2 top most liked /disliked photos*

| No | Statements/Photos | Grid position for factor 2 | Z- scores |
|---|---|---|---|
| 5 | Sloth bear | 3 | 1.779 |
| 7 | Indian leopard | 2 | 1.465 |
| **9** | **Indian giant flying squirrel** | **2** | **1.034** |
| 2 | Hanuman langur | 1 | 0.827 |
| 6 | Indian hare | 1 | 0.594 |
| 4 | Red-wattled lapwing | 1 | 0.179 |
| 11 | Small Indian civet | 0 | 0.054 |
| 13 | Indian cobra | 0 | 0.02 |
| 1 | Indian python | 0 | -0.021 |
| 10 | Blue bull | 0 | -0.062 |

| | | | |
|---|---|---|---|
| 14 | Barn owl | -1 | -0.391 |
| 8 | Grey francolin | -1 | -0.519 |
| 12 | Fruit bat (Flying fox) | -1 | -0.827 |
| 15 | Indian chameleon | -2 | -0.929 |
| 3 | Monitor lizard | -2 | -1.132 |
| 16 | Wild boar | -3 | -2.072 |

The above table 5.7 has the highest z-score to sloth bear (3) and lowest to wild boar (-3) given by the participants. Indian Giant Flying Squirrel is given number +2 in Q sort which is one raking less than sloth bear and Indian leopard as both these species attract lots of photographers and tourists. IGFS also one of the top liked species due to its charismatic gliding ability that amuses and attracts photographers and tourists in their village area. Monitor lizard ranked -2 and Wild boar ranked at -3 in q-sort as they do not provide any spiritual values or conservation importance neither they are aesthetically attractive.

*Table 5.8: Distinguishing photos of animals for factor 2*

| No. | Statements/Photos | Grid position for Factor 1 | Z-score of Factor 1 | Grid position for Factor 2 | Z-score of Factor 2 | Grid position for Factor 3 | Z-score of Factor 3 |
|---|---|---|---|---|---|---|---|
| 5 | Sloth bear | -2 | -1.54 | 3 | 1.78* | 1 | 0.58 |
| 7 | Indian leopard | -2 | -0.67 | 2 | 1.46* | 1 | 0.84 |
| **9** | **Indian giant flying squirrel** | 2 | 1.59 | **2** | **1.03*** | 1 | 0.31 |
| 6 | Indian hare | 3 | 1.68 | 1 | 0.59* | 3 | 1.77 |
| 4 | Red-wattled lapwing | 2 | 1.03 | 1 | 0.18* | 2 | 1.33 |
| 11 | Small Indian civet | -1 | -0.51 | 0 | 0.05* | -2 | -0.96 |
| 8 | Grey francolin | 1 | 0.76 | -1 | -0.52* | 2 | 1.13 |
| 12 | Fruit bat (Flying f | 0 | -0.03 | -1 | -0.83* | 0 | -0.13 |
| 15 | Indian chameleon | -1 | -0.41 | -2 | -0.93* | 0 | 0 |
| 3 | Monitor lizard | 0 | -0.26 | -2 | -1.13* | 0 | -0.09 |

In the above table 5.8 sloth bear is most liked due to its appearance and rarely seen in and around the village area. Whereas IGFS is comparatively less liked because the species is

nocturnal, fast movement and difficult to see at night. One can only confirm about presence of absence of IGFS based on eaten dropped branches by the species. The unique gliding behaviour generally attract the people, it also attracts more tourist and wildlife enthusiasts; so according to the respondents, IGFS increases the tourism values of the forest and indirectly help in their livelihood.

Factor 3: Lack of awareness

This factor describes lack of awareness which includes lack of interest compared to other animals and the species is not seen in their or around village. This factor mainly concerns individuals who lacks knowledge, proper information and are not aware about the species. Respondents of this factor are mainly living far from the place where the species is found and they have not seen IGFS, though some respondents are aware about existence of the species. Few does not seem to care about the presence or absence of the species. Some were not as interested in IGFS as other species like leopard and bear. This indicates slightly negative or neutral perception amongst participants.

*Table 5.9: Factor 3 top most liked / disliked photos*

| No | Statements/Photos | Grid position for factor 3 | Z- scores |
|---|---|---|---|
| 6 | Indian hare | 3 | 1.774 |
| 4 | Red-wattled lapwing | 2 | 1.335 |
| 8 | Grey francolin | 2 | 1.126 |
| 7 | Indian leopard | 1 | 0.837 |
| 5 | Sloth bear | 1 | 0.579 |
| **9** | **Indian giant flying squirrel** | **1** | **0.313** |
| 15 | Indian chameleon | 0 | -0.001 |
| 3 | Monitor lizard | 0 | -0.09 |
| 14 | Barn owl | 0 | -0.113 |
| 12 | Fruit bat (Flying fox) | 0 | -0.128 |
| 10 | Blue bull | -1 | -0.241 |
| 13 | Indian cobra | -1 | -0.393 |

| | | | |
|---|---|---|---|
| 1 | Indian python | -1 | -0.72 |
| 11 | Small Indian civet | -2 | -0.959 |
| 2 | Hanuman langur | -2 | -1.169 |
| 16 | Wild boar | -3 | -2.148 |

In table 5.9 Indian hare is among the most liked animals to the respondents of factor 3; according to them, it is attractive, small, frequently seen and people contain enough knowledge about it therefore it is ranked at +3. Whereas IGFS is ranked at +1 as people are not aware about the species at all and therefore, they lack knowledge and awareness. Though, these people were very interested in knowing what is it look like and their feeding habits and etc.

*Table 5.10: Distinguishing photos of animals for factor 3*

| No. | Statements/Photos | Grid position for Factor 1 | Z-score of Factor 1 | Grid position for Factor 2 | Z-score of Factor 2 | Grid position for Factor 3 | Z-score of Factor 3 |
|---|---|---|---|---|---|---|---|
| 8 | Grey francolin | 1 | 0.76 | -1 | -0.52 | 2 | 1.13 |
| 7 | Indian leopard | -2 | -0.67 | 2 | 1.46 | 1 | 0.84* |
| 5 | Sloth bear | -2 | -1.54 | 3 | 1.78 | 1 | 0.58* |
| **9** | **Indian giant flying squirrel** | 2 | 1.59 | 2 | 1.03 | **1** | **0.31*** |
| 15 | Indian chameleon | -1 | -0.41 | -2 | -0.93 | 0 | 0 |
| 1 | Indian python | 0 | -0.1 | 0 | -0.02 | -1 | -0.72* |
| 11 | Small Indian civet | -1 | -0.51 | 0 | 0.05 | -2 | -0.96 |
| 2 | Hanuman langur | 1 | 0.53 | 1 | 0.83 | -2 | -1.17* |

For this factor, IGFS scored with 1 indicating lack of knowledge among the local people mostly those, who live far from where the species is found though it falls under same sanctuary. Some people do not tend to care about the presence or absence of the species. Whereas, the respondents answered that the grey francolin is frequently seen in and around their farm filed which is why it is ranked at +2.

*Table 5.11: Consensus photos of animals among all factors*

| No. | Statements/Photos | Factor 1 Grid Position | Factor 2 Grid Position | Factor 3 Grid Position |
|---|---|---|---|---|
| 10* | Blue bull | 0 | 0 | -1 |
| 16* | Wild boar | -3 | -3 | -3 |

Table 5.11 explains consensus statements/animals meaning these are the statements/animals that has similar factor score. They do not differentiate form each other factor. Wild boar is kind of animals that almost no respondents like for any of those factor as it is considered crop destroyer which creates big loss economically. Wild boar does not look attractive or hold any religious or spiritual values as per respondents. Whereas blue bull (neelgai) also got neutral score for factor 1 and factor 2 due to it destroys crops.

Limitations

The forced Q method is used for this study and beneficial to know people's perception on animals given to them. Although the number of photos given to them was limited and other animals were left out that are found in and around their village area. Some participants mentioned and gave their opinion on animals that were not part of this study. This method supports qualitative and quantitative data; however, limitations were faced while collecting qualitative data that some participants will hesitate to disclose the reasons behind their photo organised on Q board. Another limitation is the Q Sample. For post sort interviews some villagers did not seem to disclosing the reason behind the disliking of the animals thinking this may increase conflict between villagers and forest department. Some respondents had to give negative score even though they liked the animals due to use of forced Q method. This method can be an effective alternate for semi structured interviews to know perception and attitude of locals. Q method opens many possibilities to enhance conservation approach as it also provides qualitative data. It is time consuming method which may distract people and may become difficult to keep them focused on the task.

### 5.3 To analyze ecological and anthropological threats on the Indian Giant Flying Squirrel in Gujarat

Following parameters that were found and considered to be important factors influencing the existing population of IGFS in central Gujarat. Many protected and non protected areas in Gujarat are occupied by this squirrel and population status is not known in the state which led to identify possible threats to the species. Although the species is listed in Schedule-II category in Indian Wildlife (Protection) Act, 1972, they are facing many threats such as habitat loss and through anthropogenic activity[(1)]. As per available data presence of owls, snakes, leopard and domestic cats were seen as their one of the major predators. Also, population of flying squirrels has decreased due to hunting, landing failure, accidents, electrocution and habitat loss, degradation and deforestation. Indian giant flying squirrel does not cause any harm to human beings in any way or economic loss. Following threats were observed in the both study site.

*Table 5.12: Threat table describing different threats observed on field*

| Sr. No. | Threat events reported in literature | Threat type | Threat event observed during the study period | |
|---|---|---|---|---|
| | | | Kevdi | Ratanmahal wildlife sanctuary |
| 1 | Predation | Ecological | 0 | 0 |
| 2 | Human intereference and habitat degradation | Anthropological | | |
| 3 | Hunting of flying squirrel | Anthropological | 0 | 0 |
| 4 | Forest fire | Anthropological | | |
| 5 | Human – squirrel conflict | Anthropological | 0 | 0 |
| 6 | Other<br>- tourist activity<br>- electric wires<br>- fencing | Anthropological | 15 | 4 |

#### 5.3.1 Ecological threats

##### 5.3.1.1 Predators

Indian giant flying squirrel predated by animals such as owls, snakes and carnivore species[(1)(53)] but it was not observed during the time of field work. However, during interviews, local people have seen owl hunting flying squirrel in Ratanmahal wildlife sanctuary. The photographic

documentation on IGFS by leopard and spot bellied eagle owl done by Mr. Mahendra N. in Kabini and Mr. Chirag Jain in Parambikulam tiger reserve, Kerala respectively.

### 5.3.2 Anthropogenic threats

#### 5.3.2.1 Human interference and habitat degradation

Fragmentation of forest and habitat destruction have created negative impact on the arboreal species that affects their feeding, nesting and movement[54]. Habitat loss, fragmentation and change in habitat quality are the factors that are responsible for decline in wild animals[11]. Studies have done in south India and Japan that describes the effect of habitat degradation and human interreference on habitat quality and behaviour of IGFS[3][55]. Forest fragmentation and habitat destruction by constructing roads, agricultural activities, tourist activities and other developments are matter of concern which can result in isolation of species' population[11][56]. As per observation during field work at Kevdi, tourist activity was seen at least 3 days in a week which is highly disturbed. Although the species was habituated of human presence.

Further, logging and removal of trees disrupts the forest structure, tree density and canopy continuity which are very sensitive for species survival. It is been observed during field work that in some sites the population and signs of IGFS found higher despite heavy human presence while it was not sighted and no signs were observed in their hunting place. Whereas during Ratanmahal field work there was less human disturbance and tourists' activity during the night. Cutting and clearing of dead trees provided limited availability for nesting sites and species movement. As per the observation there are two types of forest products extracted from the study site.

i. Major forest products: timber and firewood
ii. Minor forest products: bamboo, fruits, barks and medicinal plants

Collection of minor forest resources such as *M. indica* (Mahua), *T. bellerica* (Baheda) and leaves of *D. melanoxylon* (Timbru) causes negative impact on food availability for IGFS. In both the study site it was observed that live trees are cut and left them to dry to carry it home later.

#### 5.3.2.2 Hunting of flying squirrel

Hunting of Indian giant flying squirrel seem to have greatest impact of on its population in Gujarat. Among all the factors hunting highly affects the mammal abundance in very short duration that can lead to local extinction[11]. Hunting is main threat that affects survival of many species in Western Ghats[11][57]. As per literature and mentioned in results of objective 1 IGFS was hunted due to its demand of bushmeat[18].

#### 5.3.2.3 Forest fire

Forest fire generally occurs in dry season in many parts of Gujarat and mostly these are set deliberately. Local communities set fire to clear ground below mahua trees which makes it easy for them to collect Mahua fruits and flowers.

Farmer's practice "Raab" in which they make fire before monsoon to burn woods and shrubs to enrich the soil. In this kind of practice, the fire can spread to the forest and damage the understory and tree which affects the lower stories of the forest and canopy of the large trees resulting into disruption of the existing habitat.

#### 5.3.2.4 Other reasons

The other reasons responsible for the death of IGFS are high focused torches and camera flash lights to take pictures/videos to observe which affects their sighting and hinders their gliding path leading to accidents. It is been observed in Kevdi, tourists used high focused torches to see flying squirrel activity and take photos and videos using flash lights. As per staff working in Kevdi, due to use of torch and camera flash the flying squirrel has fell down while gliding from one tree to another. Barbed wire fencing around agricultural fields for protection also led to accidents and death of the animals reported from Karnataka (Conservation India article) (Plate 1).

Roads and highways are identified as threat mainly for small mammals[58][59]. Highways create disturbance by vehicles (headlights, noise and vibration) and increases faunal mortality by vehicle collision. Construction of highways and railways fragments habitat and restricts animals' movement. In Kevdi eco-tourism campsite the electric wires are not insulated due to

which IGFS accidentally fell on the wire and died immediately (Plate 1) (the incident occurred in 2019).

#### 5.3.2.5 Human – squirrel conflict

In Ratanmahal and Kevdi field site, locals do not have any major conflict with IGFS but people do not like sharing same food resources with the species. In conversation with local people have confirmed that the IGFS feeds on fruits which causes great loss in production to farmers. As per few local people IGFS pollinates Loranthus which are pest for trees and it also slows down the growth of trees. In Kevdi, these types of pests were observed on Mahua trees.

# Chapter 6

# Discussion

# Chapter 6. Discussion

This study was based on the questionnaire survey and Q-methodology to understand local community's perception on Indian Giant Flying Squirrel with respect to other animals found in their area. The study also describes the knowledge of locals on IGFS, if it is just basic or advanced. Apart from questionnaire survey and Q-methodology, observations were made in both the study sites to understand existing threats to the species in connection with available literature. It is important to understand underline viewpoints, the study do not seek to validate them but rather provides insight into underlying values, superstition and assumptions held by the local people and the frontline forest staff.

## 6.1 Knowledge of local community

The findings of this study indicates that out of 108 people interviewed only 66 people were aware about the presence of IGFS in their area. These people either spotted the species or they identified its signs. These people mostly live in the vicinity of IGFS spot and its nesting sites. Some people have seen the species foraging on the tree outside their houses.

It is observed based on results that people who live far away from the IGFS spot are not aware about the species and have no knowledge of the species and could not recognised from the photo of the species. These villages are situated on the periphery of the Ratanmahal wildlife sanctuary. In figure 5.4 one can clearly see that people from Gumli, Limdi mendri and Bhuvero have not aware about presence of the species in their area.

Based on *Chi* square test the study proves that local people only have basic knowledge and do not have technical knowledge about the species. In both the study site villagers have knowledge on specie's feeding habits and hypothesis accepted and confirmed doing *Chi*-square test. The possible reason behind people are aware about the its feeding habits is because indirect signs can be seen easily for example eaten branches dropped on the ground. Based on results villagers have enough knowledge about IGFS feeding habits and nesting therefore it accepts $H_0$ (null hypothesis) in *Chi*-square test.

In both study sites, villagers have very less knowledge about specie's biology/ecology, roosting and hunting of species as proved by in this study therefore it rejects $H_0$ (null hypothesis) for all three mentioned earlier. Based on the results, villagers need to be educated in detail about

Indian giant flying squirrel. Although many people knew about hunting practice of the species about 30 years back but now it is reduced to a greater level and population has increased since then[28]. Also, Central Gujarat has the highest flying squirrel population as it provides suitable habitat as it has good number of *M. indica* trees with minimum human presence makes[28]. This study can provide baseline for future projects and the specie in Gujarat and one can get better idea about how to approach community for conservation.

### 6.2 People's perception

Total of 53 people from local community with different occupation were interviewed using Q-method from both the field sites. Considering peoples' opinion towards animals based on "Economic Impact" (factor 1) was derived in which people highly disliked wild boar as it destroyed their crops resulting in less yield than usual and big carnivores like leopard kill their livestock and threat to human lives. Indian giant flying squirrel do not cause any major economic loss therefore it is ranked in +2 category. Although some respondents have negative scoring as it east fruits due to which villagers get comparatively less yield causing them minor economic loss.

For factor 2 which is "Aesthetic, spiritual and conservation aspects" explains perception such as aesthetics, spiritual beliefs and containing conservation values. Most of people like to watch flying squirrel gliding from tree to tree and it is helmless in every aspect therefore people do not harm the species in any way. People consider it as charismatic species therefore it increases value of forest, they live in.

Factor 3 is "lack of knowledge" that people are totally unaware about the species. As mentioned in section 6.1, people mostly live on the edge of the forest or at least 10 kilometres away from the species is spotted. The findings reveal that people do not have detailed knowledge about the species therefore lack of knowledge is considered as the factor 3.

This gave deeper understanding and unveil underlying causes to dislike Indian giant flying squirrel along with other animals mentioned in the table 4.2. Based on Q-method result, people do not have any major reason to dislike flying squirrel. Since the species is nocturnal, shy, small in size and arboreal, it does not leave major signs behind whereas people can easily identify the kill and presence of animals like leopard and wild boar as they are bigger in size.

Once the root causes are identified, it can greatly help in making conservation management plan and strategies. With this it can be very useful for forest department to tackle conflicts strategically.

### 6.3 Ecological and anthropological threats

During field work ecological and anthropological threats were observed. In Kevdi field site which is an ecotourism site, there were presence of people at least 3 times a week to see flying squirrel. It is been observed that people keep pointing torch at the species which affects in gliding judgement of the species resulting into an accident. Some people were observed using camera flash to capture good photographs which can temporarily blind the species and can affect its eyesight in long run. In conversation with a forest beat guard in Kevdi electric wires are not insulated due to which in 2019, a flying squirrel got electrocoated and died on the spot.

Flying squirrel is also predated by many animals such as owls, leopard etc[(60)]. In Ratanmahal field site, three owl calls were recorded and there is photo evidence of owl predated flying squirrel from Karnataka. Forest fragments and increase in invasive like Lantana camara, that can grow high up to the tree canopy, leading to loss of landing sites for IGFSs during glides between trees[(60)]. The species is also affected by habitat fragmentation by roads which can result in isolation of the species and collision with vehicles[(7)(8)(60)]. The species response to fragmented landscape and landscape features hence saving the older tress with larger girth is the major management requirements to conserve IGFS[(7)(60)].

# Chapter 7
# Conclusion

## Chapter 7. Conclusion

The study is about knowing the peoples' perception, the level of knowledge people has and to identify threats to Indian Giant Flying Squirrel in Central Gujarat. In the study, the results reveal that people living around the flying squirrel habitats are well aware about the presence of the species and possesses some knowledge about the species; however, the species specific knowledge such as their roosting habits, biology/ecology and threats due to hunting practices is lacking among most of the locals. Q-sort analysis further disclosed that IGFS is very much liked by local people in compared to other animals, but not as much as Indian hare. As mentioned in results of objective 1 people lack knowledge about the species and results of second objective showed that people did not give flying squirrel higher score than +1 as people are not aware about the species in detail. It seemed from this study that people are more aware and highly knowledgeable about the animals like leopard, bluebull and etc as they are seen frequently and bigger in size but species like IGFS are nocturnal and shy therefore not seen frequently. The study suggests that people need to be educated with correct information about animals living around them and their importance in the wild. The Q-method provided deep rooted reasons to like or dislike animals provided to them regardless to their age or occupation. On the other hand, the species in this area is one of the tourist attraction, people usually visit these areas just to see the flying squirrel, especially its gliding during the dusk, due to which, the locals have information about their locations and occurrence in the area. If the people are aware with the true scientific knowledge, they can use this knowledge for their livelihood (as a tourist/Eco guides). Lack of scientific knowledge also increase the possibilities that people believe myths and the same can be transfer through generation. Authentic knowledge about the species, its ecology and behaviour will also enable the opportunity of community based conservation that can help the forest department and policymakers.

This study can provide a descriptive guide for policy makers, conservation NGOs and forest department on where people lack information and where they need to focus for formulating future conservation plans and policies for the Indian Giant Flying Squirrel. The categorical representation of factor was extracted based on participant's descriptive responses that can be highly reliable for future studies. Based on findings from the study and the identified threats following conservation plan for the long term survival of IGFS are prepared.

## 7.1 Conservation Action Plan

i. Population monitoring
- Potential flying squirrel habitats should be identified and monitored regularly
- Census methods should be developed and implemented on filed to know its status and increase or decrease in their population.

ii. Forest protection
- Monitoring fire using advance technology like remote sensing and GIS can help predict fire and prevention strategies can be made in advance.
- Staff should be provided with at least basic tools like fire safety suit, fire extinguisher and etc.
- Tourism should be regulated through strict law enforcement and eco tourism policies should be revised especially for the species like flying squirrel.

iii. Capacity building
- Species specific capacity building training, workshops and seminar should be conducted for different stakeholders such as
    - Forest field staff
    - School children
    - Villagers
    - Local journalists

iv. Habitat Management
- Avoiding the removal of old trees of *M. indica, D. melanoxylon, Terminelia* sp. as they are used by the flying squirrel for nesting
- Regeneration of tree species like *M. indica, D. melanoxylon, Terminelia* sp. should be done.

v. Alternative livelihood
- Alternate livelihood should be given to locals like local tour guide, making souvenirs and etc. this would provide a source of income and also focus on conservation.

vi. Outreach and education
- The most important thing is to bring positive change among local communities. Educational and awareness programs among younger generation can bring positive change in upcoming generation.
- Local people should be educating in detail about Indian giant flying squirrel and its importance of its habitat.

- Local communities living in the vicinity should be involved in conservation planning.
- Myths and taboos should be broken down by long term outreach programs.

vii. Scientific research

- Scientific research should be encouraged on less studied small animals like IGFS on following topics
    - Behaviour
    - Pollination
    - Prey predator relation
    - Effect of tourism and pointing torch beam
    - Identifying and assessment of threats
    - Food composition of the species
    - Breeding behaviour
- Experimental research should be implemented like instalment of artificial structure like poles in fragmented habitat so that it can help gliders and other animals to move[55][61].

**Plate 1**


Photo credit: Goutham Shankar (Sanctuary Asia)

Photo credit: Shreeram M. V (Conservation Inida)

Photo credit: Mr. Mahendra N. in Kabini

Photo credit: Mr. Chirag Jain in Parambikulam Tiger Reserve

People watching IGFS pointing torch at the species

Photo credit: Forest department IGFS got electricutaed in Kevdi

## Annexure I: Questionnaires

| | | | |
|---|---|---|---|
| Date:<br>Time: | | | |
| 1 | Name of Respondent's: | Age: | Sex: |
| 2 | Name of village: Taluka:<br>District: Geo Location: | | |
| 3 | Qualification:<br>Occupation: | | |
| 4 | How frequently they visit the forest? | | |
| 5 | What is the purpose of visiting the forest? | | |
| 6 | Are you aware about the presence of IGFS? Y / N | | |
| 7 | Is flying squirrel: Bird Mammal Reptile Unsure | | |
| 8 | Is FS present in your area? Y / N | | |
| 9 | How do you know the presence of FS? | | |
| 10 | How do you recognise FS? | | |
| 11 | What do they eat? And what do they eat the most? | | |
| 12 | Where do you see squirrel? Mention area (Which type of forest) | | |
| 13 | How many offspring they give? | | |
| 14 | Which tree preferred for nesting? | | |
| 15 | Any human threat? Y / N<br>If yes, what are threats? | | |
| 16 | Have FS been killed in your area? Y / N<br>If yes, why? | | |
| 17 | Do you think FS need to be protected? | | |
| 18 | Do FS harm any human in anyway? Y / N<br>If yes, explain | | |
| 19 | Which forest product do you use which is also used by FS? | | |
| 20 | Have you seen any logging for wood in your area? Y / N<br>If yes, explain | | |
| 21 | Is there any cultural importance of FS? Y / N | | |

| | |
|---|---|
| | If yes, explain |
| 22 | Is there any religious importance of FS? Y / N<br>If yes, explain |
| 23 | Have you seen any accidents happening with FS? Y / N<br>If yes, explain |
| 24 | How many accidents and what kind of accidents?<br>Is it intentional or unintentional? |
| 25 | Have you seen any tourists or photographers coming in your area? Y / N<br>If yes, explain their activity |
| 26 | Do you think outsiders disturb FS? Y / N<br>If yes, explain why and how? |
| 27 | Predated by which animal or bird? |
| 28 | Have you noticed killing or hunting of FS? Y / N<br>If yes, explain reason |
| 29 | Any economic loss due to FS in your area? Y / N<br>If yes, explain what sort of economic loss?<br>How much loss?<br>Name items that's you lost. Ex: mahua |
| 30 | Additional notes: anything that respondents like to add. Ex: some odd activity, behaviour of FS. |

## Annexure II: Data sheet for Q-Methodology

| | | |
|---|---|---|
| Date: | Time: | Study Area: Kevdi/Ratanmahal WS |
| Age: | Sex: | |
| Village name: | | |
| Occupation: | | |
| Qualification: | | |
| Photos no. | Description | |
| P1 | | |
| P2 | | |
| P3 | | |
| P4 | | |
| P5 | | |
| P6 | | |
| P7 | | |
| P8 | | |
| P9 | | |
| P10 | | |
| P11 | | |
| P12 | | |
| P13 | | |
| P14 | | |
| P15 | | |
| P16 | | |
| Additional questions if need to ask | | |
| 1) Why are animals important (or not) to you in general? | | |
| 2) What is the importance for you that animals remain in the landscape in the future? | | |
| 3) Why do like the flying squirrel more/less than (depending on animals sorted on board)? | | |
| 4) Why is it important for you that the sloth bear remains in the landscape in the future? | | |

## Annexure III: Photos of all the 16 animals mentioned in table 4.2


Sloth bear


Bluebull


Chameleon


Indian civet


Indian cobra


Indian flying fox bats


Indian Giant Flying Squirrel


Grey Francolin


Hanuman Langur


Indian Hare


Indian Leopard


Monitor Lizaed


Indian Python


Red Wattled Lapwing


Barn Owl


Wild Boar

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