# Status and habitat preferences of White-rumped Vulture (*Gyps bengalensis*) population of Wayanad Wildlife Sanctuary, Kerala


**By**

**VISHNU M (2016-17-004)**


**THESIS**

**Submitted in partial fulfillment of the requirement for the degree**

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**THRISSUR KERALA**


**2018**

## DECLARATION

I, hereby declare that this thesis entitled **"Status and habitat preferences of White-rumped Vulture (*Gyps bengalensis*) population of Wayanad Wildlife Sanctuary, Kerala"** is a bonafide record of research done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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## CERTIFICATE

Certified that this thesis entitled **"Status and habitat preferences of White-rumped Vulture (*Gyps bengalensis*) population of Wayanad Wildlife Sanctuary, Kerala"** is a record of research work done independently by **Mr. Vishnu M (2016-17-004)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

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VISHNU M

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# *Introduction*

# INTRODUCTION

Birds have evolved from reptiles nearly 200 million years ago, during the age of dinosaurs. They are warm-blooded vertebrates with a strong four-chambered heart. They lay eggs and their fore limbs modified to wings. There are approximately 10000 species of birds which makes them the second biggest group of invertebrates. They use bills instead of teeth, skins covered with feathers and their skeleton is made of hollow bones.

Vultures are classified into Old World vultures and New World vultures and are medium to large-sized birds of prey, which are known for eating carrion. There are 23 species in total. They have a heavy body and their feathers appear loose. Some have keen eye-sight and other vulture species has a very good sense of smell and helps them in locating carcasses, or other scavengers around a body.

## 1.1 OLD WORLD VULTURES

These vultures belong to the family Accipitridae and are recorded in Europe, Asia and Africa, and spot carcasses exclusively by sight.

**Table 1: Checklist of Old World vultures**

| GENUS | SPECIES | |
|---|---|---|
| | COMMON NAME | SCIENTIFIC NAME |
| *Aegypius* | | |
| | 1. Cinereous Vulture | *Aegypius monachus* |
| *Gypaetus* | | |
| | 2. Bearded Vulture | *Gypaetus barbatus* |

| | | |
|---|---|---|
| *Gypohierax* | | |
| | 3. Palm-nut Vulture | *Gypohierax angolensis* |
| *Gyps* | | |
| | 4. Griffon Vulture | *Gyps fulvus* |
| | 5. Indian white-rumped vulture | *Gyps bengalensis* |
| | 6. Rüppell's Vulture | *Gyps rueppelli* |
| | 7. Indian Vulture | *Gyps indicus* |
| | 8. Slender-billed Vulture | *Gyps tenuirostris* |
| | 9. Himalayan Griffon Vulture | *Gyps himalayensis* |
| | 10. White-backed Vulture | *Gyps africanus* |
| | 11. Cape Griffon | *Gyps coprotheres* |
| *Necrosyrtes* | | |
| | 12. Hooded Vulture | *Necrosyrtes monachus* |

| | | |
|---|---|---|
| *Neophron* | | |
| | 13. Egyptian Vulture | *Neophron percnopterus* |
| *Sarcogyps* | | |
| | 14. Red-headed Vulture | *Sarcogypscalvus* |
| *Trigonoceps* | | |
| | 15. White-headed Vulture | *Trigonoceps occipitalis* |
| *Torgos* | | |
| | 16. Lappet-faced Vulture | *Torgos stracheliotus* |

**1.2 NEW WORLD VULTURE**

These vultures are seen in warm and temperate areas of the Americas. They belong to the family Cathartidae and are large birds. Most of the species have a good sense of smell and have a passable nostril.

The seven species of New World vultures are:

- American black vulture (*Coragyps atratus)*
- Turkey vulture (*Cathartes aura)*
- Lesser yellow-headed vulture *(Cathartes burrovianus)*
- Greater yellow-headed vulture (*Cathartes melambrotus)*
- California condor (*Gymnogyps californianus)*
- Andean condor (*Vultur gryphus)*
- King vulture (*Sarcoramphus papa)*

Wayanad Wildlife Sanctuary and the surrounding areas of the Western Ghats fall within the political limits of Kerala state. This sanctuary has only a small breeding population of vultures. Five species of vultures are reported from this area: White-rumped Vulture (*Gyps bengalensis*), Red-headed Vulture (*Sarcogyps calvus)*, Indian Vulture (*Gyps indicus*), Egyptian Vulture (*Neophron percnopterus),* and Cinereous Vulture (*Aegypius monachus*).

Vultures are mostly considered as lowly scavengers. But the fact is that they are very special key component in maintaining healthy ecosystems and play an important role in protecting human health and balancing of the economy. They are actually earth's garbage disposers and are able to keep the environment clean and free of contagious diseases such as anthrax and botulism etc.

Vultures face many threats directly and indirectly caused by man. The threats faced by the species include poisoning by feeding on meat containing lead or harmful veterinary products such as various NSAID's especially diclofenac, poisoning for the traditional medicine trade or by poachers and for agriculture and electrocution and collision in the wind mills.

The current study was conducted in Wayanad Wildlife Sanctuary and is the strongholds of vultures in Kerala. In Kerala, vultures are present only in Chinnar and Wayanad WLS. Out of 5 species found in Kerala, three are critically endangered. To conserve these species, a thorough knowledge is required.

The objectives of the present study were:

- To estimate the population size and habitat characterization
- To study the breeding biology of the *Gyps bengalensis* at Wayanad Wildlife Sanctuary
- To study the conservation challenges of *Gyps bengalensis* at Wayanad Wildlife Sanctuary.

# *Review of Literature*

# REVIEW OF LITERATURE

## 2.1 VULTURES IN THE WORLD

In ecosystems, raptors are key-species as top predators or scavengers, regulating prey population sizes and providing essential ecosystem services (Sekercioglu 2006; Whelan et al. 2008).As obligate scavengers, vultures consume large carcasses, and their scavenging helps in the nutrient cycling and limits the spread of diseases (Houston & Cooper 1975; De Vault et al. 2003).

They search prey by sight from the air and depend on carcass present in open areas, which are in most cases, naturally made available by predators and they provide an array of ecological, economic, and cultural services (Cramp and Simmons, 1980). They have eccentric adaptations such as gliding flight, fierce eyesight, and low pH levels in their stomachs (Ogada *et al.*, 2011). They are large sized bird having a wingspan of about 3 meters and weight about 10 kg (Hussain, 2015).

Vultures come under the order Falconiformes and there are a total of 5 families under this order. Old world vultures come under family Accipitridae and new world vultures come under Cathartidae. A total of 16 vultures are present in the Accipitridae family and 7 in Cathartidae family.

## 2.2 ASIAN SCENARIO

From Europe, Africa, and Asia, a total of 16 species of Old World vultures arerecorded. In South Asia, there is a sudden decline of three resident species of Gyps vulture and is a great challenge for the conservationists (Pain *et al.* 2008). In Nepal, out of eight vulture species reported, three of them are Critically Endangered (IUCN 2004). Extensive veterinary use of NSAID, diclofenac is the main reason behind the decline in vulture population of South Asia (Oaks *et al.* 2004, Shultz *et al.* 2004, Gilbert *et al.* 2006, Green*et al.* 2004).

Experiments have disclosed that the vulture deaths are due to diclofenac and they found it in the dead vulture residue (Oaks *et al.* 2004, Naidoo *et al.* 2009,Swan*et al.* 2006). Five species of the Gyps genus is highly affected by diclofenac (Das *et al.* 2010). Ali and Ripley 1987 reported

that a total of nine species of vultures is found in India, despite the geographical and environmental variations.

## 2.3 STATUS, DISTRIBUTION, ECOLOGY AND BEHAVIOUR OF OLD WORLD VULTURES

**Cinereous Vulture** (*Aegypius monachus)*-Near Threatened

They are the largest of the raptors. Commonly seen in Africa, Europe, Central Asia, East Mongolia, India (A. Khan *et al.*2005). They have an average weight of 14kg and one of the heaviest birds with a wingspan about 300cm. In Asia, this species occupy higher elevation upto 4,500m and mostly seen in scrub, arid, semi-arid alpine steppe and grassland (Thiollay 1994).

It forages in different kinds of terrain like forest, bare mountains, steppe, and grasslands. Their nest is built in trees and on rocks. Its main food includes carcasses from medium-sized to large size and also insects and snakes. They rarely consume live prey (Batbayar *et al.* 2006).

**Bearded Vulture** (*Gypaetus barbatus)* – Near Threatened

This species is commonly found throughout the Himalayan ranges in India (R. Naoroji, 2011).The main threat to this species is habitat degradation, disturbance of breeding sites, collision with powerlines, and poisoning(Ferguson-Lees and Christie 2001). Eventhough it resides where it occurs it has a wide range of habitat where juveniles wander more widely than adults (Ferguson-Lees and Christie 2001).

These species inhabit remote mountainous areas having frequent rainfall usually above 1,000 m (R. Naoroji, 2011).Their main food is carrion, and it includes large amount of bones, from which they can get enough nutrition. They scavenge in useless dumps and especially seen in areas where there are mountain goats, ibex, and sheep and also where large predators such as wolves and Golden Eagles are present.

This vulture builds big nests which are made of branches and enclosed by animal remain such as dung, skin, wool etc. They reuse their nests for longand it is usuallylocated on cliff ledges or in caves. In India, breeding season is from December-June (Ferguson-Lees and Christie 2001).

**Griffon Vulture** (*Gyps fulvus)*–Least Concern

It is mostly found in Europe and South Asian regions. During winter, some of them are migratory but most of them are resident. (delHoyo *et al.* 1994). They flies at higher altitudes up to 10,000 m and even more higher. This species usually do hunting individually, roosts, and gather at food sources and sometimes migrate singly (delHoyo *et al.* 1994), but sometimes they gather at sea crossings and strong thermals (Ferguson-Lees and Christie 2001). It is found in a wide range of habitat, from high mountains to semi-desert areas, and spotted frequently up to 3,000 m (delHoyo *et al.* 1994).

Its food is exclusively carcasses, mostly large mammals and buildsnests on a rocky terrain, small caves usually preferred (delHoyo *et al.* 1994). Its number decreased in Europe, Middle East, and North Africa during 19$^{th}$ to 20$^{th}$ centuries (Snow and Perrins 1998), whose reason is direct hunting and also accidently harmed from the poisoned carcasses (Ferguson-Lees and Christie 2001, Orta *et al.* 2015).

Conservation methods such as providing surplus food and reintroduction programme in its range have been successful and shown increase in population (delHoyo *et al.* 1994).

**Indian White-rumped Vulture** (*Gyps bengalensis)* - Critically Endangered

This species occurs in Pakistan, India, Bangladesh, Nepal, Thailand, Laos, Cambodia, Bhutan, and Myanmar (BirdLife International 2001).

Mostly they are seen in plains also seen in woodland, villages, and open areas and in cities. They mainly feed on carrion. They eat both fresh and the old ones. These birds are very social and always seen specific flocks. It breeds in tall trees by forming colonies [Thakur, 2015) and are seen near human settlements.

Declines in the population of this species were first reported in India by Prakash (1999) in Keoladeo National Park, Rajasthan. Within the vultures, they are the smallest, but in the bird group they are still a large one.

**Indian Vulture** (*Gyps indicus)* - Critically Endangered

*Gyps indicus* breeds in India and Pakistan (Collar *et al.* 2001). It is found in both urban and rural areas, and also in open and wooded areas.

This species are closely attached to *Gyps bengalensis* when scavenging at carcass dumping sites and feeds entirely on carrion. They are seen near slaughterhouses and nests almost in colonies exclusively on cliffs and ruins, and also in trees where there is no cliffs (Prakash *et al.* 2012b).

The populations of *Gyps indicus* had shown a rapid decline of more than 92% between 1991 and 2000 (Prakash *et al.* 2003;2005) and repeat surveys (in 2002 and 2003) showed that the average annual decline rate was 22% for Indian vulture (Green *et al.* 2004). They weigh around 6.5 kg and have a wingspan of around 230 cm.

**Slender-billed Vulture** (*Gyps tenuirostris)* - Critically Endangered

They are usually found in India, Burma and Cambodia (BirdLife International 2001). Their main habitat is dry open country and forested areas. And they are not seen near human settlements.

Like Indian vulture this species also feeds entirely on carrion. They usually scavenges at carcass dumping sites and near slaughterhouses. They also scavenges at a carcasses dumped in the fields and bank of rivers.

It has been recorded that they are usually seen nesting in large trees at a height of 7-25 m. It is a solitary nester. These birds are very social and always seen specific flocks. This species is recorded as the most critically endangered vulture and also it is said that they may be the most endangered raptor in the world (Prakash *et al.*, 2003, 2007). Only less than 200 pairs are left (Green *et al.*, 2004; Birdlife International, 2010).

**Himalayan Vulture** (*Gyps himalayensis)* –Near Threatened

This species is seen mostly seen in mountain areas usually at altitudes of 1,200-5,500 m (Lu, 2016). It feeds on carrion (delHoyo *et al.* 1994) and regularly visits carcass dumps in South and South-East Asia (Praveen, 2012, Galligan, 2016).

**Egyptian Vulture** (*Neophron percnopterus)* - Endangered

This species occurs in occurs in Africa, Arabia, Indian Subcontinent, Algeria, Niger, Cameroon, Chad and northern Sudan (I. Angelov, 2012). Nests are found in ledges, caves, crags, rocky areas (Sarà and Di Vittorio 2003), large trees, buildings, electricity poles (Naoroji 2006) and

also rarely on the ground too (Gangoso and Palacios 2005). They forage in lowland and montane regions and also scavenges in human settlements.

Their diet includes tortoises, young vertebrates, insects, organic waste, eggs, carrion (Margalida *et al.* 2012), and even faeces (Dobrev *et al.* 2015, 2016). They are not social and usually solitary. But at feeding sites they will gather mainly at vulture restaurants (Ceballos and Donázar 1990). The Indian population has diminished much but the exact cause is not known though it is possibly related to diclofenac poisoning. They are one of the most migratory amongst vultures often covering distances as long as 6000 km and 500 km in a single day.

**Red-headed Vulture** (*Sarcogyps calvus)* - Critically Endangered

*Sarcogyps calvus* occurs mainly in Pakistan, Nepal, Malaysia, India, Bangladesh, Bhutan, Myanmar, and Singapore (Ferguson-Lees *et al.*2001). they usually prefers open country and are not seen in human settlement and forages below 2,500 m.

This species nests are found in tall trees and occurs at a density less than Gyps vultures. Their behavior is predominantly territorial and the records of movements are poorly known. By 2007, red-headed vulture has been reduced to only 9% of the population that occurred in the early 1990s (Cuthbert *et al.* 2006).They are medium-sized with adults weighing around 5.5 kg and a wingspan of around 250 cm.

**Palm-nut Vulture** (*Gypohierax angolensis*) – Least Concern

This is an Afrotropical species, distributed all around Africa and it is rarer in the south and east and abundant in north and central. It is seen in altitudes from sea level up to 1800 m (Ferguson- Lees and Christie, 2001).

Carcass is not their unique diet. They feed on numerous items such as fruits of oil and raffia palms, fruits and grains of other plants and altogether forms the 70% of its diet. However it will also predate on small and big animals amphibians, and also feed at small carcasses (Ferguson-Lees and Christie, 2001; del Hoyo *et al.,* 1994). They are usually nests in tall trees and makes stick nests. This species are not vulnerable to pesticides (delHoyo *et al.,* 1994).

**Ruppell's Vulture** (Gyps rueppelli) – Critically Endangered

It is found in Europe and mainly in Africa (C. Barlow *in litt.* 2006). This species is seen frequently in woodlands, montane regions and grasslands. They are social and gregarious and flocks together. They breeds mainly in colonies and found in cliffs and broad range of elevations (Virani *et al.* 2012) and locates their food only by sighting while soaring.

The species faces various threats which are common to other African vultures. Reduced availability of carrion due to loss of wild ungulates, hunting, habitat conversion for agriculture and poisoning cause's threat to this vulture (Ogada *et al.* 2016).

**White-backed Vulture** *(Gyps africanus)* - Critically Endangered

This species has the record of highest population in Africa but they are facing rapid decline (J. M. Thiollay, 2006). Recent publications on this species's population shows that the species has declined a lot and estimated 90% of decline over three generations (Ogada *et al.* 2016).

It is a lowland species, mainly seen areas with Acacia because they prefer tall trees for nesting. They congregates at carcasses and roosting. They usually nests in loose colonies and also seen nesting on electric poles.

**Cape Vulture** *(Gyps coprotheres)* – Endangered

This species is found in South Africa (Vernon 1999, Barnes 2000, Benson 2000). In 2006, the recorded total population was around 10,000 individuals (M. Diekmann2006).

This species has a long life span (Oatley *et al.* 1998) and usually feed on large carcasses. They are migratory and flies large distances and found near steep terrains. In those terrains, they breeds and roosts on cliffs (Mundy *et al.* 1992).

This species is facing multiple threats in its range and that leads to the possibility of drastic decline in the coming years (Boshoff and Anderson 2007). Some of the suspected mortality factors are the reduction of food availability, indirect poisoning from poisoned baits which are meant for other animals, collision with electric cables, accidents due to electric shocks, loss of foraging habitat due to conversion of the sites for the agricultural and other purposes (Mundy *et al.* 1992, Barnes 2000, Benson 2000, Borello and Borello 2002, Boshoff and Anderson 2007).

**Hooded Vulture** *(Necrosyrtes monachus)* - Critically Endangered

This species is widely seen in Africa. Recent publications on this species's population shows that the species has declined a lot and estimated 82% of decline over three generations (Ogada *et al.* 2016).

This species are seen in human inhabitants and also found in grasslands, open areas, forests, deserts, savannas and along coastal areas (Ferguson-Lees and Christie 2001). They tend to locate at high densities. Even though they occurs in high altitudes of 4000 m, high abundance is seen below 1,800 m. they usually feed on carrions but sometimes predate insects too (Smalley 2016).

This species always nests in trees (arboreal) favoring *Ceiba pentandra.* Their incubation period is 46-54 days, and 130 days is needed for the wing development of young ones and even after this 130 days, they depend on parents about 3-4 months more (Ferguson-Lees and Christie 2001).

This species faces many threats and they are on the brim of drastic decline. Consumption of poisoned baits which are not targeted for them is a major issue and they are captured for making medicines and also for bush meat (McKean *et al.* 2013).

**Lappet-faced Vulture** *(Torgos tracheliotos)* – Endangered

This species is facing a drastic decline at rapid rate due to severe threats Ogada *et al.* (2016). Recent publications on this species's population shows that the species has declined a lot and estimated 79.5% of decline over three generations.

They are scavengers and ranges widely when foraging. They feed mainly on carcasses and their remains (Mundy 1982, Mundy *et al.*1992). They also predate and hunt on reptiles, mammals, birds and fish (McCulloch 2006a, 2006b).

Ringing studies were done to study its migration and that shows a very low return rate (Simmons, 1995 and Bridgeford 2009).The minimum home range of this species is estimated to be 8 $km^2$ to 15 $km^2$ in some habitats (Shimelis *et al.* 2005), but now it has increased to 80-150 $km^2$ approximately (C. Murn2016).

Major threats faced by this species are due to farmers due to the using of strychnine and carbofuran for predator control and that caused accidental poisoning. (Brown 1986, Otieno *et al.* 2010, Kendall2012).

**White-headed vulture** *(Trigonoceps occipitalis) – Critically Endangered*

This species are seen in wide range of Africa and they are mostly seen outside the forested regions (Harrison *et al.* 1997). This species face drastic decline in West Africa and southern Africa (F. Dowsett-Lemaire 2006, J.M. Thiollay 2006, Ferguson-Lees *et al.* 2001). They are usually found in dry woodlands at low altitudes when other vulture species prefer higher altitudes and they usually avoid semi-arid areas (Mundy *et al.* 1992).

This species has a long life span and they are always strict about maintaining a territory (delHoyo *et al.* 1994, Murn and Holloway 2014). They feed both on large and small carcasses (Mundy *et al.* 1992, Murn 2014).

This species usually nests and roosts on trees specifically on *Acacia* spp. or baobabs (Mundy *et al.* 1992).

Major threats faced by this vulture is the reduction of food availability due to decline in populations of small mammals and wild ungulates throughout its range (Mundy *et al.* 1992). The other threats are accidental poisoning from the baits aimed at jackals and other mammalian carnivores (C. Kendall 2012).

## 2.4 White-rumped Vulture (*Gyps bengalensis*) in the study area (Wayanad WLS)

Overall abundance of white-rumped vulture is greatest in May and June. March, April, and May are the months when large hordes of herbivorous animals especially elephant and gaur migrate to Wayanad from the neighboring protected areas of Tamil Nadu and Karnataka on account of acute water and fodder scarcity, often triggered by the summer heat and frequent forest fires.

Consequent to this influx of wildlife, mortality rates are also correspondingly higher in Wayanad around this time (KFD, pers.commu.). This brings in more scavengers to this area and the increase of vulture population in May and June would indicate that vulture populations of neighboring states also are coming into Wayanad around this time of the year. Wayanad is

relatively a dry tract with open canopies and vast vayals. This area favors vultures that fly high and wide and rely exclusively on sight for locating their prey.

## 2.5ECOLOGICAL SIGNIFICANCE

Vultures are unique in terms of their ability to dispose of animal and human waste. For example, Egyptian Vultures consumed up to 22% of annual waste in towns on Socotra off the Horn of Africa, so the loss of vultures contributes to environmental pollution (Gangoso *et al.* 2013). There are about $34 billion healthcare costs in India between 1993 and 2006 (Markandya *et al.* 2008). One of the reasons for this heavy cost is the decline of vulture population.

Vulture helps in the reduction of the number of other scavengers at carcasses which results in fewer contacts between infected individuals (Ogada *et al.* 2012).The decline resulted in an increase of feral dog population which is the main reason for an increase in the animal bites and rabies among humans.

Pollution of water due to rotting carcasses increased the incidence of anthrax and water-borne diseases among people and also fouling of watercourses (Prakash *et al*, 2003). If there was a good population of vulture present, then this scenario wouldn't be happening.

## 2.6 CULTURAL SIGNIFICANCE

Vultures have been revered in most of the ancient civilizations due to their associations with different cultures. Egyptian Vultures was sacred to ancient Egyptians. They have a cultural association with the Parsis. They leave the bodies of their dead above ground. They believe that the vultures help release the spirit or soul of the dead. There is an epic Ramayana in Hindu religion association. The bird is depicted as the vehicle of Ketu.

## 2.7 THREATS

Vultures are the most threatened among the raptors, and low reproductive rates are one of the reasons for this (Newton 1998; Ogada et al. 2012).In the late 1990s, the Asian Vulture Crisis saw a population decline of three *Gyps* species *Gyps bengalensis, Gyps indicus* and *Gyps tenuirtostris* throughout South Asia and 96% of the population is vanished in just ten years (Prakash 1999; Gilbert *et al.* 2002; Oaks *et al.* 2004). These three species of *Gyps* vultures are Critically Endangered and are Endemic to South Asia (Prakash *et al.*, 2007; IUCN, 2010). The decline in the vulture population resulted in the increase of feral dog populations and they are the main cause of diseases such as rabies (Markandya*et al.* 2008).

The major threat is theover use of diclofenac (Oaks *et al.*, 2004). This NSAID is widely used to treat domesticated ungulates which become the principal food source for vultures. Diclofenac poisoning occurs when they feed on carcasses of treated livestock and causes renal disease due to deposition of residues of diclofenac.

A survey of dead wild Gyps vultures in India, Nepal, and Pakistan had done in 2000-2004 and they found 259 wild Gyps vultures dead of which 237 (83%) vultures had visceral gout(Oaks *et al.* 2004) and this condition occurs due to intensive renal dysfunction (Lumeij 1994). Road transect surveys done in India shows that the rates of population decrease of *Gyps bengalensis* is 48% a year, and around 22% a year for *Gyps indicus* and *G. tenuirostris* (Prakash et al. 2007). Additional threats include ongoing habitat loss, food shortage, land use change, improved rural farming and animal husbandry techniques.

## 2.8 CONSERVATION

First and the foremost aim was to find the cause of vulture decline all over the world and that leads to the study on feeding of vulture on diclofenac contaminated cow carcasses and that gives a shocking fact about the decline. This motivated ZSL and the other conservation partners to call for a ban on the drugs causing vulture deaths, passed in 2000. Despite the ban, other conservation measures have been necessary to reduce the agricultural uses of diclofenac, encourage the use of a non-toxic substitute, and to help reverse vulture declines.

Besides this, they set up a recovery plan by conducting workshops in India giving awareness about captive breeding centres in India and Nepal and that lead to the formation of vulture restaurants and first formed in Kailali, where the birds can feed and fly safely.

In 2006 due to extensive safety testing on meloxicam, it is discovered as vulture safe (Swan *et al.*, 2006). They had set up captive breeding centers for the reintroduction of birds into the wild in future *in situ* and also *ex situ* conservation is actively done.

Frequent monitoring of the level of diclofenac in cattle carcasses is initiated and activities are done to avoid chances of exposure of wild vultures to diclofenac contaminated food. The numbers of all three species are improving each year as a result of these efforts.

# Materials and Methods

# MATERIALS AND METHODS

## 3.1 STUDY AREA

Wayanad, a major part of Nilgiri Biosphere Reserve, which is under the administration of North Wayanad Division, South Wayanad Division and Wayanad Wildlife Sanctuary Division. Wayanad is contiguous with Bandipur Tiger Reserve and Mudumalai National Park in the South and Southeast and Rajiv Gandhi National Park in the North and Northeast (between 11° 20′ and 12° 7′ N latitude and between 75°28′ and 76° 36′ E longitude). The total extent of the area is about 520.78 $km^2$, of which 344.44 $km^2$ forms the Wayanad Wildlife Sanctuary (Figure 1).

'Wayanad' derives its name from the numerous swamps (locally called as *vayals*). Coffee was probably the first plantation crop to be introduced into Wayanad in 1828 and 1839. Paddy was the commonest crop and was cultivated in the swamps. The dry higher grounds were cultivated with crops such as ragi and chama. These were often grown on the shifting system. Wildlife was so numerous that crop raiding was frequent. The annual rainfall varies from 1200-1700 mm and maximum precipitation is from June to September. The South West monsoon brings the greater part of the total rainfall bursts normally by the first week of June proceeded by a few showers in April and May. Mean atmospheric temperature in Southern Ranges varied from a monthly maximum of 31°C in March to 24°C in July and a monthly minimum of 19°C in May to 14°C in December. The average relative humidity ranged between 60.4% in January and 87.6% in June.

The northern portion of Kurichiat Range is drained by Kannaram puzha and Kurichiat thodu flowing northward and joining Kabini river. Cheru puzha, Bavali puzha,and Chedalathu puzha are the other drainage systems in Wayanad WLS (Nair, 1991; Easa and Sankar, 2001). About one-third of the sanctuary is covered by plantations of teak, eucalyptus and mixed species interspersed with bamboo. The forest types could be broadly classified into the following categories (Champion and Seth, 1968).

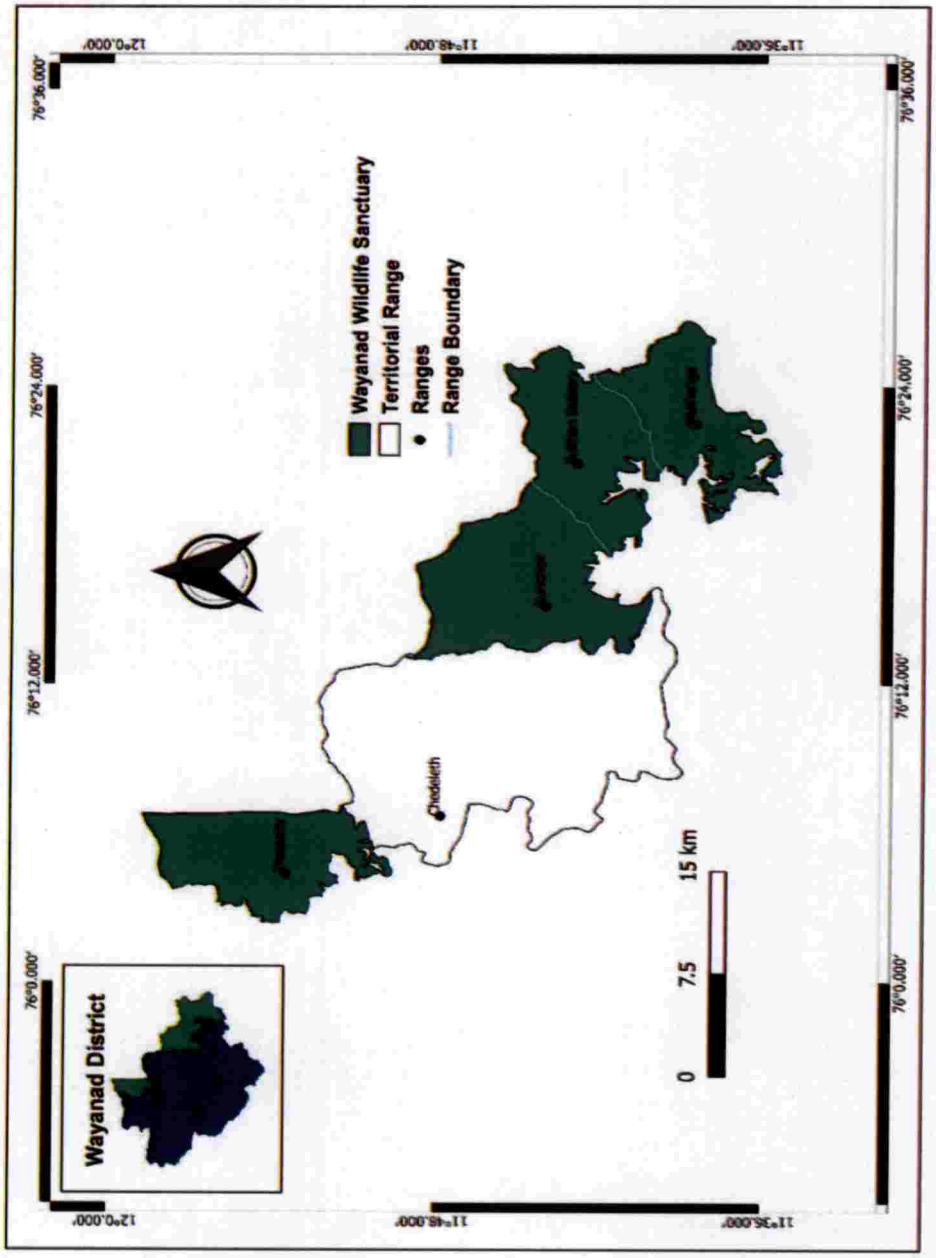


**Figure 1: Location map of Wayanad Wildlife Sanctuary**

### 3.1.1 Southern Moist Mixed Deciduous Forest (3B/C2)

The Southern Moist Mixed Deciduous Forest covers most of the area of the sanctuary. Moist deciduous forests are interspersed with seasonally waterlogged areas in the depressions known as *vayals* (marshy/wet lands). Vayals are dominated by grass and are devoid of tree cover. The moist deciduous forest has a moderate canopy cover (50-70%) during the wet seasons. During the dry season, most of the trees shed leaves and canopy cover is comparatively less (10-20%).

Bamboo brakes (*Bambusa arundinacea*) are distributed sporadically all over the habitat. It is also found all along the perennial streams and in the wet areas. The upper canopy consists of *Terminalia tomentosa, Terminalia bellirica, Terminalia paniculata, Pterocarpus marsupium, Tectona Grandis, Grewia tilifolia, Adina cordifolia* etc. A few climbers like *Butea parviflora, Caesalpinia sp., Calycopteris floribunda* are also seen. Grasses such as *Cyrtococcum patens, Apluda mutica and Oplismenus compositus* are thinly distributed with low productivity. Fire occurrence is comparatively less in this type of forests.

### 3.1.2 Southern Dry Mixed Deciduous Forest (5A/C3)

The dominant tree species are *Shorea roxburghii, Anogeissus latifolia, Terminalia alata, Terminalia chebula, Pterocarpus marsupium, Gmelina arborea, Schrebera sweitenioides, Diospyros montana, Schleichera oleosa, Grewia tilifolia, Dalbergia latifolia, Mitragyna parvifolia, Bauhinia racemosa, Xerom phisuliginosa* and*Tectona grandis*. Grass species such as *Themeda cymbaria, Themeda triandra, Cymbopogon flexuosus* and *Imperata cylindrica grow* more than 200 cm in height and form a dominant ground cover.

The canopy layer of the trees is broken due to the spatial distribution as well as comparatively low tree density. Canopy cover is less (10-20%) during dry season. The bamboo (*Bambusa arundinacea*) is less frequented compared to moist deciduous forest. In the dry deciduous forests, the *vayals* are comparatively less and are dominated by tall grass (*Themeda sp.* and *Pennisetum hohenackeri*).

### 3.1.3 Plantations

The total area of the plantation in the study area is about 163 $km^2$, which includes pepper, eucalypts, teak and mixed softwood species. Eucalyptus plantations do not have any other tree species except a few saplings of *Cassia fistula* and *Terminalia sp*. The whole plantation is occupied

by *Lantana camara*, Tall grasses *viz*., *Themeda cymbaria, Themeda triandra,* and *Cymbopogan flexuosus* are found in open areas in the plantations. In Teak plantations, apart from a few deciduous tree species, *Helicteres isora* occupy a large proportion of the area.

**Plate 1: Dry deciduous forest in Wayanad Wildlife Sanctuary**

**Plate 2: Dried Vayal bed in the Wayanad Wildlife Sanctuary**

**Plate 3: Eucalyptus plantation at Wayanad Wildlife Sanctuary**

**Plate 4: Teak plantation at Wayanad Wildlife Sanctuary**

## 3.2 METHODS

Reconnaissance of the study area was done during May 2017. Five study locations were selected after the reconnaissance. Intensive field work carried out from August 2017 to April 2018. There were four study locations *viz.*, Kurichiat, Muthanga, Sulthan Batheri and Tholpetty. To determine the population White-rumped Vultures were observed using direct sightings, feeding ground and nest observations. Also, observations were made from watchtowers in the sanctuary.

### 3.2.1 Nest identification and habitat characterization of vultures

Nests of vultures present in the sanctuary were located. The nest habitat characters were studied by taking up the nest tree as the central point. Vegetation around the nest tree was studied in a 10 m radius of the circular plot. An active nest is defined as a nest in which eggs had been laid, whereas an occupied nest is one in which an egg need not have been laid, but a minimum of nest building must have taken place. Nest observations were made from the ground, and details recorded.Presence or absence of breeding habitat across the sanctuary was mapped. The spatial data obtained using GPS were used to create a spatial database of the area. Attribute information collected from the nesting site was overlaid with the spatial data and GIS mapping was carried out.

The quantitative analysis of the vegetation was done. Sample plots were taken using a compass, plastic ropes, measuring tapes, pegs and GPS. Fourty four circular plots were taken in the field. Each of the plots is a 10 m radius circular plot. All the trees $\geq$ 10 cm girth at breast height (1.3 m) were identified and measured. The attributes taken for the measurement were girth at breast height (gbh) and a total height of the tree. Floristic diversity and phyto-sociological analysis were done with the help of diversity indices after the process of data collection, for which Simpson's Index and Shannon Weiner Index were used for analyzing floristic diversity and Important Value Index for the phyto-sociological analysis. Non parametric Mann-Whitney U Test was used to examine differences in habitat variables between nesting plots and non-nesting plots of Kaithallam, Ayyappanpara-doddadi, Kazukankolli and Karamukku.


**Plate 5: Vegetation studies (a) Measuring the GBH using tape; (b) Using hypsometer to measure the height**

### 3.2.2 Observations at carcass using camera trap

In order to assess the population and food availability in the study area, it is necessary to count the number of carcasses of large mammals found as well as the number of vultures attending to them. This was studied using camera traps. Other animals seen scavenging the carcass were also noted. The type of available carcass and the location where the carcass were dumped also recorded.

Camera trapping technique is one of the best method used to study the activities of animals with minimum disturbance to the animals. Digital camera with infra-red sensors for heat and motion detection sensor (Model: Cuddeback Attack C1) was used for the study. One camera trap station was identified at the carcass dumping site of Kakkapadam in the Muthanga range. The camera traps were set at a height of 30cm – 40cm above the ground. Three camera traps were fixed in 3 directions in order cover the maximum area of the feeding site (Plate 6). The cameras were set up in default mode with the time-delay as fast as possible between pictures in day time. The camera trap locations were marked using a Garmin GPS etrex 30. The cameras were kept open for 24 hours a day and remained open for 10-20 days at the station. The date and time of exposure were automatically recorded on the images, as and when the images were taken. Thus, a total of 84 camera-trap days with 2016 trapping hours were carried out in the Wayanad WLS. The camera trap data is given in Appendix 2.

**Plate 6: (a) Camera trap; (b) Fixing camera trap; (c) Camera trap set in the field**

### 3.2.3 Socio-economic survey

A socio-economic survey was conducted among various stakeholders regarding the threats and conservation issues faced by the vultures of Wayanad Wildlife Sanctuary. Also, survey was conducted on the usage of Diclofenac in and around the study area. Interview were conducted among the different stakeholders such as NGO's, Forest Department officials, settlers, tribals, veterinary doctors and medical shop vendors.

- NGO and other stakeholders including forest officials (30)
- Local and Tribal People (30)
- Veterinary doctors and medical shops (30)

Statistical analysis of this survey was done using SPSS.The collected data was analyzed by using tables, diagrams and graphs. The data was analyzed according to the objectives of the study. The total numbers of the respondents were 90. They were categorized into 3 groups for getting maximum information from them. Descriptive methods were used for data analysis and interpretation of study. Frequency distribution and graphical representations including pie diagram, bar charts, etc. are used for the anaysis of the study.

## 3.3 DATA ANALYSIS

### 3.3.1 Floristic Diversity

A number of indices have been suggested for the measurement of floristic diversity. Three of such indices have been calculated for trees with girth ≥10 cm.

#### 3.3.1.1 Simpson's index

$D = 1 - \sum_{i=1}^{s}(\frac{ni}{N})^2$

Where ni = number of individuals of the species i

N = total number of individuals in the plot

s = number of species in the plot

Expressed in this form, Simpson's index may easily be interpreted in terms of probability.

### 3.3.1.2 Shannon-Wiener's index (H')

$H' = 3.3219(\log_{10} N - \frac{1}{N}\sum_{i=1}^{s} ni \log_{10} ni)$

Which is derived from $H' = -\sum_{i=1}^{s}(\frac{ni}{N}) \log_2(\frac{ni}{N})$

Where ni, N and S denote the same as in Simpson's index and 3.3219 corresponds to the conversion factor from $\log_2$ to $\log_{10}$.

### 3.3.1.3 Important Value Index (IVI)

The Important Value Index (IVI) of Curtis (1950) and Curtis and McIntosh (1951) takes into consideration the number of individuals (density) belonging to each species, their basal area (dominance) and distribution (frequency) in the plot. To calculate IVI the method described by Cain et al. (1956) was followed.

- Density, $n_i$ = number of individuals of species 'i'
- Relative density, $rD = \frac{ni}{N} \times 100$ (where N is the total number of individuals in the plot)
- Dominance, di = sum of basal areas (at 1.3) of individuals of same species)
- Relative Dominance, $rd = \frac{di}{d} \times 100$ (where d is the basal area of the plot)
- Frequency, $fi = \frac{Ci}{C} \times 100$ (where Ci = number of quadrats where the species is present and C = total number of quadrats studied)
- Relative Frequency, $rF = \frac{fi}{F} \times 100$ (where $F=(\sum fi)$)

Thus, IVI of each species = rD + rd + rF and the value varies from 0 to 300. The IVI for each habitat types were calculated separately. The IVI for each botanical families were also calculated by adding the IVI of different species of same family found in the plot.

### 3.3.2 Statistical Analysis

The Mann-whitney U test is used to test the significance of association between variables. Here the null hypothesis is that;

$H_o$ = the two variables are independent or there is no significant association between two variables (Ludwig and Reynolds, 1988).

If the p-value is greater than 0.05, we will accept the null hypothesis. That means, statistically there is no significant association between two variables. If the p-value is less than 0.05, that means statistically there is significant association between two variables. The method was completed using the SPSS software. Statistical package in the Microsoft Office Excel (Version 2007) was also used for statistical analysis of data collected.

# Result

# RESULT

## 4.1 POPULATION STATUS OF VULTURES AT WAYANAD WILDLIFE SANCTUARY

The population estimation of the different species of vultures at Wayanad Wildlife Sanctuary were done using the methods such as camera trapping, direct sightings at feeding ground, nest survey and opportunistic record.

The population of *Gyps bengalensis* varied from 8-24 (SD), *Gyps indicus* was estimated to be 6-9 (SD), and *Sarcogyps calvus* population ranged between 1-9 (SD), (Table 2). About 250 plus vultures were recorded from Wayanad Wildlife Sanctuary during the study period. *Gyps bengalensis* was the most common vulture species at Wayanad Wildlife Sanctuary.

**Table 2: Number of individuals of vultures recorded using different methods in Wayanad Wildlife Sanctuary.**

| Method of Study | Number of individuals | | | | |
|---|---|---|---|---|---|
| | *Gyps bengalensis* | *Gyps indicus* | *Sarcogyps calvus* | *Gyps sps* | Range (SD) |
| Camera Trapping (Camera Trap Success Rate) | 24 (3.06%) | 9 (1.15%) | 9 (1.15%) | 225 (28.73%) | 216 (225-9) |
| Direct sighting (Feeding ground) | 14 | 6 | 8 | 58 | 52 (58-6) |
| Nest survey | 8 | 0 | 2 | 0 | 6 (8-2) |
| Opportunistic record | 11 | 0 | 1 | 27 | 26 (27-1) |
| Range (SD) | 16 (24-8) | 3 (9-6) | 8 (9-1) | 198 (225-27) | |

**Plate 7: (a) Ottippara watchtower, (b) Observing vultures from watchtower, (c) View of Ottippara**

**Plate 8: (a) Ayyappanpara watchtower, (b) Observing vultures from watchtower, (c) View of Ayyappanpara**

## 4.2 NESTING HABITAT CHARACTERISATION OF VULTURES

Four nests of 2 vulture species were located from the Wayanad Wildlife Sanctuary during the course of the study in 2017-18. Out of 4 nests, Three belonged to the *Gyps bengalensis* and one of *Sarcogyps calvus*. The nests of both *Gyps bengalensis* and *Sarcogyps calvus* were on the *Haldina cordifolia* trees. The average GBH of the nesting trees used by *Gyps bengalensis* ranged between 285 cm-376 cm (SD), while the average height of the nesting tree ranged between 25 m-29 m (SD).

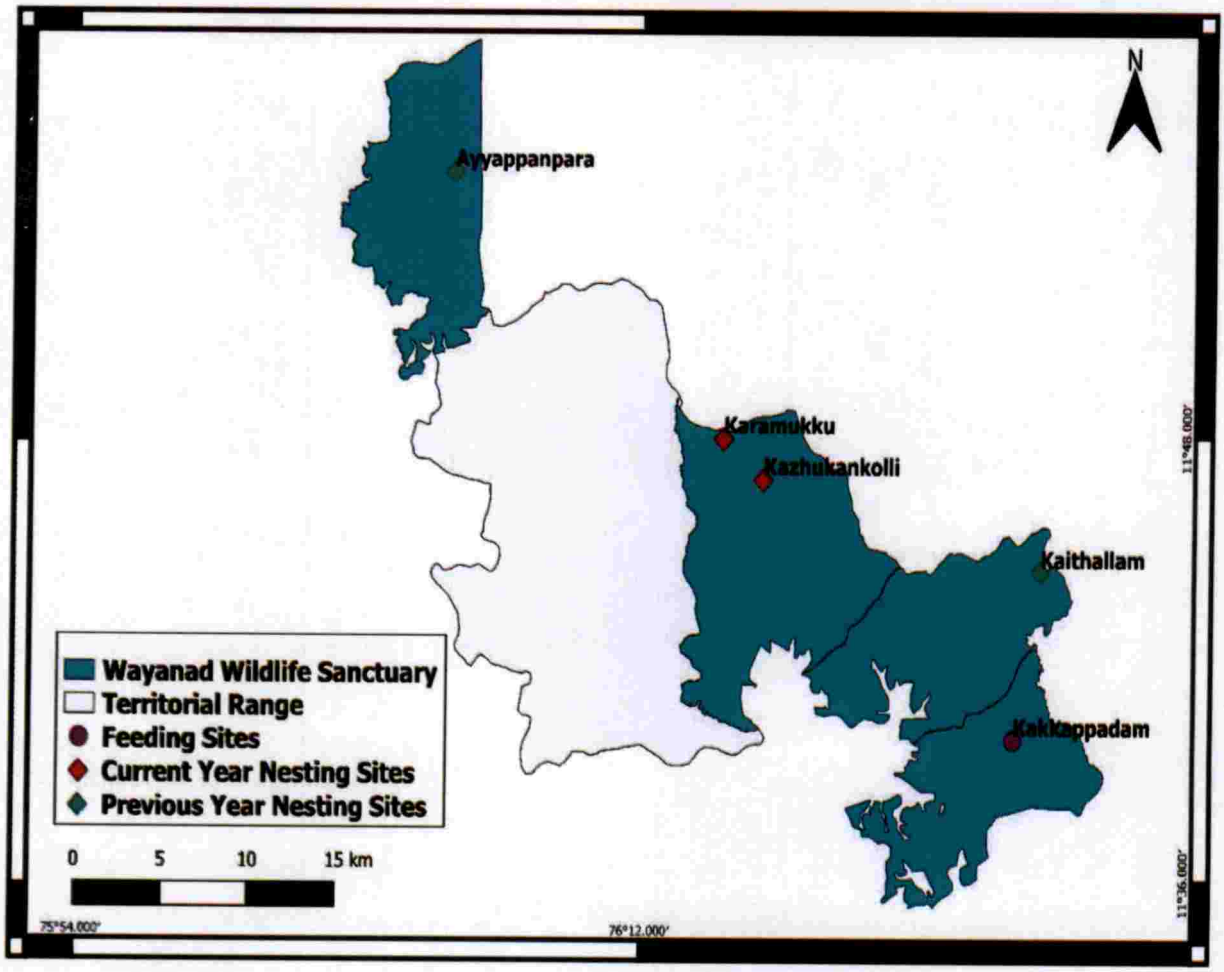


**Figure 2: Location map of nesting and feeding sites of vultures**

The nesting habitat of the vultures in Wayanad Wildlife Sanctuary is characterised by the vegetation association of *Terminalia elliptica*, *Tectona grandis*, *Anogeissus latifolia* and *Haldina cordifolia* (Table 3, Fig. 3). Thirty tree species belonging to 16 families have been recorded from the vulture breeding areas at Wayanad Wildlife Sanctuary.

**Table 3: The abundance of the tree species recorded from the nesting habitat of vultures at Wayanad Wildlife Sanctuary, Kerala**

| SCIENTIFIC NAME | FAMILY | VERNACULAR NAME | No. of individuals |
|---|---|---|---|
| 1. *Terminalia elliptica* | Combretaceae | മട്ടി | 58 |
| 2. *Anogeissus latifolia* | Combretaceae | മഴുകാഞ്ഞിരം | 27 |
| 3. *Tectona grandis* | Lamiaceae | തേക്ക് | 27 |
| 4. *Lagerstroemia lanceolata* | Lythraceae | വെണ്തേക്ക് | 22 |
| 5. *Haldina cordifolia* | Rubiaceae | മഞ്ഞകടമ്പ് | 21 |
| 6. *Cassia fistula* | Fabaceae | കണികൊന്ന | 16 |
| 7. *Dalbergia latifolia* | Fabaceae | വീട്ടി | 14 |
| 8. *Stereospermum chelonoides* | Bignoniaceae | പാതിരി | 9 |
| 9. *Aegle marmelose* | Rutaceae | കൂവളം | 7 |
| 10. *Grewia tilifolia* | Tiliaceae | ചടച്ചി | 6 |
| 11. *Phyllanthus emblica* | Euphorbiaceae | നെല്ലി | 6 |
| 12. *Butea monosperma* | Fabaceae | പ്ലാശ് | 5 |
| 13. *Olea dioica* | Oleaceae | എടന | 4 |
| 14. *Schleichera oleosa* | Sapindaceae | പൂവം | 4 |
| 15. *Elaeocarpus serratus* | Elaeocarpaceae | കാരമാവ് | 3 |
| 16. *Bauhinia malabarica* | Fabaceae | ആറംപുളി | 2 |
| 17. *Bauhinia racemosa* | Fabaceae | മന്ദാരം | 2 |
| 18. *Bombax ceiba* | Malvaceae | ഇലവ് | 2 |
| 19. *Lannea coromandelica* | Anacardiaceae | ഉഡി | 2 |

**The abundance of the tree species recorded from the nesting habitat of vultures**

| SCIENTIFIC NAME | FAMILY | VERNACUAR NAME | NUMBER OF INDIVIDUALS |
|---|---|---|---|
| *20. Mangifera indica* | Anacardiaceae | മാവ് | 2 |
| *21. Alstonia scholaris* | Apocynaceae | ഏഴിലംപാല | 1 |
| *22. Gmelina arborea* | Lamiaceae | കുമ്പിൾ | 1 |
| *23. Lagerstroemia reginae* | Lythraceae | മണിമരുത് | 1 |
| *24. Mytragyna parviflora* | Rubiaceae | കടമ്പ് | 1 |
| *25. Pongamia pinnata* | Fabaceae | ഉങ്ങ് | 1 |
| *26. Pterygota elliptica* | Malvaceae | ആനതൊണ്ടി | 1 |
| *27. Syzigium cumini* | Myrtaceae | ഞാവൽ | 1 |
| *28. Terminalia bellerica* | Combretaceae | താന്നി | 1 |
| *29. Terminalia paniculata* | Combretaceae | വെള്ളമരുത് | 1 |
| *30. Vitex altissima* | Lamiaceae | മയിലെള്ള് | 1 |

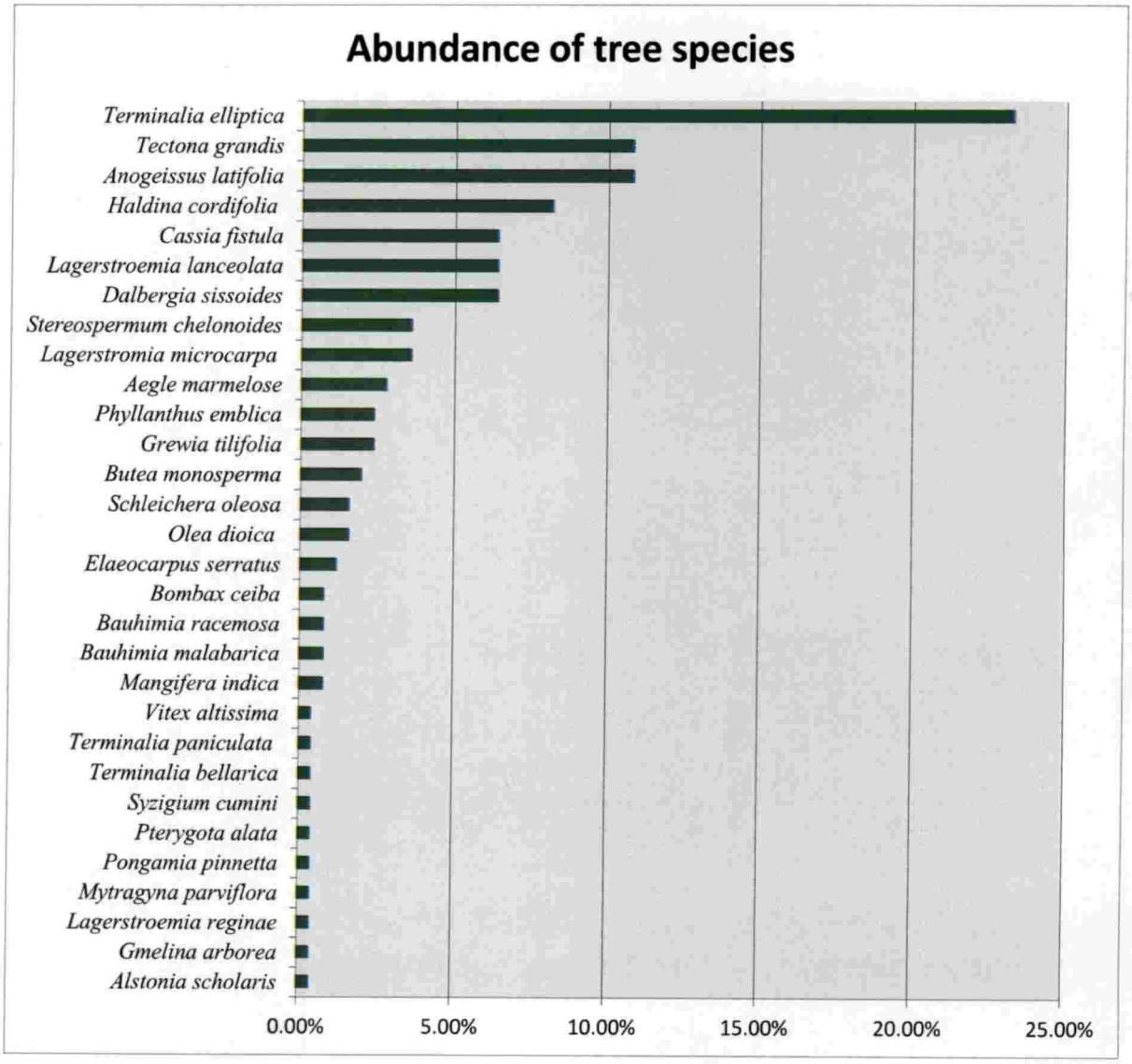


**Figure 3: Abundance of tree species recorded from the nesting colony**

### 4.2.1 Family wise distribution of trees identified from nesting colony

The highest number of species were recorded from the Fabaceae family (6), followed by Combretaceae family (4). The most dominant families in the study area were Fabaceae, Combretaceae, Lamiaceae, Lythraceae, and Anacardiaceae.

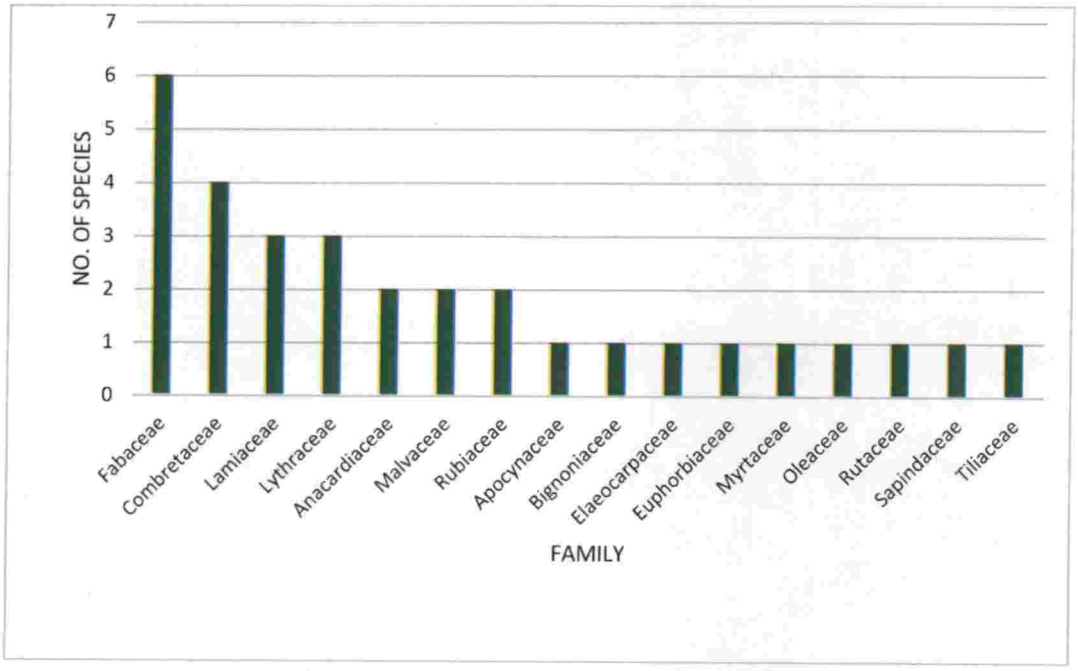


**Figure 4: Family wise distribution of trees identified from nesting colony**

The family wise Important Value Index details of the tree species in the vulture habitat in the Wayanad landscape are given in Table 4. The dominant plant families were Combretaceae ( IVI-61), Fabaceae (IVI-60.46), Rubiaceae (IVI-35.9), Lamiaceae (IVI-28.14), Lythraceae (IVI-24.74), and Anacardiaceae (IVI-24.36).

**Table 4: Family wise IVI of tree species in Wayanad Wildlife Sanctuary.**

| Family | Relative Density | Relative Frequency | Relative Basal Area | Important Value Index |
|---|---|---|---|---|
| 1 Combretaceae | 34.93 | 22.52 | 3.55 | 61 |
| 2 Fabaceae | 16.06 | 16.55 | 27.85 | 60.46 |
| 3 Rubiaceae | 8.83 | 10.59 | 16.48 | 35.9 |
| 4 Lamiaceae | 11.44 | 11.91 | 4.79 | 28.14 |
| 5 Lythraceae | 9.23 | 11.25 | 4.26 | 24.74 |
| 6 Anacardiaceae | 1.6 | 1.98 | 20.78 | 24.36 |
| 7 Bignoniaceae | 3.61 | 3.97 | 3.73 | 11.31 |

**Family wise IVI of tree species in Wayanad Wildlife Sanctuary**

| Family | Relative Density | Relative Frequency | Relative Basal Area | Important Value Index |
|---|---|---|---|---|
| 8 Tiliaceae | 2.4 | 3.97 | 4.77 | 11.14 |
| 9 Sapindaceae | 1.6 | 2.64 | 6.63 | 10.87 |
| 10 Rutaceae | 2.81 | 3.97 | 0.44 | 7.22 |
| 11 Euphorbiaceae | 2.4 | 3.31 | 0.37 | 6.08 |
| 12 Malvaceae | 1.2 | 1.98 | 2.19 | 5.37 |
| 13 Oleaceae | 1.6 | 2.64 | 1.1 | 5.34 |
| 14 Myrtaceae | 0.4 | 0.66 | 2.93 | 3.99 |
| 15 Elaeocarpaceae | 1.2 | 1.32 | 0.04 | 2.56 |
| 16 Apocynaceae | 0.40 | 0.66 | 0.02 | 1.08 |

The vegetation characteristics of the vulture habitat at Wayanad Wildlife Sanctuary are detailed in Table 5. The density (number of trees per sq.km.) is highest for *Terminalia elliptica* (58), followed by *Tectona grandis* (27), *Anogeissus latifolia* (27) and *Haldina cordifolia* (21). The basal area was greatest for the *Haldina cordifolia* ($18.95 m^2/cm^{-1}$, followed by *Terminalia elliptica* ($13.65 m^2/cm^{-1}$). The Important Value Index details of the tree species in the vulture habitat in the Wayanad landscape are given in Table 5. The dominant tree species were *Terminalia elliptica* (IVI-62.47), *Haldina cordifolia* (IVI-49.03), *Tectona grandis* (IVI-31.22), *Lagerstroemia lanceolata* (IVI-26.35), and *Anogeissus latifolia* (IVI-26.11).

**Table 5: IVI of the tree species in Wayanad Wildlife Sanctuary.**

| SPECIES | Density | RD | Frequency | RF | Basal area | RBA | IVI |
|---|---|---|---|---|---|---|---|
| *Terminalia elliptica* | 58 | 23.29 | 65.9 | 16.47 | 13.65 | 22.7 | 62.47 |
| *Haldina cordifolia* | 21 | 8.43 | 36.36 | 9.09 | 18.95 | 31.5 | 49.03 |
| *Tectona grandis* | 27 | 10.84 | 36.36 | 9.09 | 6.79 | 11.28 | 31.22 |
| *Lagerstroemia lanceolata* | 22 | 8.83 | 36.36 | 9.09 | 5.07 | 8.43 | 26.35 |
| *Anogeissus latifolia* | 27 | 10.84 | 45.45 | 11.36 | 2.34 | 3.9 | 26.11 |

**IVI of the tree species in Wayanad Wildlife Sanctuary**

| SPECIES | Density | RD | Frequency | RF | Basal area | RBA | IVI |
|---|---|---|---|---|---|---|---|
| *Dalbergia latifolia* | 14 | 5.62 | 27.27 | 6.81 | 1.81 | 3.01 | 15.45 |
| *Cassia fistula* | 16 | 6.42 | 29.54 | 7.38 | 0.43 | 0.72 | 14.54 |
| *Stereospermum chelonoides* | 9 | 3.61 | 13.63 | 3.4 | 1.75 | 2.92 | 9.94 |
| *Grewia tilifolia* | 6 | 2.4 | 13.63 | 3.4 | 1.5 | 2.49 | 8.31 |
| *Mangifera indica* | 2 | 0.8 | 2.27 | 0.56 | 3.11 | 5.18 | 6.55 |
| *Aegle marmelose* | 7 | 2.81 | 13.63 | 3.4 | 0.16 | 0.27 | 6.49 |
| *Schleichera oleosa* | 4 | 1.6 | 9.09 | 2.27 | 1.39 | 2.31 | 6.19 |
| *Phyllanthus emblica* | 6 | 2.4 | 11.36 | 2.84 | 0.13 | 0.22 | 5.48 |
| *Butea monosperma* | 5 | 2 | 6.81 | 1.7 | 0.47 | 0.78 | 4.49 |
| *Olea dioica* | 4 | 1.6 | 9.09 | 2.27 | 0.23 | 0.38 | 4.26 |
| *Lannea coromandelica* | 2 | 0.8 | 4.54 | 1.13 | 1.23 | 2.05 | 3.99 |
| *Elaeocarpus serratus* | 3 | 1.2 | 4.54 | 1.13 | 0.006 | 0.01 | 2.35 |
| *Bombax ceiba* | 2 | 0.8 | 4.54 | 1.13 | 0.21 | 0.35 | 2.28 |
| *Bauhinia racemosa* | 2 | 0.8 | 4.54 | 1.13 | 0.04 | 0.07 | 2 |
| *Bauhinia malabarica* | 2 | 0.8 | 2.27 | 0.56 | 0.12 | 0.2 | 1.57 |
| *Syzigium cumini* | 1 | 0.4 | 2.27 | 0.56 | 0.15 | 0.25 | 1.22 |
| *Pterygota elliptica* | 1 | 0.4 | 2.27 | 0.56 | 0.13 | 0.22 | 1.19 |
| *Terminalia bellerica* | 1 | 0.4 | 2.27 | 0.56 | 0.103 | 0.17 | 1.14 |
| *Terminalia paniculata* | 1 | 0.4 | 2.27 | 0.56 | 0.09 | 0.15 | 1.12 |
| *Lagerstroemia reginae* | 1 | 0.4 | 2.27 | 0.56 | 0.05 | 0.09 | 1.06 |

**IVI of the tree species in Wayanad Wildlife Sanctuary**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Mytragyna parviflora* | 1 | 0.4 | 2.27 | 0.56 | 0.04 | 0.07 | 1.04 |
| *Gmelina arborea* | 1 | 0.4 | 2.27 | 0.56 | 0.04 | 0.07 | 1.03 |
| *Pongamia pinnata* | 1 | 0.4 | 2.27 | 0.56 | 0.04 | 0.07 | 1.03 |
| *Vitex altissima* | 1 | 0.4 | 2.27 | 0.56 | 0.007 | 0.01 | 0.98 |
| *Alstonia scholaris* | 1 | 0.4 | 2.27 | 0.56 | 0.001 | 0.001 | 0.97 |

### 4.2.2 Floristic Diversity

Tree species diversity was estimated by Simpson's diversity index and Shannon diversity index. The Simpson's diversity of the nesting site is 0.91 and the Shannon diversity index comes to 1.11. The Simpson's index of the non-nesting site is 0.89 and Shannon diversity index is 1.10.

**Table 6: Diversity indices of nesting and non-nesting sites of the study area.**

| Variables | Habitats | | |
|---|---|---|---|
| | Nesting plots | Non-nesting plots | Whole area |
| Area of study (ha) | 0.4082 | 0.9734 | 1.3816 |
| Species richness | 18 | 25 | 30 |
| Simpson index | 0.91 | 0.89 | 0.90 |
| Shannon index | 1.11 | 1.10 | 1.15 |
| | | | |

Species richness was found to be more in the non-nesting plots. Simpson index and Shannon index value were found to be more in the nesting plots.

**Table 7: Comparison of site and habitat parameters at Vulture nesting and non-nesting plots in Wayanad Wildlife sanctuary**

| Variables | Nesting Plot N = 13 (No. of plots) Mean (SE) | Non-nesting Plot N = 31 (No. of plots) Mean (SE) | Mann-Whitney *U* Test *Z* | *P* |
|---|---|---|---|---|
| Species density | 4.61 (0.28) | 3.81 (0.22) | -2.11 | 0.034 |
| Tree density | 6 (0.43) | 5.52 (.37) | -1.30 | 0.191 |
| Tree girth (cm) | 167.73 (14.53) | 140.63 (9.80) | -2.40 | 0.016 |
| Tree height (m) | 17.07 (0.82) | 15.00 (0.40) | -2.07 | 0.038 |
| Canopy cover (%) | 65 (1.8) | 62.87 (1.26) | -1.03 | 0.30 |

Habitat variables such as species density, tree girth and tree height were significantly higher in nesting plots than in non-nesting plots.

### 4.2.3 Height Class distribution of trees in the vulture habitat in Wayanad landscape

The height class distribution of the trees in the vulture habitat in the Wayanad landscape clearly indicate that the most of the trees come under the height class of 11-15m height class (figure 5). The trees in the lower height class as well as the greater height class are very few and sparse.

Ideally the height class distribution should have followed an inverse 'J' pattern. The current pattern indicate that the 'set of the future' which indicate the regeneration community is very poor at the vulture habitat.

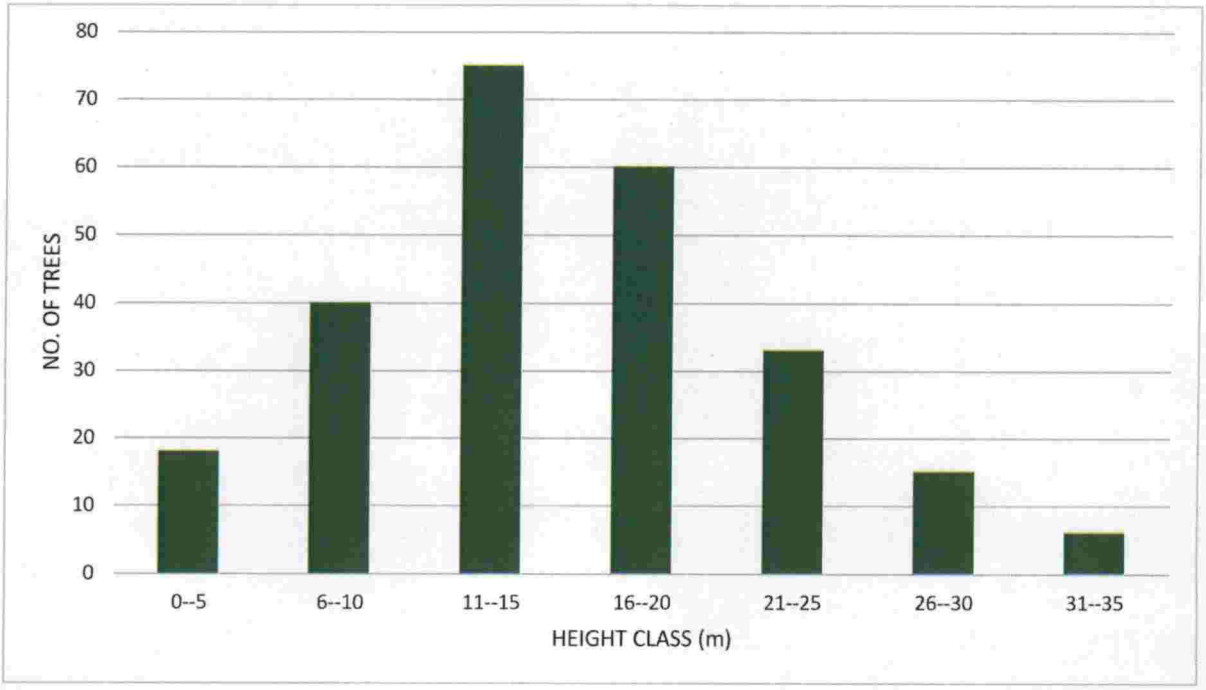


**Figure 5: Height Class Distribution of trees in the vulture habitat in the Wayanad landscape**

### 4.2.4 Girth class distribution of trees in the vulture habitat in the Wayanad landscape

The girth class distribution of the trees in the vulture habitat in the Wayanad landscape is given in Figure 6. Most of the trees belong to the girth class categories 80cm to 140 cm. The trees belonging to the lower girth categories which indicate the regeneration status of the vegetation is sparse and poor at Wayanad. The condition of the large and old grown trees are also very bad at Wayanad. This creates a very alarming scenario in the bleak future of these vegetation, unless urgent restoration activities are carried out.

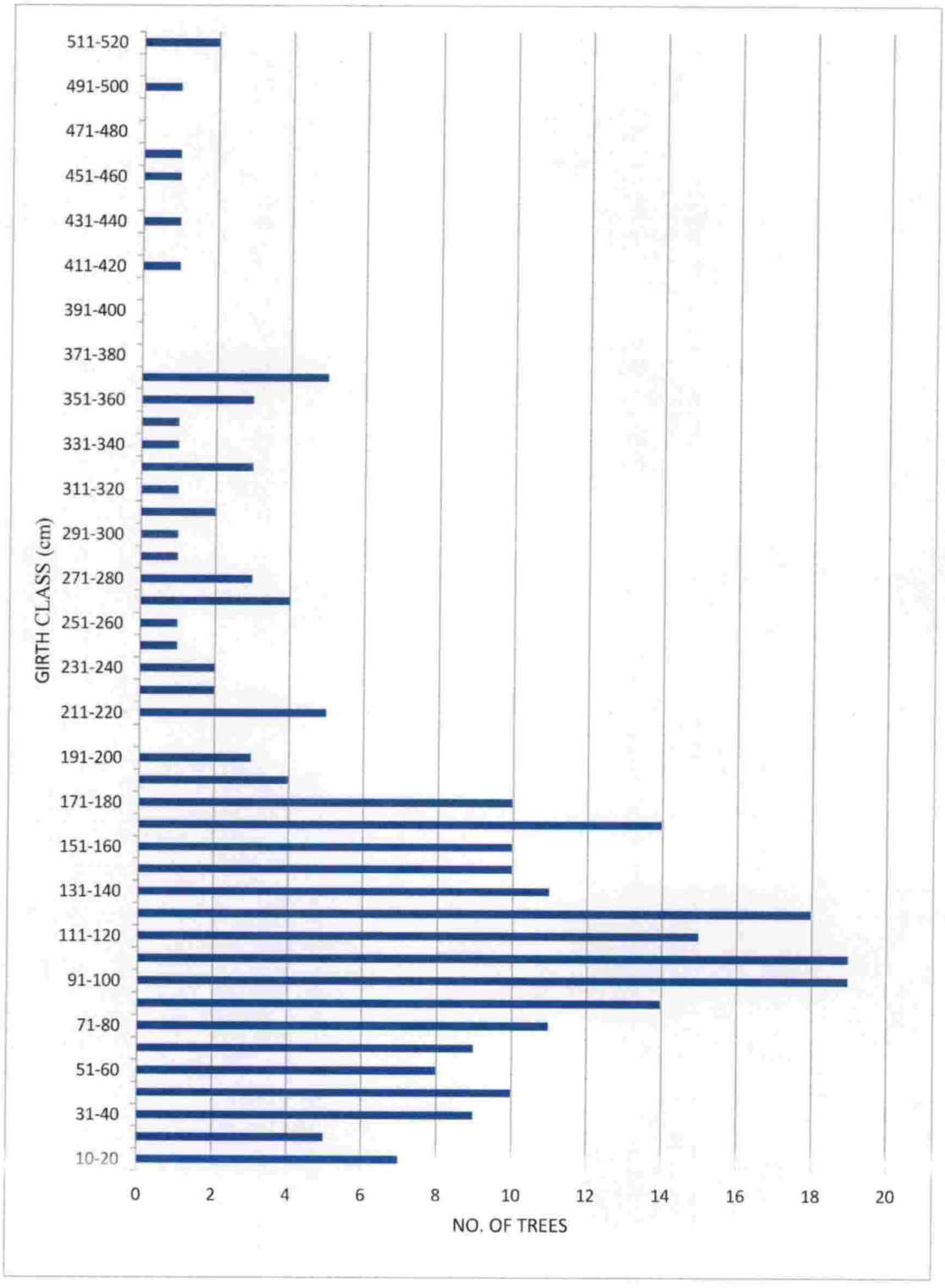


**Figure 6: Girth class distribution of trees recorded from the study area**

### 4.2.5 Nesting tree preference by the vultures in the Wayanad Wildlife Sanctuary

The vultures were found nesting on six different tree species. They are *Haldina cordifolia* (54%), *Terminalia elliptica* (15%), *Lagerstroemia lanceolata* (8%), *Dalbergia latifolia* (8%), *Stereospermum chelonoides* (8%), and *Tectona grandis* (8%).

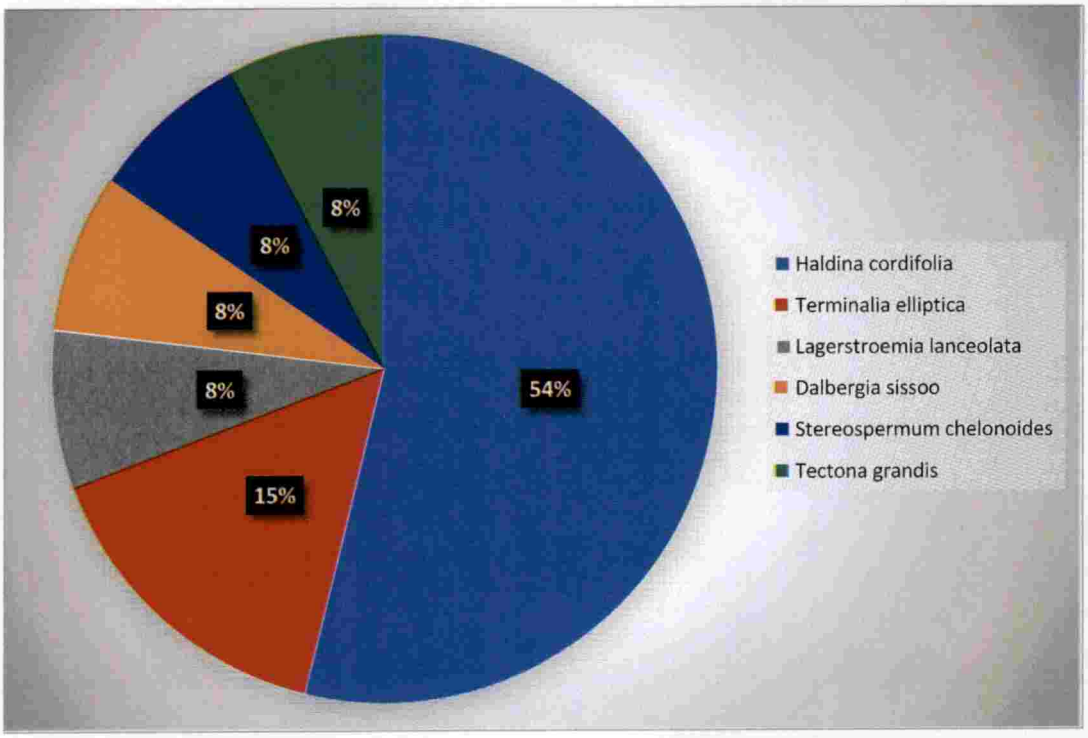


**Figure 7: Nesting tree preference by the vultures in the Wayanad Wildlife Sanctuary**

#### 4.2.5.1 *Haldina cordifolia* at Wayanad Wildlife Sanctuary

*Haldina cordifolia* accounted for the 54% of the total nesting trees inWayanad Wildlife Sanctuary. The vultures were found nesting in *Haldina cordifolia* having a girth ranging between 285 cm to 492 cm (Mean = 379.67; SD = 78.97). The girth class distribution of the *Haldina cordifolia* in the vulture habitat at Wayanad Wildlife Sanctuary is given in Figure 8. It clearly indicate that the regeneration of the *Haldina cordifolia* is extremely low in the Wayanad landscape. It is interesting to note that about 78% of the *Haldina cordifolia* belongs to girth class >285 cm. The vultures seem to prefer large trees for nesting.

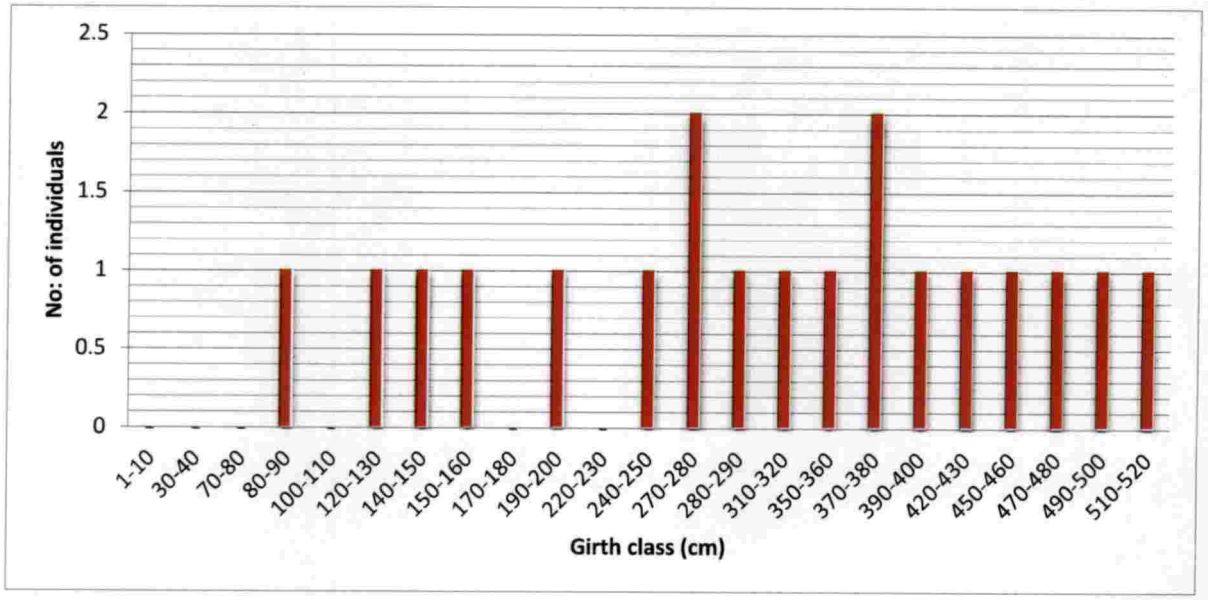


**Figure 8: Girth class distribution of *Haldina cordifolia***

### 4.2.5.2 *Dalbergia latifolia* at Wayanad Wildlife Sanctuary

There was a single nest in *Dalbergia latifolia* in the Wayanad landscape at Kazhukankolli region. This tree has a girth of 225cm. only 14% of *Dalbergia latifolia* belong to a girth class of >225cm (Figure 9).

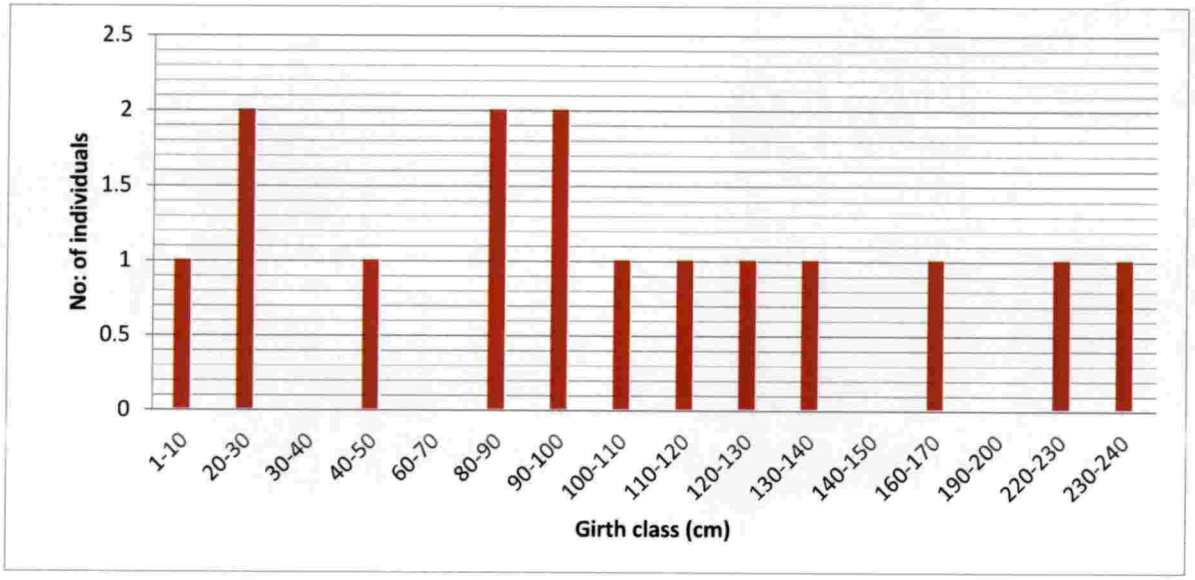


**Figure 9: Girth class distribution of *Dalbergia latifolia***

#### 4.2.5.3 *Lagerstroemia lanceolata* at Wayanad Wildlife Sanctuary

There was a single nest on *Lagerstroemia lanceolata* in Wayanad landscape at Kazhukankolli region. This tree has a girth of 360cm. Only 6% of the *Lagerstroemia lanceolata* at the study area belong to the girth class of >360cm (Figure 10).

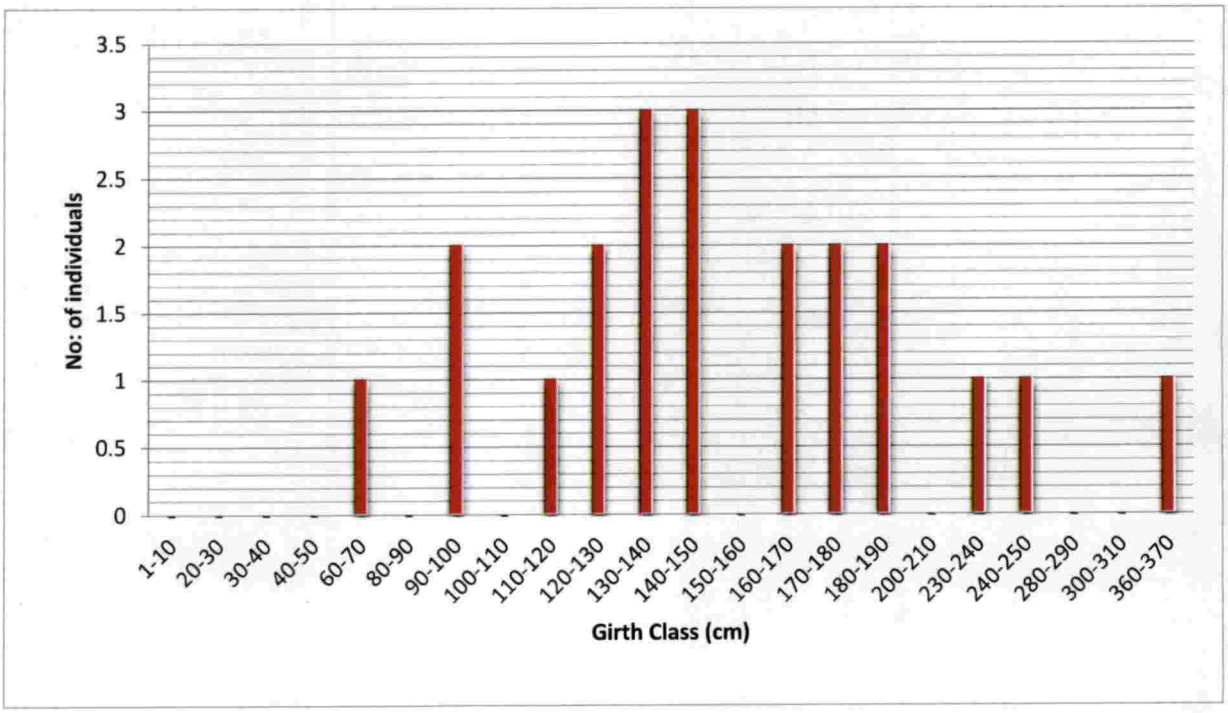


**Figure 10: Girth class distribution of *Lagerstroemia lanceolata***

#### 4.2.5.4 *Stereospermum chelonoides* at Wayanad Wildlife Sanctuary

One nest was located in a *Stereospermum chelonoides* tree having a girth of 329cm. Only 11% of *Stereospermum chelonoides* has >329cm at Wayanad Wildlife Sanctuary (Figure 11).

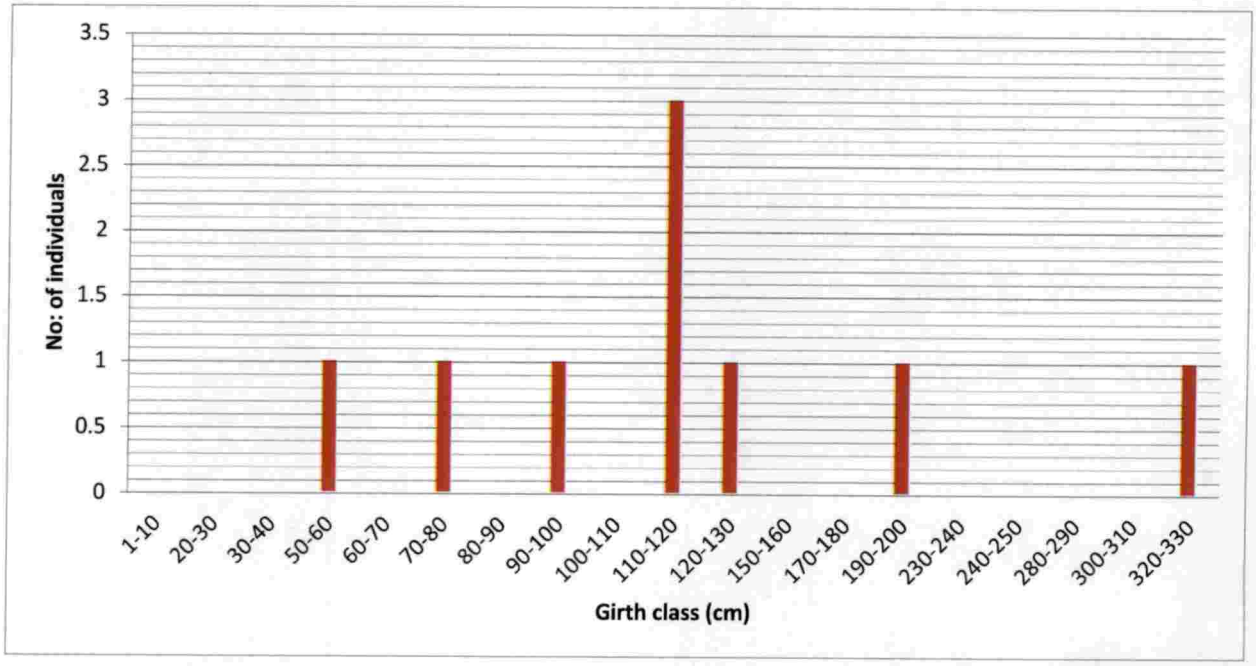


**Figure 11: Girth class distribution of *Stereospermum chelonoides***

### 4.2.5.5 *Terminalia elliptica* and *Tectona grandis* at Wayanad Wildlife Sanctuary

The two nests on the *Terminalia elliptica* have a girth of 315cm and 390cm respectively (Figure 12), while the nest on *Tectona grandis* has a girth of 258 cm (figure 12).

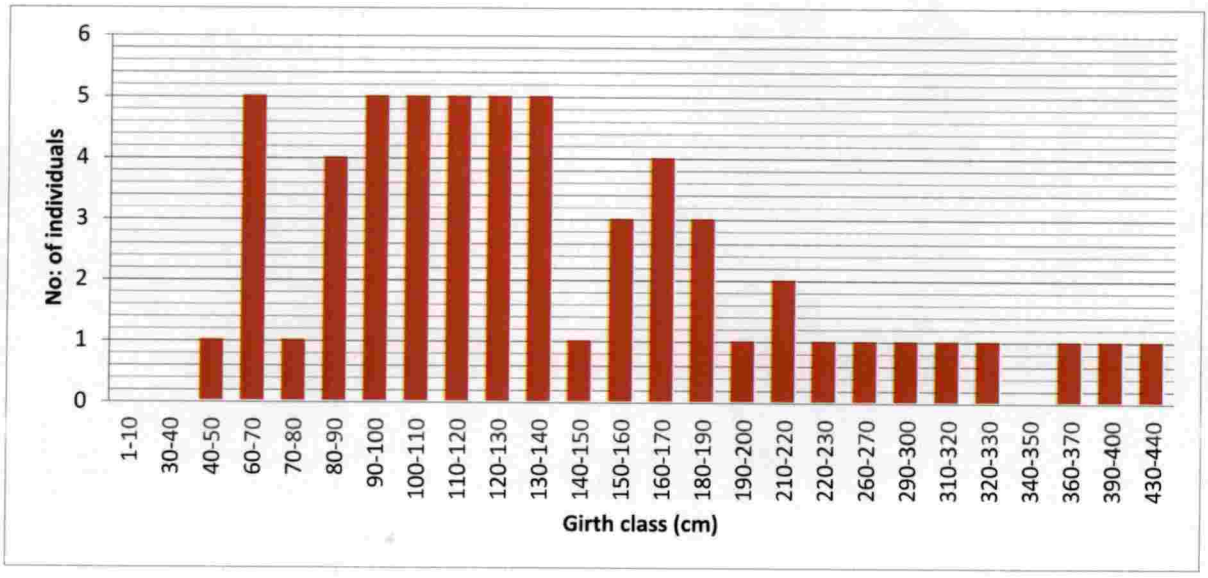


**Figure 12: Girth class distribution of *Terminalia elliptica***

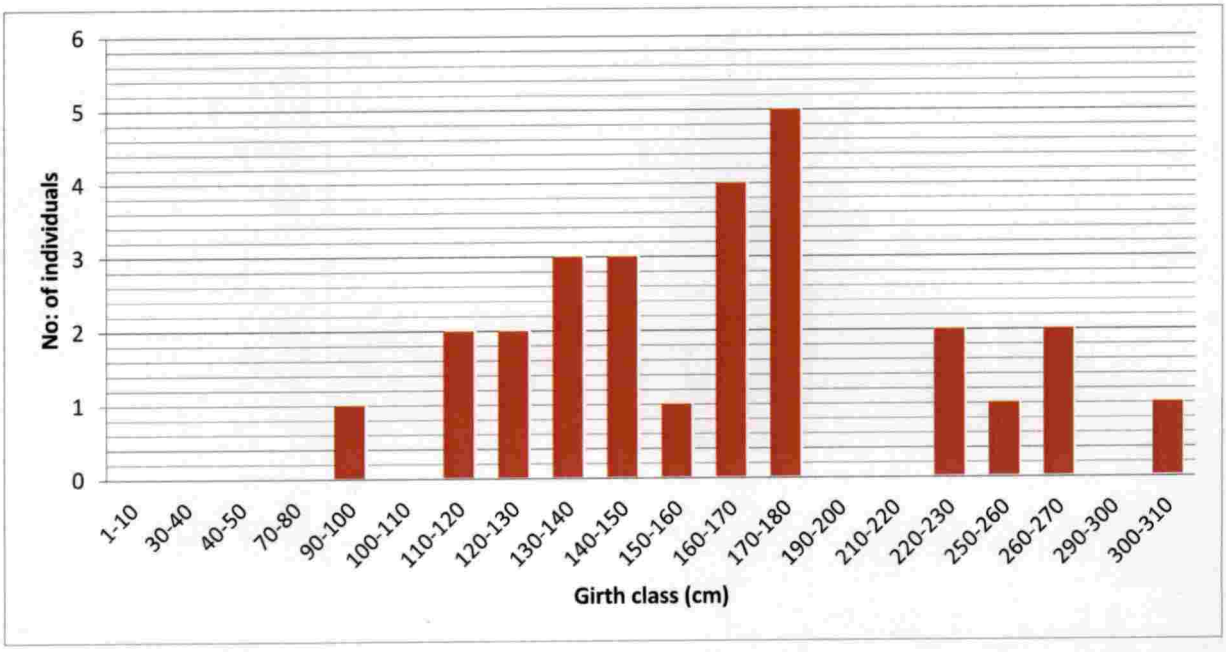


**Figure 13: Girth class distribution of *Tectona grandis***

It can be concluded that vulture has a preference for larger areas (>250cm girth at breast height) for constructing the nest. They also have a preference for *Haldina cordifolia*. Whether this preference to the *Haldina cordifolia* due to the availability of larger trees at Wayanad landscape or due to any other plant characteristics is something that need further investigation.

### 4.2.6 Region wise distribution of tree species in the study area

The vulture nests were located in four sites in Wayanad landscape. They are Kazhukankolli region of Kurichiad range (latitude 11°46 N and longitude 076°15 N), Ayyappanpara/Doddadi region of Tholpetty range (latitude 11°55 N and longitude 76°05 N), Kaithallam region of Sulthan Bathery range (latitude 11°44 N and longitude 76°24 N), and Karamukku region of Kurichiad range (latitude 11°47 N and longitude 76°14 N).

### 4.2.6.1 Kazhukankolli region

Kazukankolli region of Kurichiad forest range in Wayanad Wildlife Sanctuary is an important nesting area of *Gyps bengalensis.*

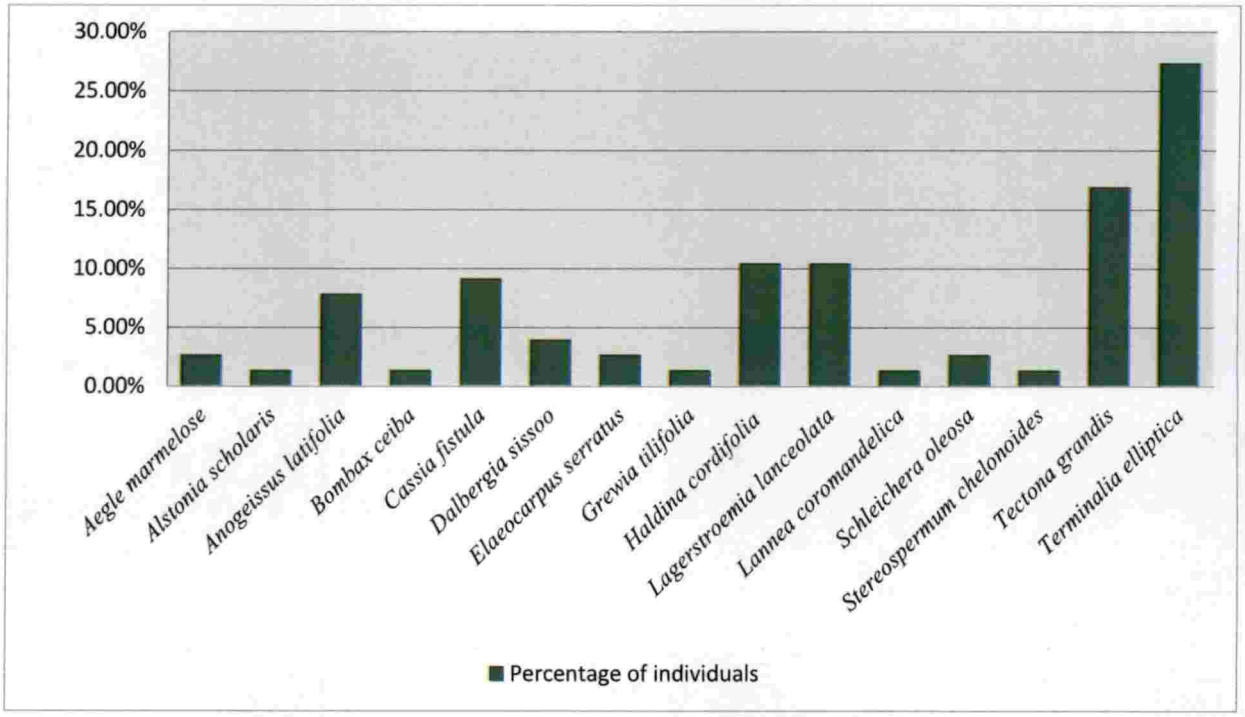


**Figure 14: Percentage of tree species recorded from Kazhukankolli region**

### 4.2.6.2 Ayyappanpara/Doddadi region

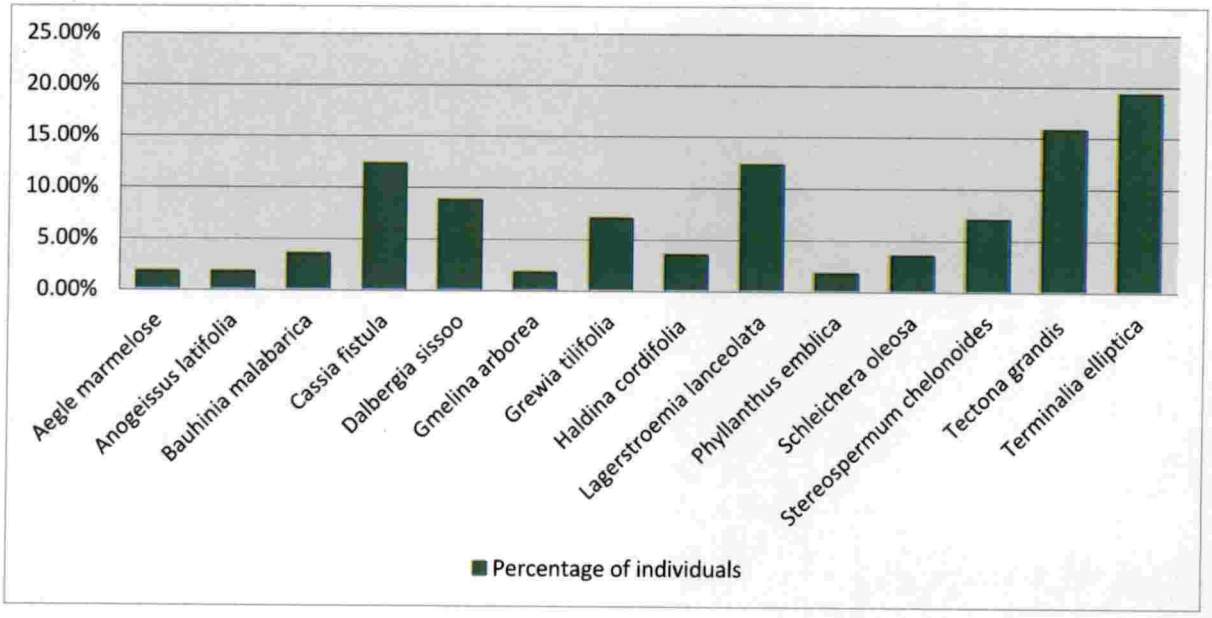


**Figure 15: Percentage of tree species recorded from Ayyappanpara/Doddadi region.**

### 4.2.6 .3 Kaithallam region

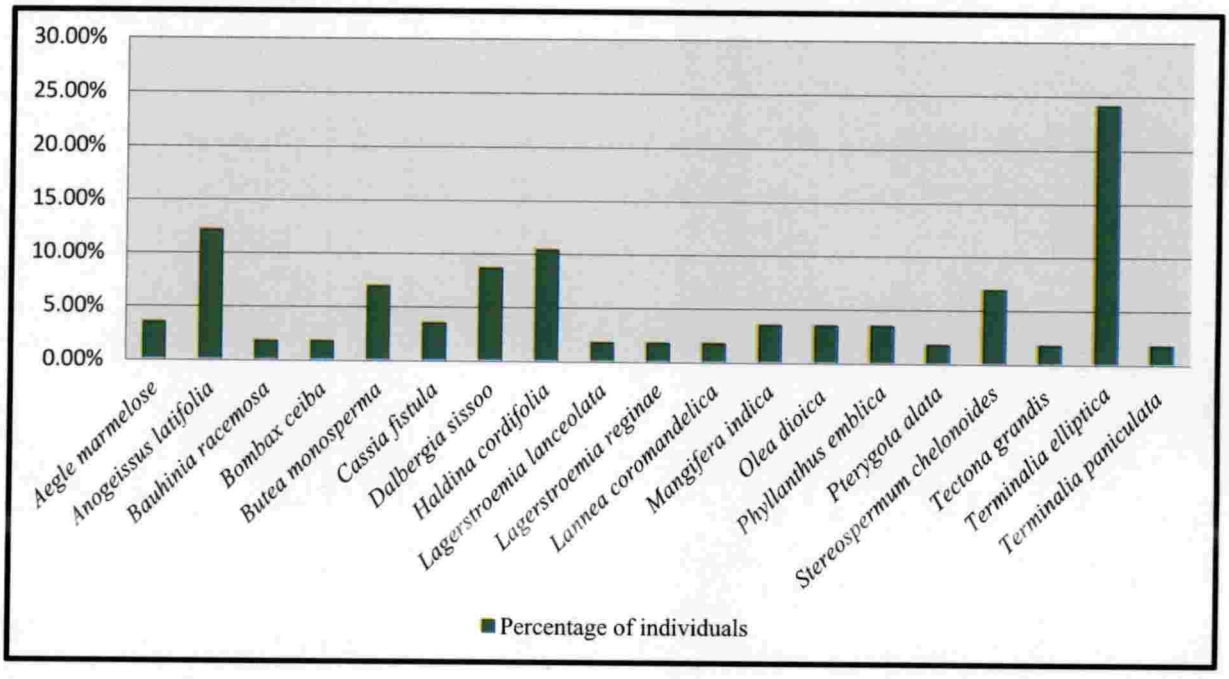


**Figure 16: Percentage of tree species recorded from Kaithallam region.**

#### 4.2.6.4 Karamukku region

Karamukku region of Kurichiad forest range in Wayanad Wildlife Sanctuary is an important nesting area of *Sarcogyps calvus.*

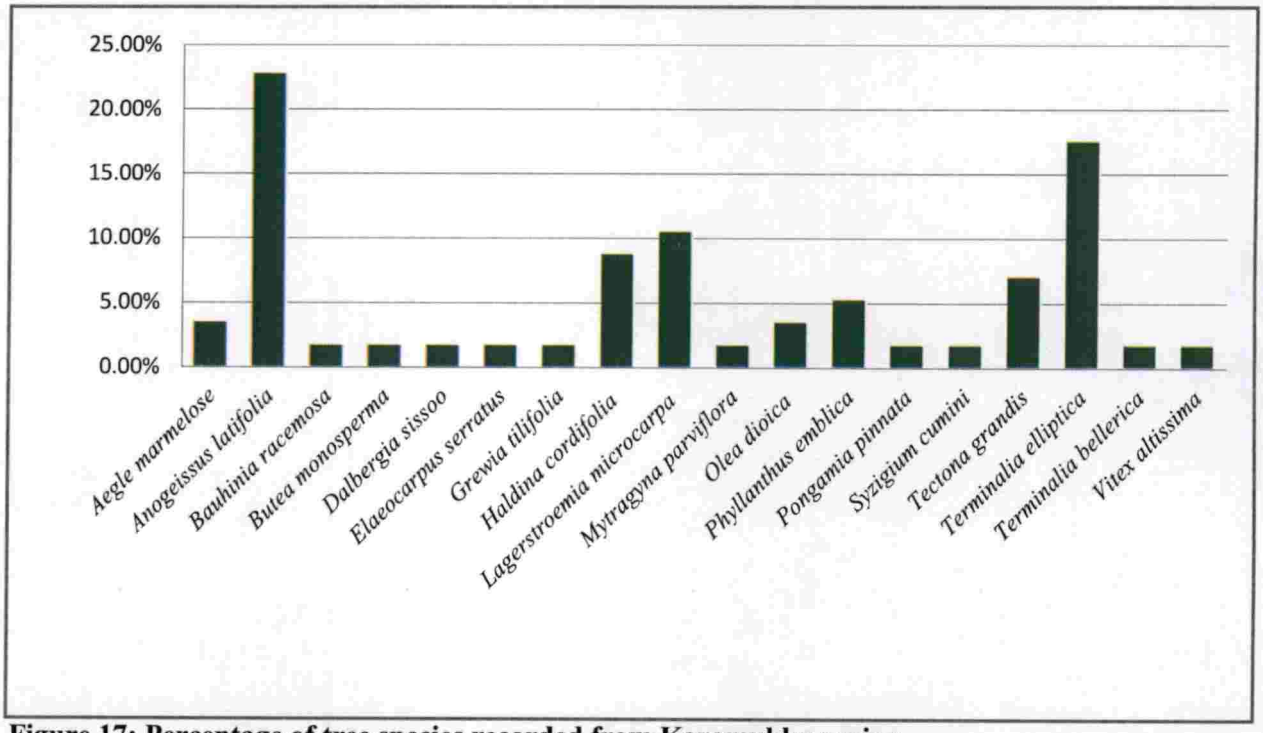


**Figure 17: Percentage of tree species recorded from Karamukku region**

**Plate 9: *Gyps bengalensis* perched on *Haldina cordifolia* (nesting tree) at Kazhukankolli region in Wayanad Wildlife Sanctuary**

**Plate 10: Vulture nest on *Haldina cordifolia* in Kazhukankolli region in Wayanad Wildlife Sanctuary**

**Plate 11: Juvenile White-rumped Vulture on *Haldina cordifolia* recorded from Kazhukankolli in Wayanad Wildlife Sanctuary**

**Plate 12: Juvenile Vulture on *Haldina cordifolia* at Kazhukankolli region in Wayanad Wildlife Sanctuary**

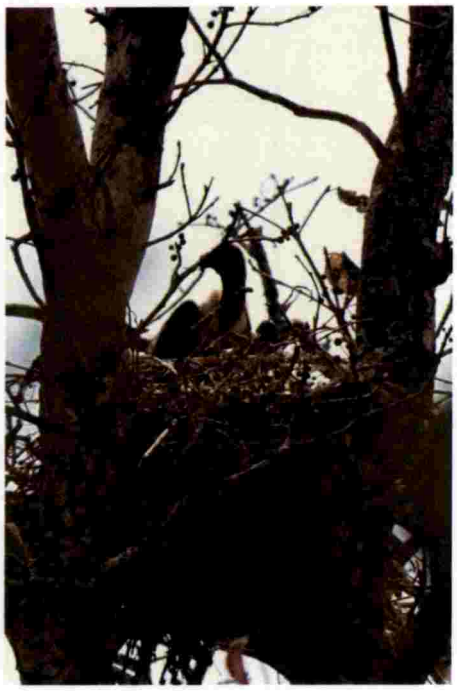

**Plate 13: White-rumped Vulture resting in the nest on *Haldina cordifolia* at Kazhukankolli region in Wayanad Wildlife Sanctuary.**

**Plate 14: Vulture nesting tree *Haldina cordifolia* at Kazukankolli region in Wayanad Wildlife Sanctuary**

**Plate 15: Red-headed Vulture nest on *Haldina cordifolia* at Karamukku in Wayanad Wildlife Sanctuary**

**Plate 16: Vulture nesting tree *Haldina cordifolia* at Karamukku region in Wayanad Wildlife Sanctuary**

**Plate 17: Red-headed Vulture soaring near its nest at Karamukku region in Wayanad Wildlife Sanctuary**

### 4.3 Camera trap study on the Vulture population of Wayanad Wildlife Sanctuary

The food and feeding habits of the Vultures were studied by employing camera traps. The camera trap was kept open for 84 days and 2016 hours at one carcass dumping site, Kakkapadam in Muthanga range. The camera trap success rate of *Gyps* sps. is 32.94% and Sarcogyps calvus is 1.15%

Between the month of October 2017 and March 2018, the feeding of seven carcass of deer species were at the Kakkapadam. Two were that of Sambar Deer and five were the carcass of Spotted Deer (Table 8). Of the seven individuals monitored, a total 267 visits of vultures were recorded of which 24 species of White-rumped Vulture, nine species of Red headed vulture and nine Species of Indian Vulture were identified.

**Table 8: Details of the carcass dumped at Kakkapadam of Muthanga range in Wayanad Wildlife Sanctuary**

| Date of dumping of carcass | Type of carcass | Cause of death |
|---|---|---|
| 12/08/2017 | Spotted Deer | Road kill |
| 27/10/2017 | Sambar Deer | Road kill |
| 04/01/2018 | Spotted Deer | Road kill |
| 09/01/2018 | Sambar Deer | Road kill |
| 21/01/2018 | Spotted Deer | Road kill |
| 29/01/2018 | Spotted Deer | Road kill |
| 01/03/2018 | Sambar Deer | Road kill |

#### 4.3.1. The Time-activity Pattern of Camera Trapped Vultures in Kakkapadam, Wayanad Wildlife Sanctuary

A time-activity pattern of the Vultures that were camera trapped during the feeding of 7 different carcasses of Spotted Deer and Sambar Deer was prepared at Wayanad WLS. For studying the active period, the camera trapping hours were divided into 1 hour interval classes. Apart from the three species of vultures 10 species of mammals and four species of other birds were also recorded in the camera trap (Table 9).

**Table 9: Mammals and birds recorded in the camera trap at Kakkapadam carcass dumping site in Wayanad Wildlife Sanctuary**

| Species | Scientific Name | Family | No. of individuals |
|---|---|---|---|
| 1. Spotted deer | *Axis axis* | Cervidae | 1782 |
| 2. Indian peafowl | *Pavo cristatus* | Phasianidae | 299 |
| 3. Elephant | *Elephus maximus* | Elephantidae | 66 |
| 4. Wild boar | *Sus scrofa* | Suidae | 40 |
| 5. Sambar deer | *Rusa unicolor* | Cervidae | 28 |
| 6. Black-naped hare | *Lepus nigricollis* | Leporidae | 14 |
| 7. Tiger | *Panthera tigris* | Felidae | 8 |
| 8. Indian Crested Porcupine | *Hystrix indica* | Hystricidae | 4 |
| 9. Stripe-necked mongoose | *Herpestes vitticollis* | Herpestidae | 3 |
| 10. Wild Dog | *Cuon alpinus* | Canidae | 3 |
| 11. Jungle Crow | *Corvus macrohynchos* | Corvidae | 2 |
| 12. Common Myna | *Acridotheres tristis* | Sturnidae | 2 |
| 13. Bee-eater sp. | *Merops* | Meropidae | 1 |
| 14. Gaur | *Bos gaurus* | Bovidae | 1 |

The Vulture feeding at Kakkapadam and other sites in Wayanad need to be reexamined. The reason for starting a vulture feed supplement area within natural forest is unknown. Was this been based on any study done on the food availability of the vultures? Is there a shortage of natural food for the vultures that warranted such an action? Why should one move the carcass from any location of its origin to the carcass dumping yards? Why can't it be left at the same site where the mortality of the animal occurred?

The effect of artificial feeding sites in the movement of large carnivores like Tigers to the fringe area/human habitation, has anyone thought about it? These questions need satisfactory answers before one should think of continuing the vulture artificial feeding sites.

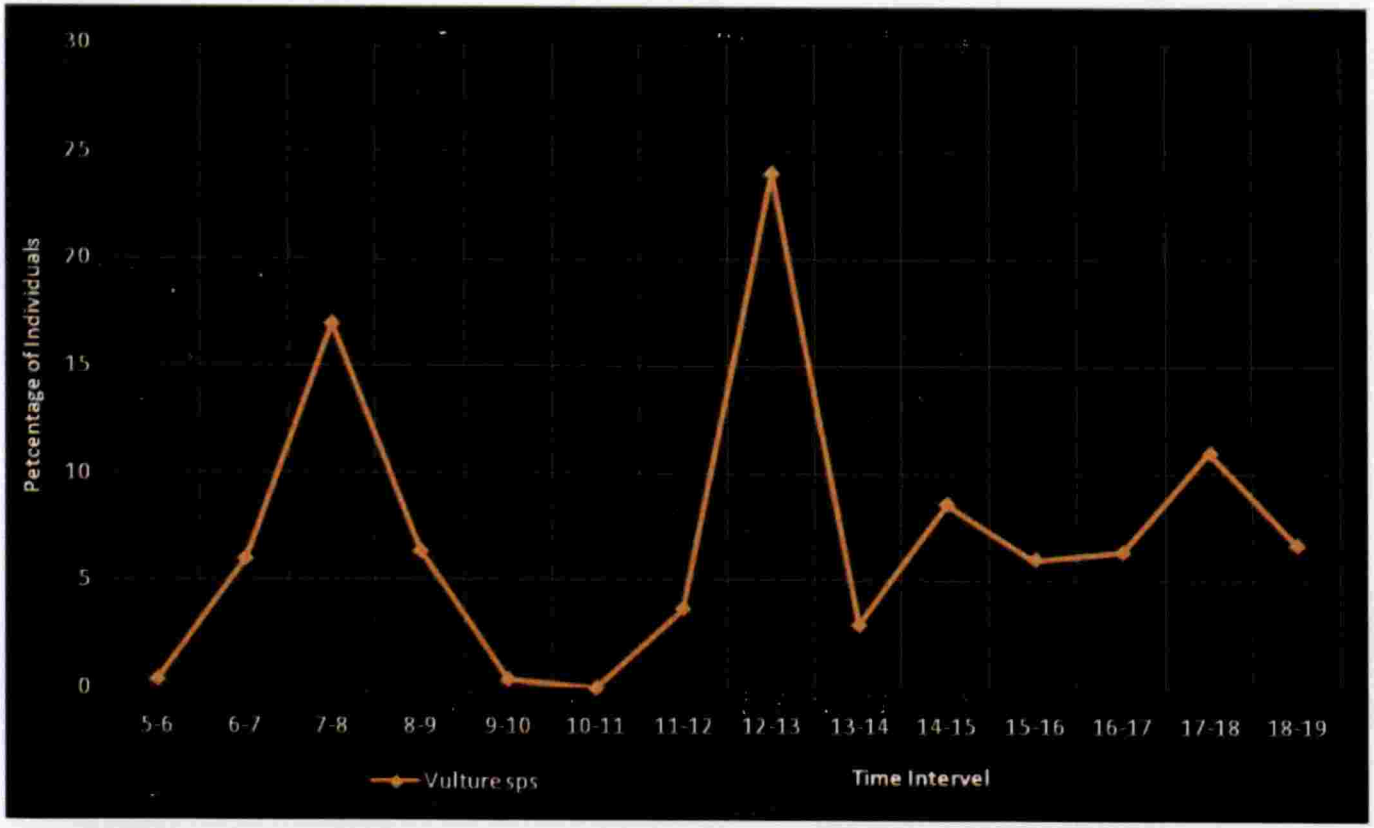


**Figure 18: Activity period of Vulture sps. feeding on carcasses at Vulture feeding ground, Kakkapadam, Wayanad WLS WWLS.**

**Plate 18: *Gyps* sp. sitting on Eucalyptus tree near Kakkapadam carcass dumping site at Wayanad wildlife sanctuary**

**Plate 19: Red-headed Vulture resting on *Senna spectabilis* near Kakkapadam, carcass dumping site at Wayanad Wildlife Sanctuary**

**Plate 20: *Gyps bengalensis* on flight near carcass dumping site at Wayanad Wildlife Sanctuary**

**Plate 21: The camera traps at Kakkapadam, Wayanad Wildlife Sanctuary**

**Plate 22: A fresh carcass of Spotted Deer at Kakkapadam, Wayanad Wildlife Sanctuary**

**Plate 23: Feeding by vultures on the carcass of a Spotted Deer at Kakkapadam, Wayanad Wildlife Sanctuary**

**Plate 24: Remnants of Spotted deer at the carcass dumping site in Kakkapadam, Wayanad Wildlife Sanctuary**

**Plate 25: Feeding by Vultures on the carcass of Spotted Deer at Kakkapadam, Wayanad Wildlife Sanctuary**


**Plate 26: Feeding by Vultures on the carcass of Spotted Deer at Kakkapadam, Wayanad Wildlife Sanctuary (Camera Trap Image)**


**Plate 27: Feeding by vultures on the carcass of a Spotted Deer at Kakkapadam, Wayanad Wildlife Sanctuary (Camera Trap Image)**

### 4.4 Socio-economic survey to understand the conservation challenges of the vultures

The socio-economic survey was conducted among the different stakeholders to understand and to address the conservation challenges being faced by the vultures at Wayanad landscape.

#### 4.4.1 Profile details of NGO and other stakeholders including forest officials

Most of the respondents were distributed the age class 45-60 years (46.67%) and 30-45 years (43.33%).

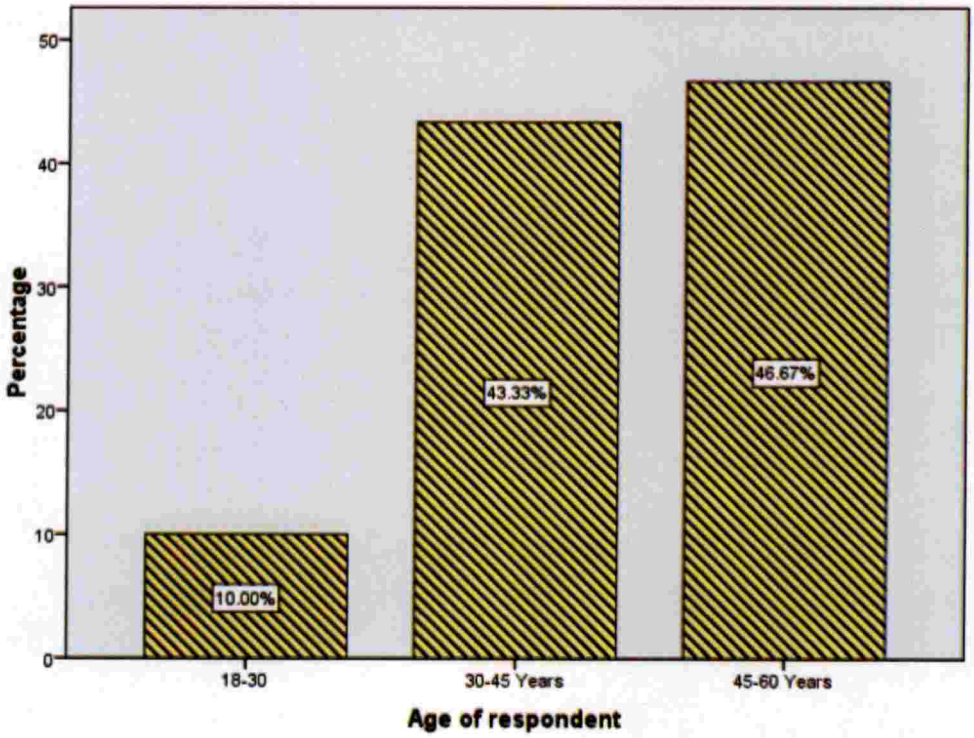


**Figure 19: Age of respondents.**

#### 4.4.1.1 Threats faced by vultures in the sanctuary

Most of the respondents (63.3%) felt that the vulture habitat is being lost at Wayanad landscape. However, 72.2% of the respondents agree that the Non-steriodal Anti-inflammatory Drug (NSAID) is not being used in and around Wayanad Wildlife Sanctuary and 90% of them felt that safe food is available for vultures. About 56.7% of the respondents believe that vulture

restaurants provides safe food and also in sufficient and 66.7% of the respondents felt that there is not much threat at the breeding sites.

**Table 10: Threats faced by vultures in the sanctuary**

| Items | Yes | | No | |
|---|---|---|---|---|
| | Frequency | Percentage | Frequency | Percentage |
| Loss of habitat of vultures | 19 | 63.33 | 11 | 36.67 |
| Use of NSAID's to treat live stock | 8 | 27.80 | 22 | 72.20 |
| Loss of available safe food | 3 | 10.00 | 27 | 90.00 |
| Unscientific management of feeding sites | 13 | 43.3 | 17 | 56.7 |
| Threats at breeding sites of vultures | 10 | 33.3 | 20 | 66.7 |

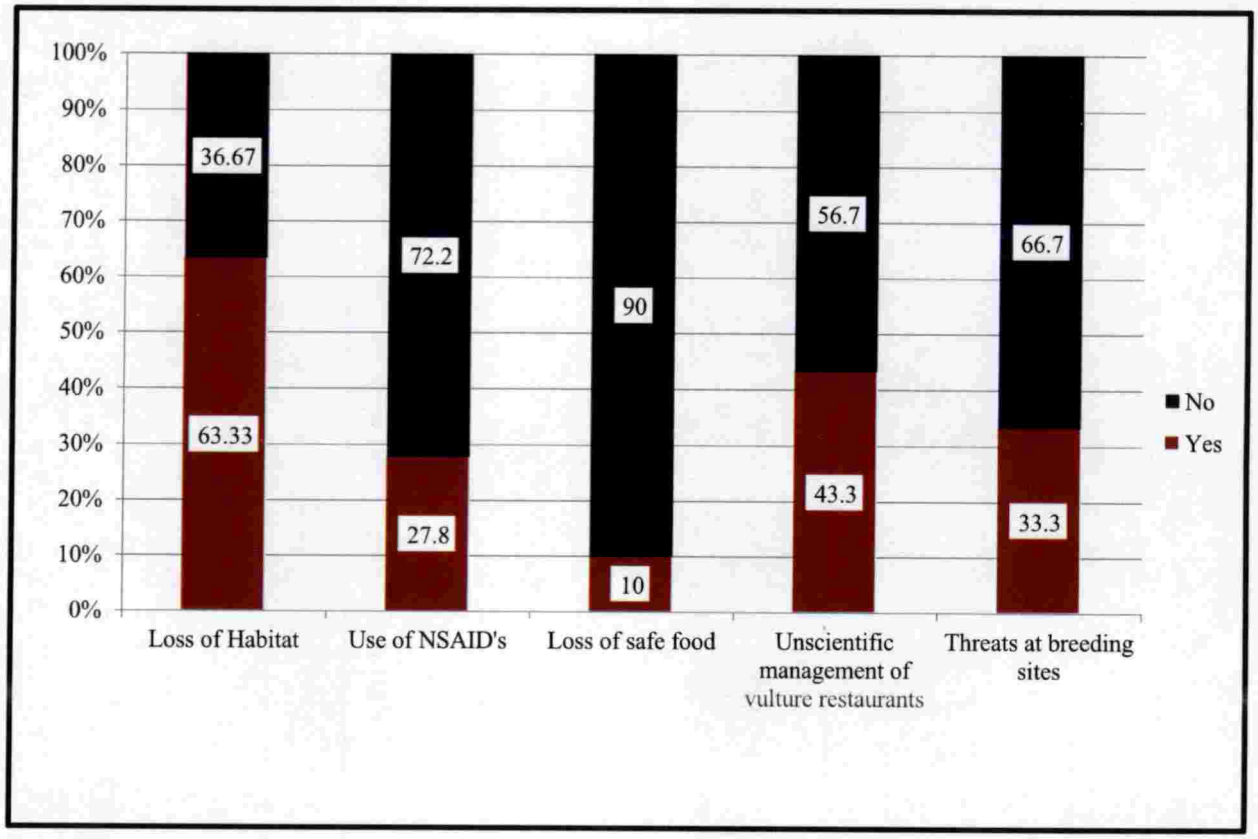


**Figure 20: Threats faced by vultures in the Wayanad Wildlife Sanctuary**

Most of the respondents (96.7%) felt that there are no behavioral changes in vultures and so no threat faced by vulture due to this. Fortunately, all of the respondents felt that there are no practices of hunting and poaching of vultures in the Wayanad Wildlife Sanctuary, thus there is no threat faced by the vultures due to this.

#### 4.4.1.2 Cases registered in the past regarding vultures in the sanctuary

All the respondents said that there are no cases registered in the sanctuary in the past regarding vultures.

**Table 11: Interviewees response about the case registered in the past regarding vultures in the sanctuary**

| | Frequency | Percent |
|---|---|---|
| No | 30 | 100.0 |

#### 4.4.1.3 Misuse of diclofenac available in the market

About 40% of the respondents believe that the diclofenac which is authorized for human use might be misused by some medical practitioners and other retailers to treat livestock because of it is priced low and is effective. However, 13.3% felt that there is no misuse of diclofenac by the people. Unfortunately, 46.7% didn't know what is diclofenac and its effect on vultures.

**Table 12: Misuse of diclofenac which is available in the market**

| | Frequency | Percent |
|---|---|---|
| Yes | 12 | 40.0 |
| No | 4 | 13.3 |
| Ignorant | 14 | 46.7 |
| Total | 30 | 100.0 |

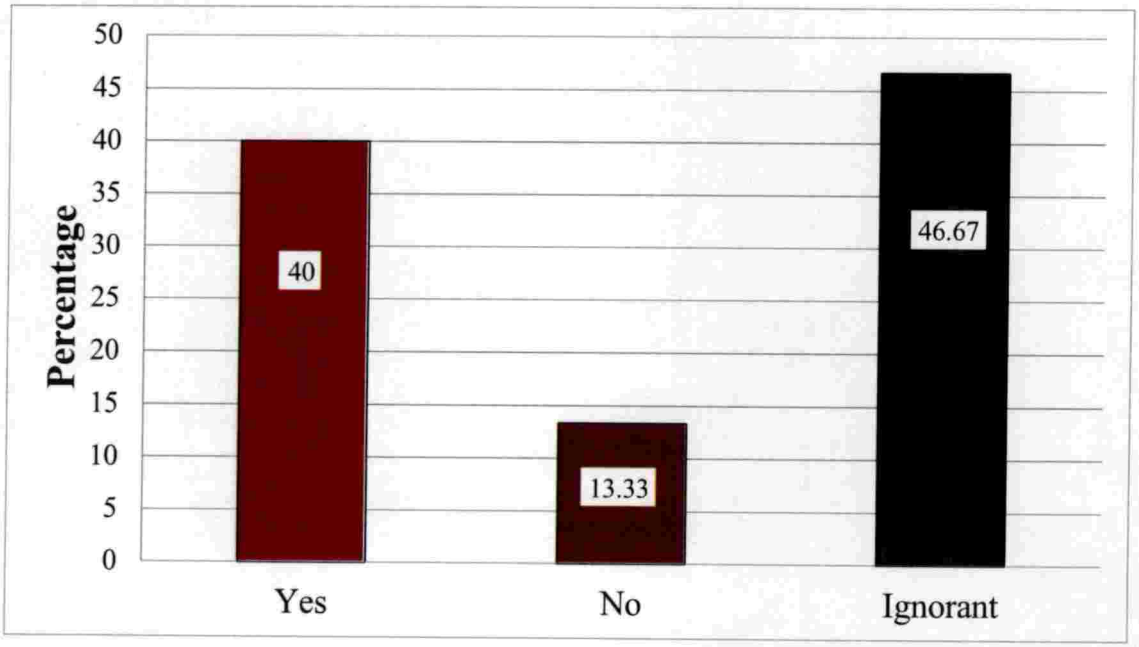


**Figure 21: Misuse of diclofenac which is available in the market**

#### 4.4.1.4 Suggestions to improve the condition of vultures in the sanctuary

Most of the respondents (73.3%) felt that there is a need of vulture awareness programme. Though the Vulture population is stable in Wayanad Wildlife Sanctuary, 86.7% of the respondents felt that there is no need of breeding programme for vultures at present and about 73.3% of the respondents believe that scientific management is necessary. Most of the respondents (66.7%) felt that there is no need of improving the conditions of the nesting sites.

**Table 13: Suggestions to improve the condition of vultures in the sanctuary**

| Need for | Yes | | No | |
|---|---|---|---|---|
| | Frequency | Percentage | Frequency | Percentage |
| Vulture awareness programme | 22 | 73.3 | 8 | 26.7 |
| Breeding programme | 4 | 13.3 | 26 | 86.7 |
| Improving conditions of nesting sites | 10 | 33.3 | 20 | 66.7 |
| Scientific management of vulture feeding sites | 22 | 73.3 | 8 | 26.7 |

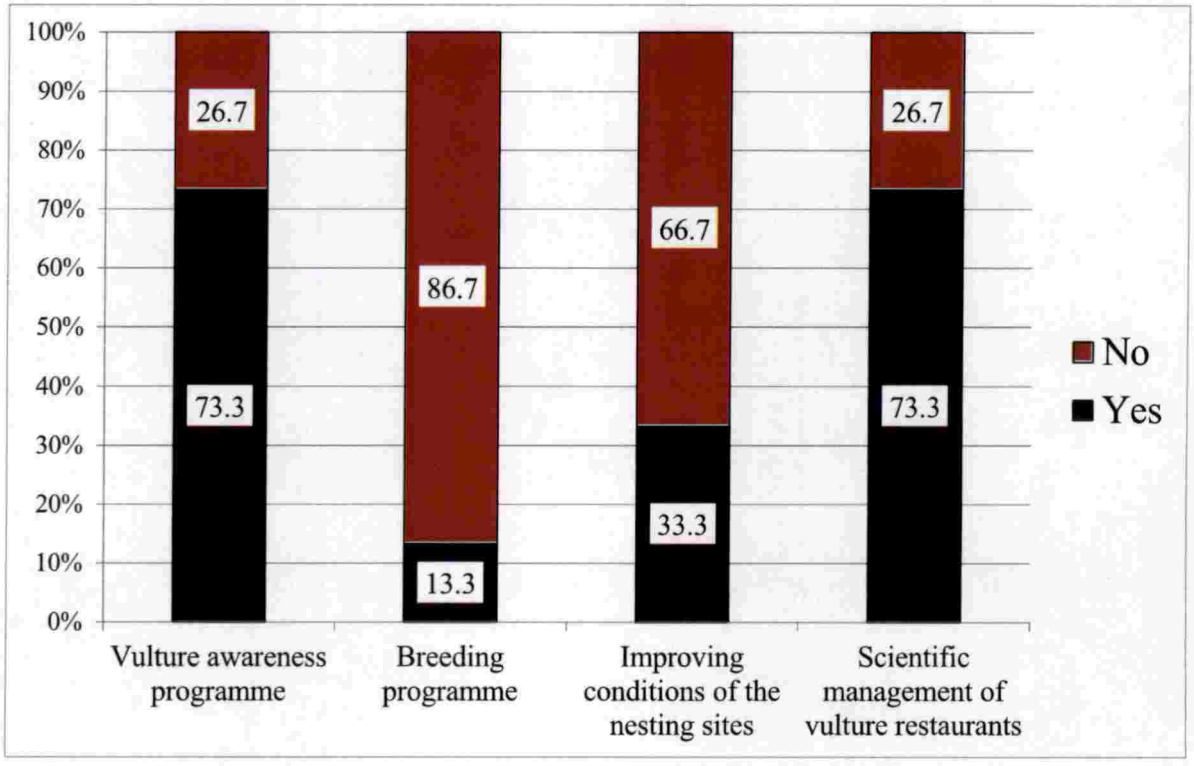


**Figure 22: Suggestions to improve the condition of vultures in the sanctuary**

#### 4.4.1.5 Vulture population statistics

About 43.33% of the respondents have an opinion that, over the last available years vulture population is stable,53.33% of the respondents replied its population is increasing and 3.33% of the respondents think that vulture population is decreasing over the last available years.

**Table 14: Vulture population statistics in Wayanad Wildlife Sanctuary over the last available years**

| | **Frequency** | **Percent** |
|---|---|---|
| Stable | 13 | 43.3 |
| Increasing | 16 | 53.3 |
| Decreasing | 1 | 3.3 |
| Total | 30 | 100.0 |

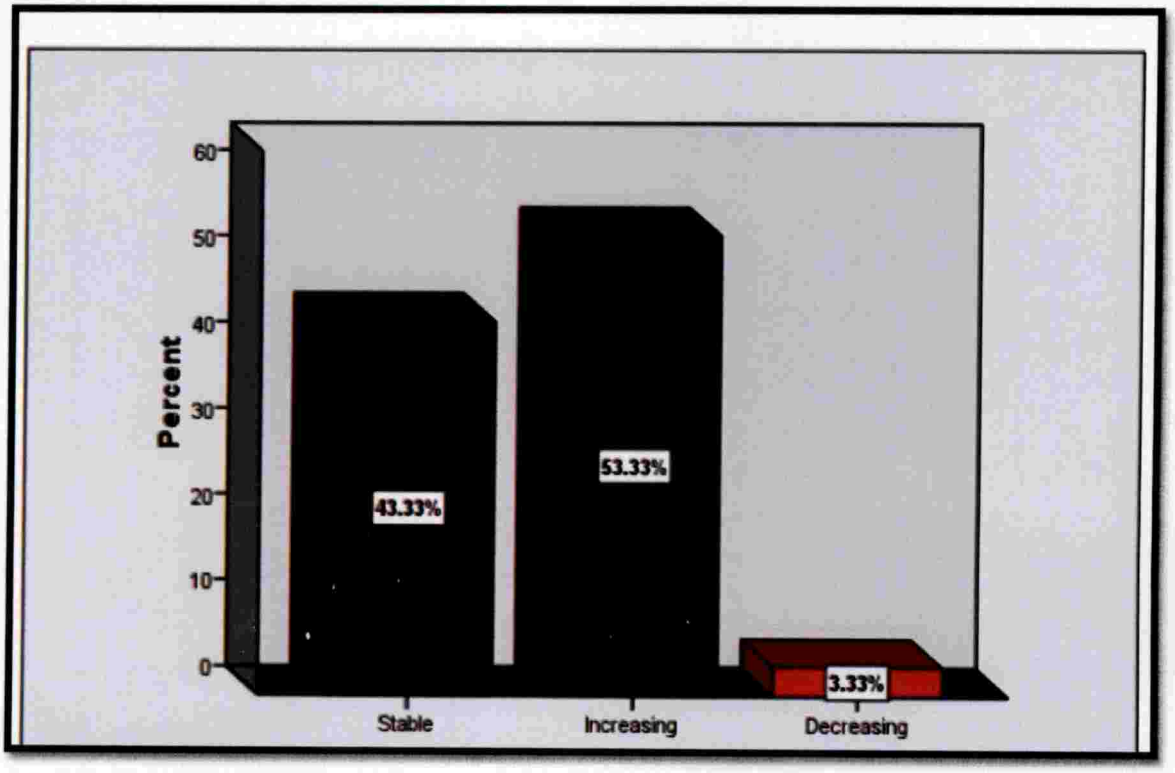


**Figure 23: Vulture population statistics of Wayanad Wildlife Sanctuary over the last available years**


**Plate 28: Interview with Forest Range Officer, Bandhipur**

### 4.4.2 Profile details and perception of Local and Tribal People

Most of the respondants belonged to the age class 45-60 years (30%) and 60-75 years (36.67%).

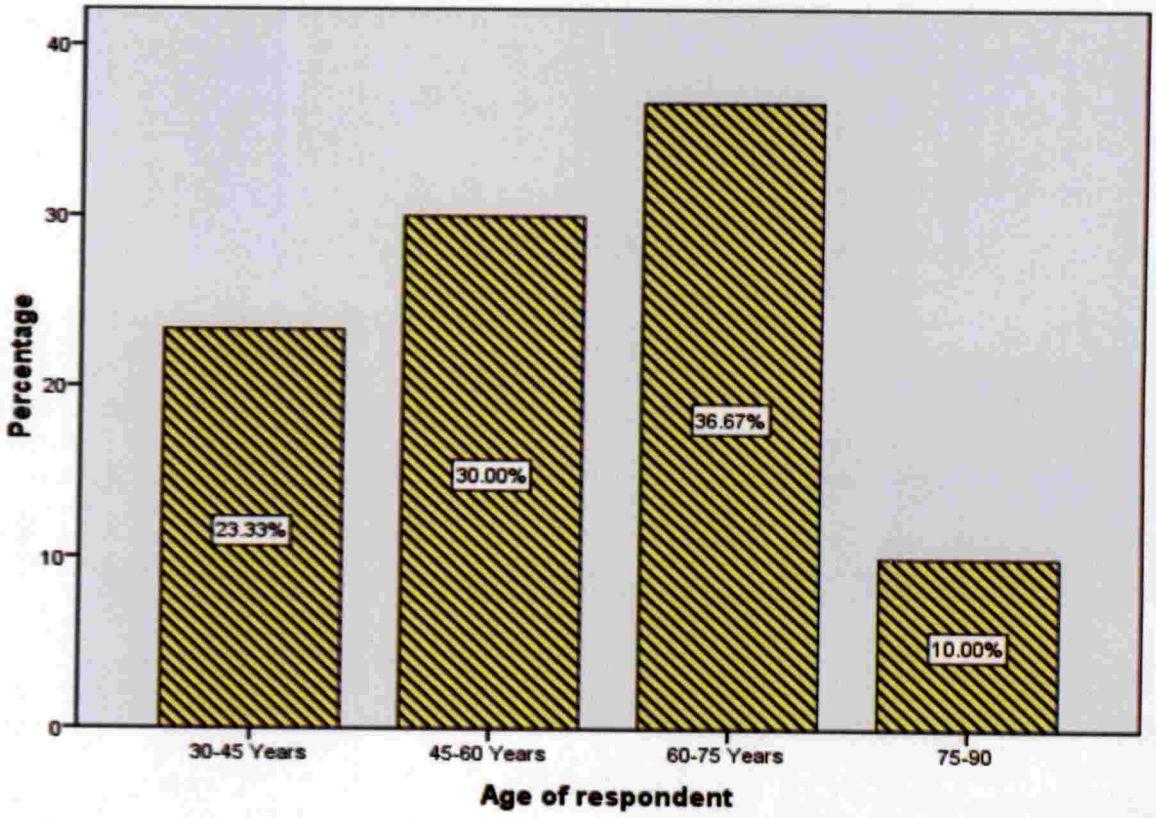


**Figure 24: Age of respondents.**

#### 4.4.2.1 Attitude towards wildlife/vulture

Most of the respondents (83.3%) felt that vulture should be conserved for the future generation like all other species and has equal right to live as human do. Most of the respondents (70%) are not satisfied with the conservation policies and most of the respondents (63.4%) felt that the life of a wild animal is valuable than the human life according to officials and government.

**Table 15: Attitude towards wildlife/vulture**

| Attitude towards wildlife/vultures | Strongly Agree | | Agree | | Neutral | | Disagree | |
|---|---|---|---|---|---|---|---|---|
| | f | % | f | % | f | % | f | % |
| Conservation of vultures for the future | 7 | 23.3 | 18 | 60 | 3 | 10 | 2 | 6.7 |
| Vulture's right to live as humans do | 4 | 13.3 | 21 | 70 | 2 | 6.7 | 3 | 10 |
| Conservation policies of the Government | 8 | 26.7 | 13 | 43.3 | 6 | 20 | 3 | 10 |
| Wildlife is getting more priority than human | 6 | 20 | 11 | 36.7 | 8 | 26.7 | 5 | 16.6 |

Here, f = frequency; %= percentage

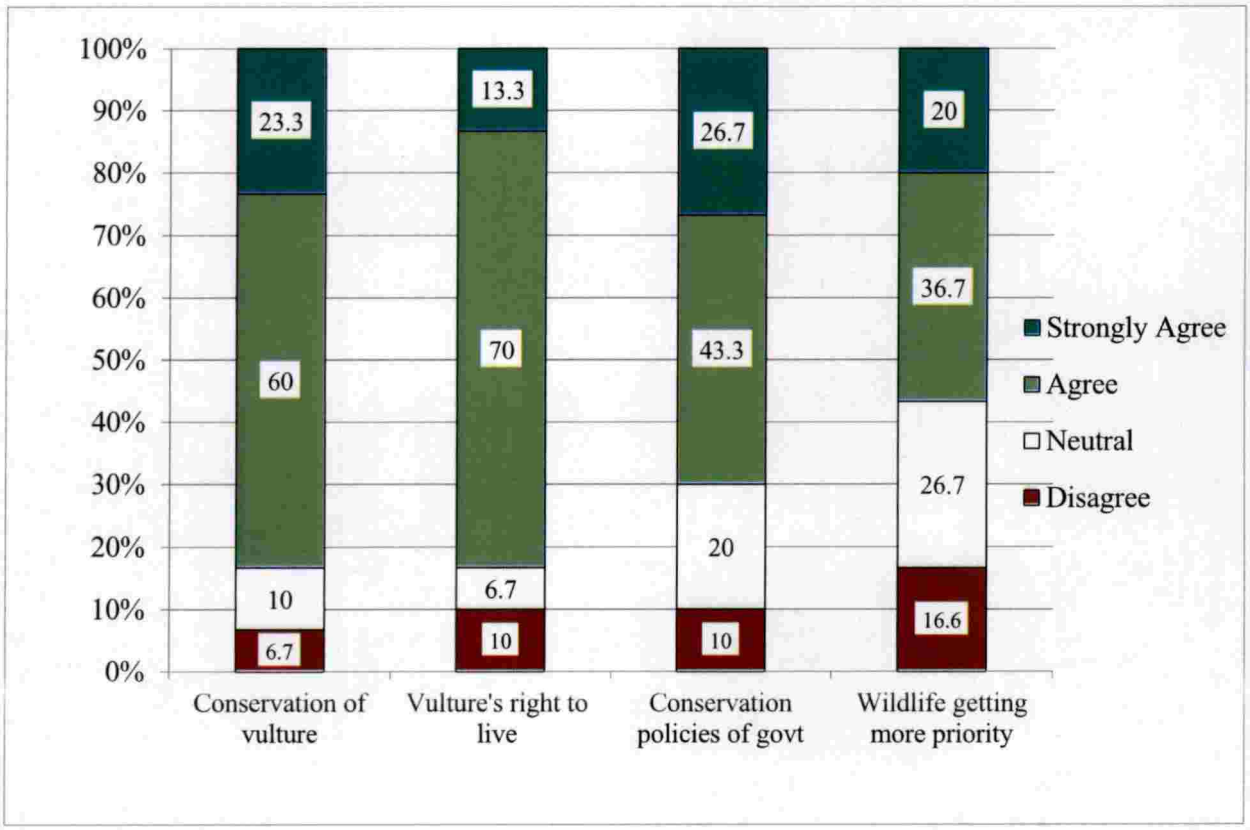


**Figure 25: Attitude towards wildlife/vulture**

#### 4.4.2.2 Awareness about forest and related biodiversity laws

Majority of the respondents don't have much knowledge about the forest related laws and rules and the Wildlife Protection Act, 1972 and about hunting. Also, Most of the respondents (96.7%) are not aware about the diclofenac and its impact on vulture population.

**Table 16: Awareness about forest and related biodiversity laws**

| Awareness about | Reasonably aware | | Somewhat aware | | Non-aware | |
|---|---|---|---|---|---|---|
| | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage |
| Forest related laws and rules | 2 | 6.7 | 7 | 20 | 21 | 73.3 |
| Wildlife Protection Act, 1972 and hunting | 1 | 3.3 | 2 | 6.7 | 27 | 90 |
| Diclofenac and its impact on vultures | 0 | 0 | 2 | 6.7 | 28 | 93.3 |

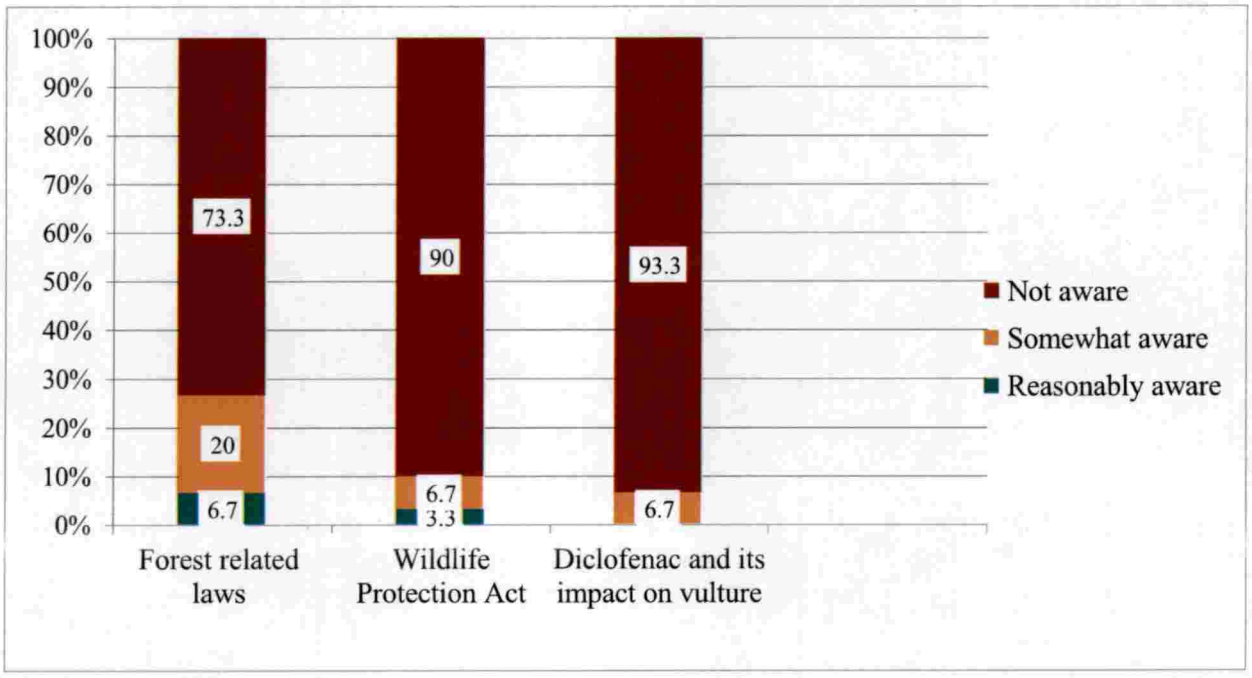


**Figure 26: Awareness about forest and related biodiversity laws**

Unfortunatey, majority of the respondents (90%) were not able to identify vulture species.

**Table 17: Statistics on the respondents ability to identify vulture species**

| | Frequency | Percent |
|---|---|---|
| Able | 3 | 10.0 |
| Unable | 27 | 90.0 |
| Total | 30 | 100.0 |

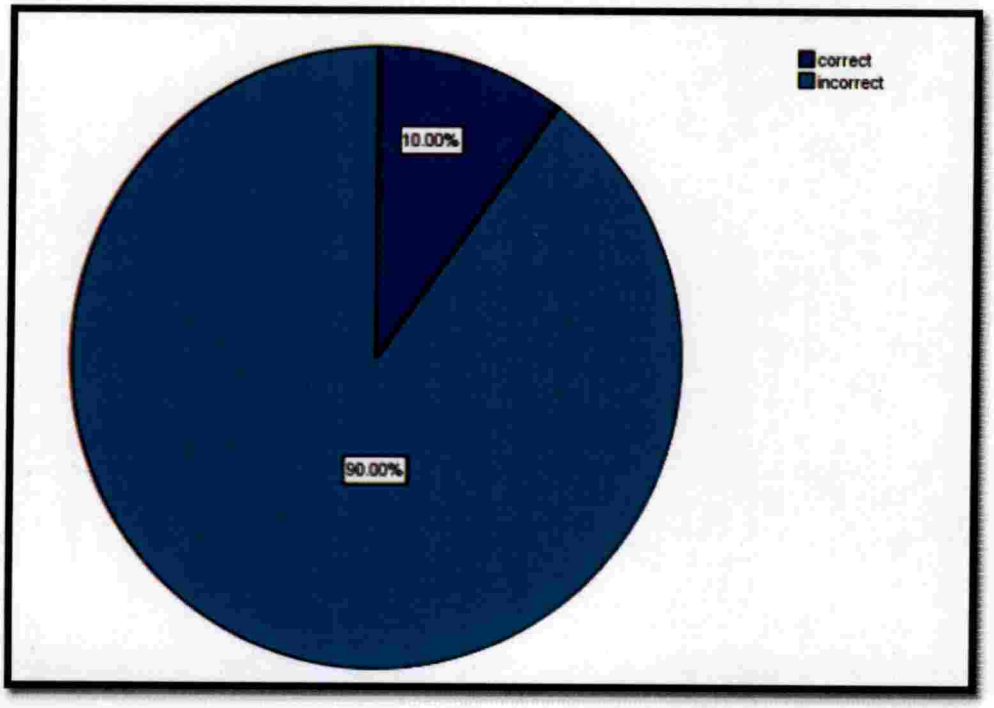


**Figure 27: Statistics on the respondents ability to identify vulture species**

#### 4.4.2.3 Cultural/ritualistic link with vulture by the community

All of the respondents strongly believe that the people residing near the Wayanad Wildlife Sanctuary doesn't have any cultural/ritualistic link with vulture.

**Table 18: Statistics on the respondents cultural/ritualistic link with vulture**

| | Frequency | Percent |
|---|---|---|
| No | 30 | 100.0 |

#### 4.4.2.4 Livestock Population and details

##### 4.4.2.4.1 Number of livestock

Most of the colonies (36.67%) have 20-50 live stocks per colony and about 20% of colonies even have more than 80 cows . But they are harmless to vultures in the sanctuary as long as the live stocks are not left behind the forest and buried properly.

**Table 19: No: of livestock in colonies near the sanctuary**

| | Frequency | Percent |
|---|---|---|
| 1-20 | 4 | 13.3 |
| 20-50 | 11 | 36.7 |
| 50-80 | 9 | 30.0 |
| More than 80 | 6 | 20.0 |
| Total | 30 | 100.0 |

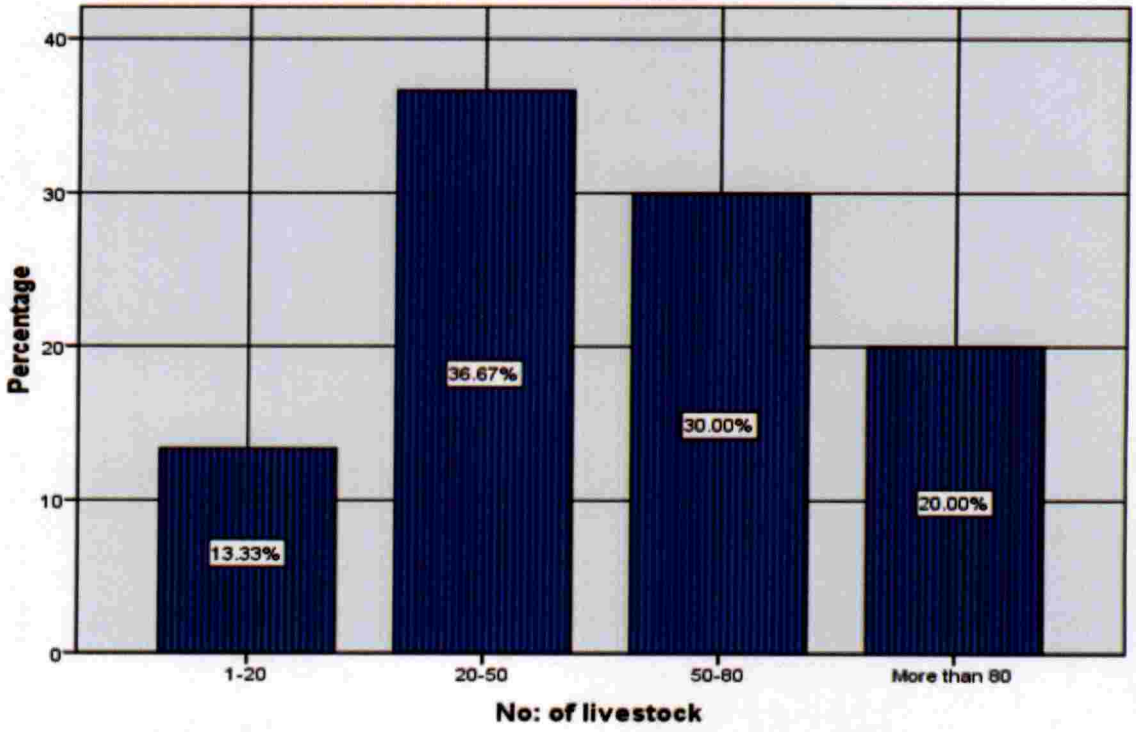


**Figure 28: No. of livestock in the colonies near the sanctuary**

#### 4.4.2.4.2 Usage of dead livestock

According to 96.67% of the respondents, livestock are being buried. This is a good practice as it will reduce the risk of consumption of live stocks by Vulture.

**Table 20: Usage of dead livestock**

| | | |
|---|---|---|
| Buried | 29 | 96.7 |
| Used as food | 1 | 3.3 |
| Total | 30 | 100.0 |

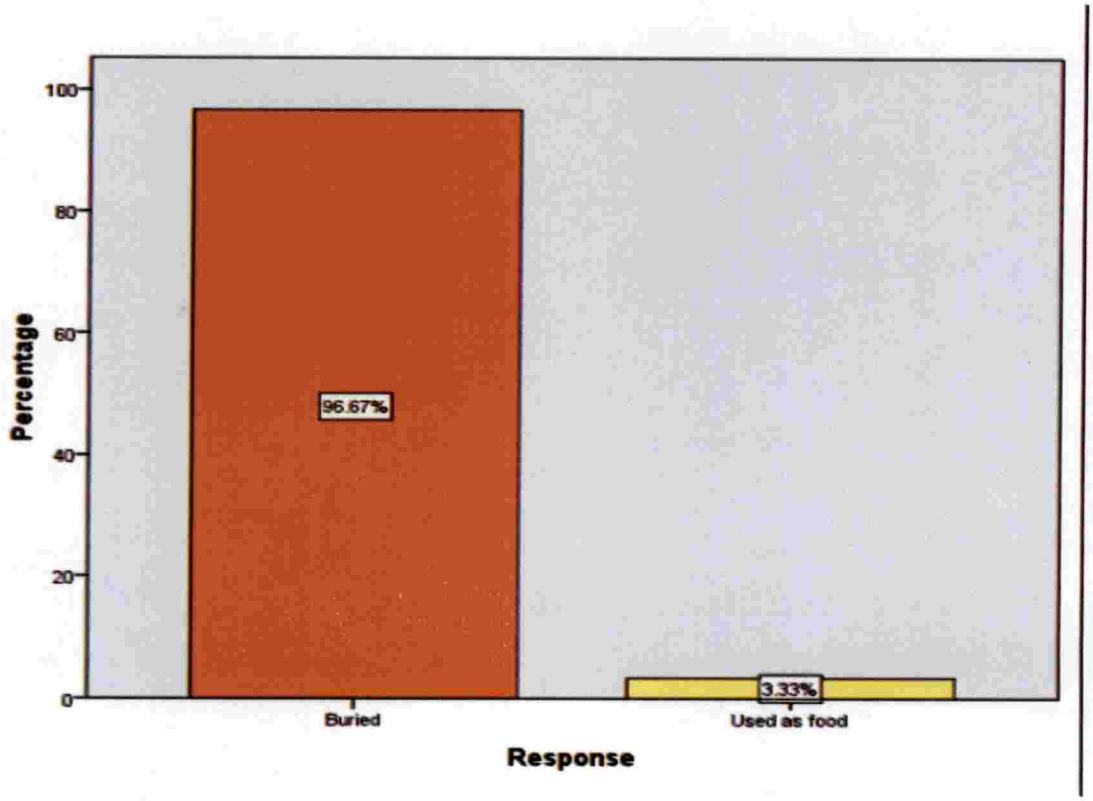


**Figure 29: Usage of dead livestocks**

#### 4.4.2.4.3 Veterinary usage of Diclofenac

Most of the respondents (66.67%) didn't responed to the statement. This shows that they are not aware of NSAID Diclofenac and how it declined the Vulture population in India.

**Table 21: Response about the veterinary usage of Diclofenac**

| | Frequency | Percent |
|---|---|---|
| No Response | 20 | 66.7 |
| Useful | 3 | 10.0 |
| Harmful | 7 | 23.3 |
| Total | 30 | 100.0 |

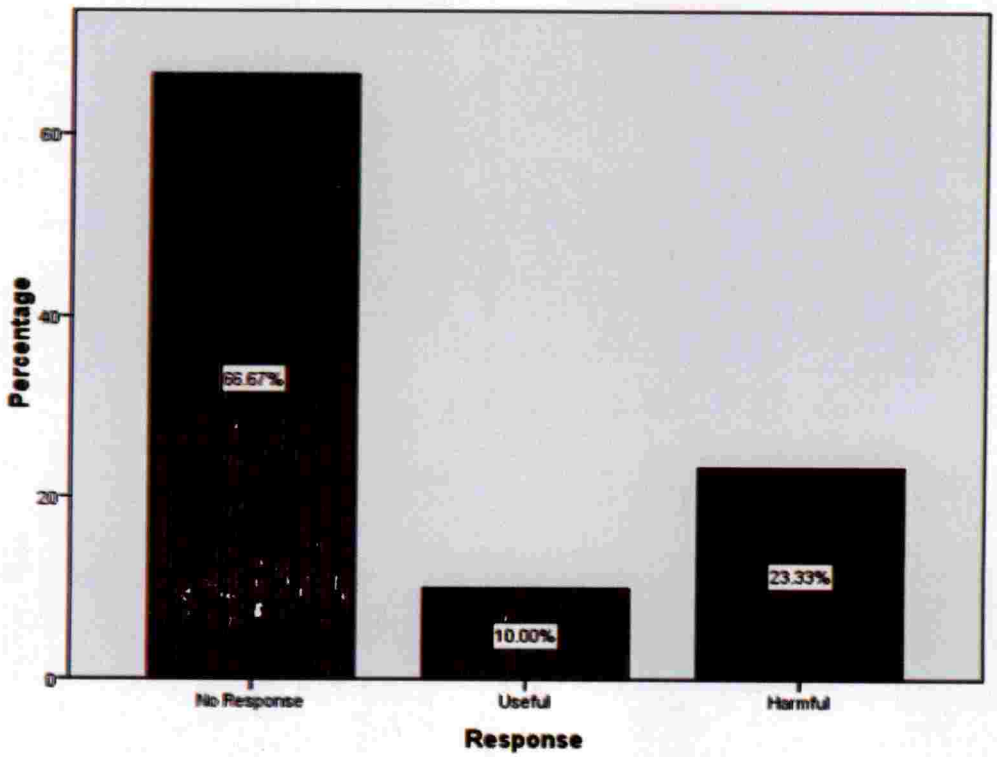


**Figure 30: Response about the usage of Diclofenac**

#### 4.4.2.4.4 Trends in the price of veterinary medicine

56.67% of the respondents said that the price of veterinary medicines remained constant and 26.67% of the respondents said that the price has decreased. This clearly indicates that the ban of NSAID Diclofenac didn't affect the price of veterinary medicines in the market

**Table 22: Trends in the price of veterinary medicine over the past years**

| | Frequency | Percent |
|---|---|---|
| No: response | 17 | 56.7 |
| Increased | 5 | 16.7 |
| Decreased | 8 | 26.7 |
| Total | 30 | 100.0 |

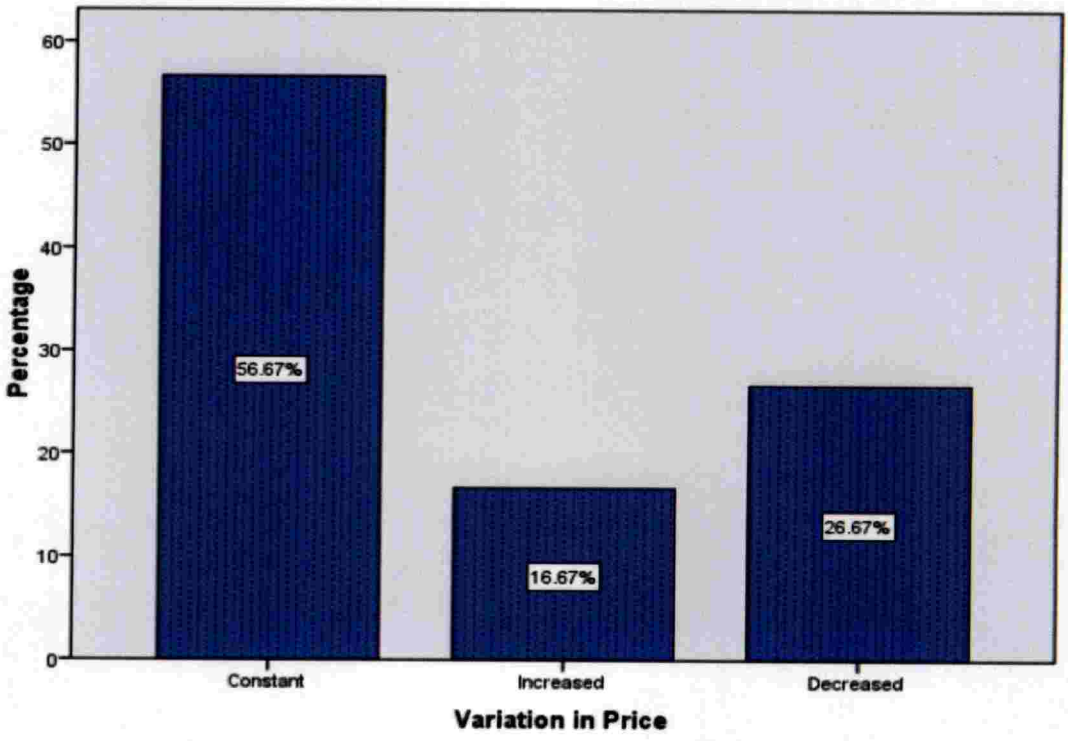


**Figure 31: Trends in the price of veterinary medicines over the past years**

**Plate 29: Interview schedule in tribal colony, SulthanBathery**

**Plate 30: Interview in Kurichiat colony, Kurichiyat Range**

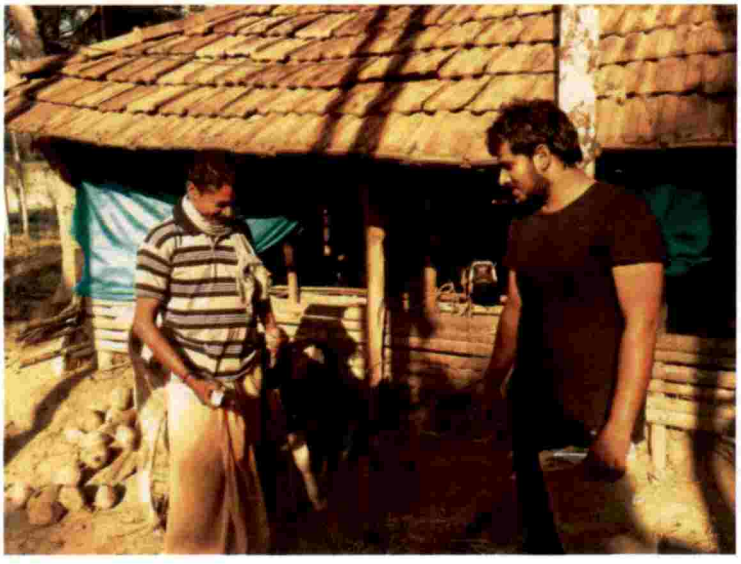

**Plate 31: Interview with local livestock owner near the sanctuary.**

**Plate 32: Cattles owned by tribal people grazing at Eravan Vayal near Muthanga range, Wayanad Wildlife Sanctuary.**

### 4.4.3 Profile details of Veterinary doctors and medical shop owners

Majority of the respondants belonged to the age class 30-45years (60%) and 45-60 years (30%).

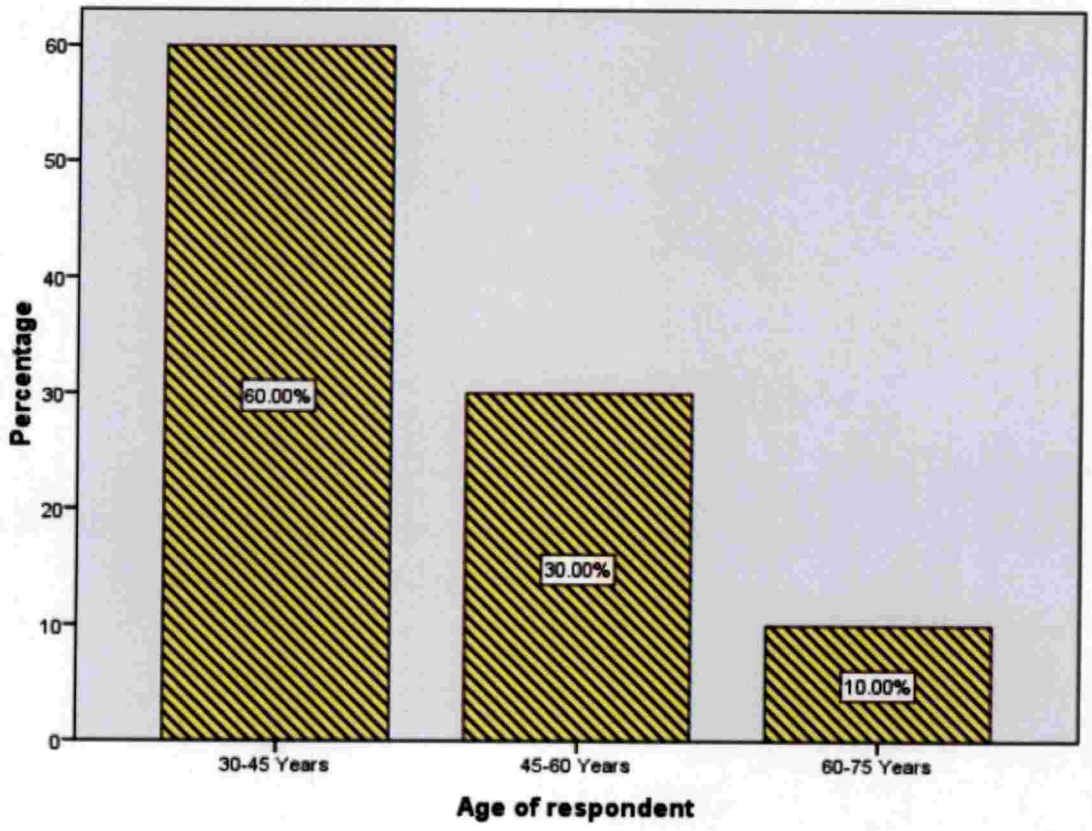


**Figure 32: Age of respondents**

The survey was conducted among the vets and medical shop owners of Wayanad, Gudallur in Tamil Nadu and Gundelpet in Karnataka. Unlike Wayanad, Gudallur and Gundalpet are highly populated with livestock and their carcasses are not properly disposed of.

Another most dangerous drug for vulture 'Ketoprofen' was readily available in the market and some vets even informed the drug is one of the most recommended drugs by them. The presence of this kind of a drug in the market can be a threat to vultures. Even though the vultures are wild species and not seen outside the sanctuary, there are chances of encountering carcasses of live stocks which are not properly buried near the sanctuary. Ketoprofen which is proved to be of

the same effect as Diclofenac should also be banned and have to take strict control of other NSAID's for treating livestock near the sanctuary.

**Table 23: Availability of NSAID's in the medical shops and veterinary hospitals near sanctuary**

| NSAID's | Available | | Not available | |
|---|---|---|---|---|
| | f | % | f | % |
| Ketoprofen | 11 | 36.6 | 19 | 63.4 |
| Aceclofenac | 5 | 16.6 | 25 | 83.4 |
| Carprofen | 10 | 33.3 | 20 | 66.7 |
| Flunixin | 20 | 66.7 | 10 | 33.3 |
| Nimesulide | 17 | 56.6 | 13 | 43.3 |
| Piroxicam | 8 | 26.6 | 22 | 73.3 |
| Ibuprofen | 6 | 20 | 24 | 80 |
| Analgin | 7 | 23.3 | 23 | 76.7 |
| Neproxen | 8 | 26.6 | 22 | 22 |
| Aspirin | 0 | 0 | 30 | 100 |
| Melfenamic acid | 12 | 40 | 18 | 60 |
| Tolfenamic acid | 17 | 56.6 | 13 | 43.3 |
| Phenyl-butazone | 14 | 46.7 | 16 | 53.3 |
| Meloxicam | 30 | 100 | 0 | 0 |

Here, f = frequency; %= percentage

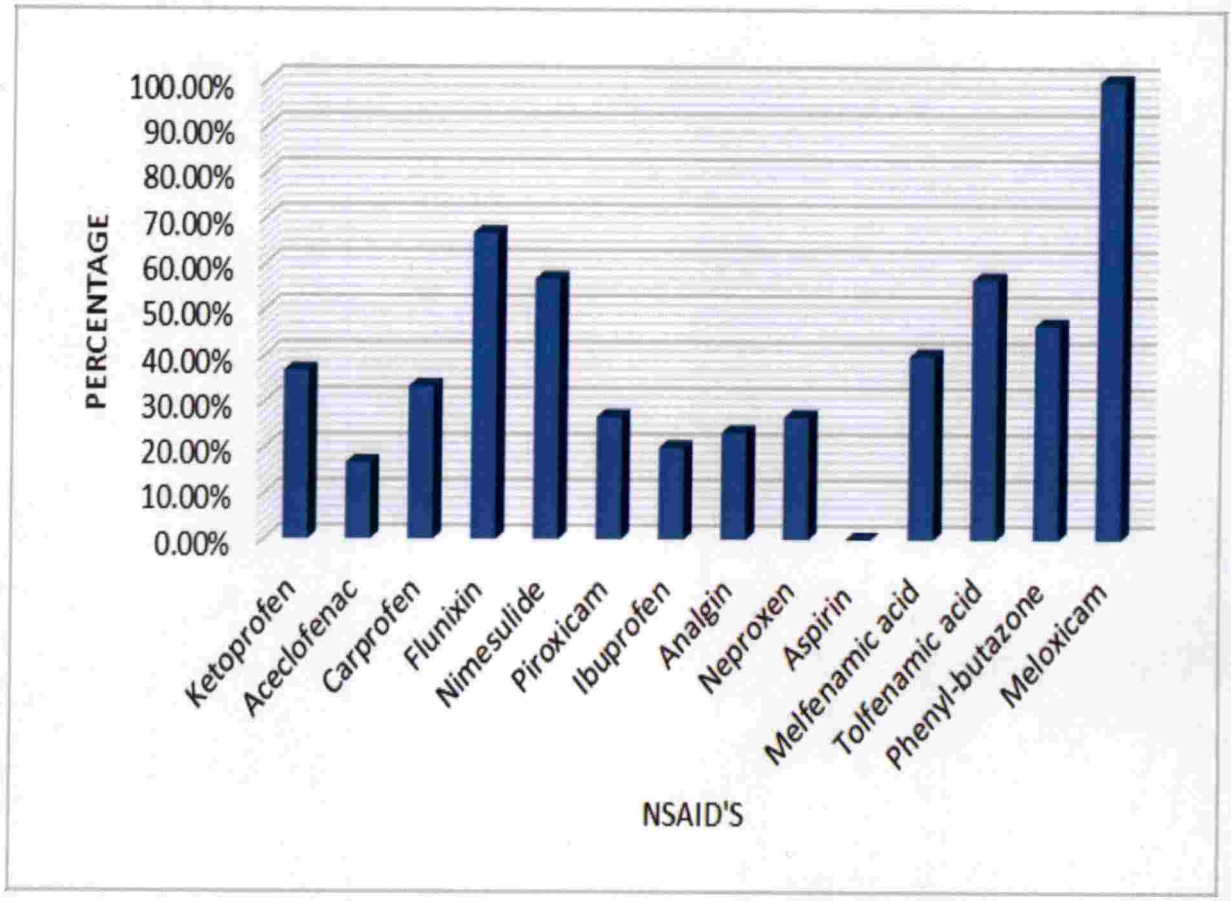


**Figure 33: Availability of NSAID's in the medical shops and veterinary hospitals near sanctuary**


**Plate 33: Interview with Dr. K Assainar, Noolpuzha veterinary dispensary**

**Plate 34: Interview with Dr. Madesh S, Veterinary Officer, Gundalpet**

**Plate 35: Survey at medical shop, Meenangadi**

**Plate 36: Survey at medical shop, Gundalpett, Karnataka**

# *Discussion*

# DISCUSSION

## 5.1 Diversity of White-rumped Vulture of Wayanad Wildlife Sanctuary

The present study revealed the presence of 3 species of vultures in Wayanad Wildlife Sanctuary. Nesting habitat characterization was done taking 10 m radius plot near to the nesting sites. A total of 2016 camera trap hours were carried out in the feeding site for the present study. Apart from this, a questionnaire survey was also carried out in order to supplement the field data including medical surveys which reveals the use of NSAID's in and around the sanctuary.

An estimated population of about 250-300 individuals of vultures were recorded from the sanctuary. But vultures are rare species in the sanctuary. These scavenger birds play a major role in cleaning up and control spreading of diseases in the sanctuary. Three species of vultures belonging to 2 different Genus were recorded.

## 5.2 Family Accipitridae

Old World Vultures belong to this family and are recorded in Europe, Asia and Africa, and they usually spot carcasses exclusively by sight. In the present study 3 of the species in the Accipitridae family was recorded. They are *Gyps bengalensis*, *Gyps indicus* and *Sarcogyps calvus*.

### 5.2.1 White-rumped Vulture

This species belongs to the genus Gyps. About 75-85 cm long, it is a heavy, dirty, blackish brown bird, with long naked neck, and head. In overhead flight, a broad whitish band stretching along the underside of the wings, interrupted by the contrastingly dark coloured body, is diagnostic. Sub-adult birds are chocolate brown without the white back or under wing bands. Sexes are alike. White-rumped vultures are critically endangered (CR) on the IUCN Red List and listed in Appendix 2 of CITES.

The present study got 24 camera trap images, 14 direct sightings from feeding ground and 11 opportunistic sightings of White-rumped Vulture were recorded during the study period. All individuals were recorded in the natural forest.

### 5.2.2Red-headed Vulture

The red-headed vulture is about 85 cm long, blackish in colour, with deep yellowish red naked head, neck and legs. The neck is flanked by 2 broad red folds of skin known as lappets. When airborne, the whitish band on the underside of the wings is prominent as are also the white patches on the upper thighs and the base of the neck. Males and females are similar, except for the eyes, which, in the male are white or yellowish, and dark in the female. Juveniles have dark eyes and more mottled dark brown plumage.

In the record submitted to Forest Department by Deepakumar Narayana Kurup, there were no reports of Red-headed vulture breeding in Wayanad and it was believed that White-rumped Vulture is the only vulture species breeding in Wayanad WLS. In the present study, there are records of breeding sites of Red-headed Vulture. The present study got 9 camera trap images, 8 direct sightings from feeding ground and 1 opportunistic sighting of the Red-headed Vulture. All individuals were recorded in the natural forest.

### 5.2.3 Indian Vulture

Perched adults have pale-yellowish bill and cere; pale eyerings; large white neck-ruff; and buff back and upperwing coverts. The stout blackish neck has pale down. Juveniles have dark bill with pale culmen; pinkish head and neck covered in pale down and dingy heavily streaked underparts. In-flight thighs are heavily feathered and concolourous with the rest of the underparts.

The present study got 9 camera trap images and 6 direct sightings from feeding ground Indian Vulture were recorded during the study period. All individuals were recorded in the natural forest.

### 5.3 Habitat preference of White-rumped vultures for nesting in the sanctuary

For defining the habitat chosen by vultures, a total of 44 plots were taken in which each of them are of 10 m radius located in the 5 vulture colonies which is located in different locations inside the sanctuary. In these 44 plots, the most dominant family is Combretaceae family and has an IVI of 61, followed by Fabaceae family (IVI-60.46), Rubiaceae (35.9), Lamiaceae (27.14), and Lythraceae (24.74). *Terminalia elliptica* has the highest IVI of 62.47, followed by *Haldina cordifolia* (49.03), *Tectona grandis* (31.22), *Lagerstroemia lanceolata* (26.35) and *Anogeissus latifolia* (26.11).

A total 4 active nest were recorded during the study. Of which 3 nests belongs to *Gyps bengalensis* and the other one nest belongs to *Sarcogyps calvus*. These 4 active nests are seen in the tree species *Haldina cordifolia* which has an IVI of 49.03. Old tree nests were found in the tree species such as *Haldina cordifolia* (IVI-49.03), *Tectona grandis* (IVI-31.22), *Terminalia elliptica* (IVI-62.47), *Stereospermum chelonoides* (IVI-9.94), *Lagerstroemia lanceolata* (IVI-19.69) and *Dalbergia latifolia* (IVI-15.45). The results shows that the nesting of vultures is more related with the tree species having more IVI value in that area. This year, vulture nests are fully associated with the tree species *Haldina cordifolia*. 78% of the *Haldina cordifolia* belongs to girth class >285cm.

Most of the nesting trees were at a height of 25-35 m and girth >300 cm. The average canopy cover in the nesting area is 65%. The study reveals that the old nests and active nests of vultures are present in the trees which have large girth size. 4 active nests is present in 4 trees of species *Haldina cordifolia*, which has girth size of 350cm, 376cm, 285cm and 322cm. Old nest trees such as *Haldina cordifolia (*453cm, 492cm*)*, *Tectona grandis* (258cm), *Terminalia elliptica* (315cm, 390cm), *Stereospermum chelonoides* (329cm), *Lagerstroemia lanceolata* (360cm) and *Dalbergia latifolia* (225cm) also has large girth size. This implies that old and large trees influence the nesting of vultures.

Also the results from Man-Whitney U test indicates that the nesting preference of Vultures is influenced by species density, tree girth and tree height. Thus from the conservation point of view, regeneration of trees is essential and prevention and control of forest fire also matters. It has less to do with canopy cover and tree density. Near all the nesting plots there was presence of Eupatorium. So ground growth can also be a factor for their site selection. All the nests has a proximity to water within 3 km

### 5.4 Carcass dumping sites and feeding of Vultures in the sanctuary

Feeding observations were made on seven carcass dumped on the supplimentory feeding site Kakkapadam, Muthanga range. Vultures on the 7 carcasses monitored using camera trap mostly feed between 7-8 in the morning hours, 12-13 in the afternoon hours and 17-18 in the evening hours.

Vulture population of Wayanad Wildlife Sanctuary only gets a chance to feed on wild carcasses. Carcasses of domestic cattle are being properly buried. So there is less threat of NSAID's in the sanctuary. But NSAID use in the Karnataka and Tamil Nadu region is high because of the high population and mismanagement of cattle and this causes a severe threat to vulture population of the sanctuary.

As vultures have high foraging range they can move to different locations and come from different locations. So, availability of food is an important factor which influences the population of Vultures in the sanctuary. The availability of safe food for Vultures has increased in the sanctuary as we have supplementary feeding sites in Wayanad WLS in which most of the road kills are left in these feeding sites to feed vultures. This can affect the foraging range of Vultures and other predators on the vulture supplementary sites. Although it can help in increasing the population of Vultures, it will not do any long-term benefits to them.

The Vulture feeding site at Kakkapadam and other sites in Wayanad need to be re-examined. The reason for starting a vulture feed supplement area within natural forest is unknown. Was this been based on any study done on the food availability of the vultures? Is there a shortage of natural food for the vultures that warranted such an action? Why should one move the carcass from any location of its origin to the carcass dumping yards? Why can't it be left at the same site where the mortality of the animal occurred?

The effect of artificial feeding sites in the movement of large carnivores like Tigers to the fringe area/human habitation, has anyone thought about it? These questions need satisfactory answers before one should think of continuing the vulture artificial feeding sites.

### 5.5 The threats to Vultures of Wayanad WLS

Vultures mostly nests in *Haldina cardifolia.* Looking into the regeneration of that species, it is very low. Most of them are old trees and are prone to forest fire. So taking fire lines is important.

Interview with NGO's reveals that threats at breeding site from other predators like Black Eagle can affect the breeding success of vulture nests. Attack from the Black Eagle had killed a chick of White-rumped Vulture from the previous year nest at Ayyappanpara. This year there were

no nests of vultures in that area. This can be the reason for the absence of nest by vultures from that area. However, there is not much threat from humans at the breeding sites, because these breeding sites are situated at the interior portion of the forest and also vulture nests which are built in large trees are safe and well protected by vultures.

Interview with local and tribal people in and around the sanctuary indicates that there are no culturalistic links between tribes. Also there is no specific local demand for vulture parts in the Indian market as that of Africa. So, there are no threats from poachers in the sanctuary as there are no cases reported so far.

Some respondents supposed that banned and harmful NSAID's being used to treat livestock in and around Wayanad Wildlife Sanctuary. They also responded diclofenac which is authorized to human use are also misused by some medical practitioners to treat livestock because of its cheap rate and effectiveness. This is something that is quite alarming and need to be further investigated and curbed completely to ensure the long term survival of the vultures at Wayanad landscape.

Vulture restaurants are concentrated on specific locations (Kakkapadam, Muthanga and other carcass dumping grounds) and so this limits their foraging range which indirectly effects its natural behavior. Also, the tourist intrusions and jeep safari in Kakkapadam region shows the inappropriate management of vulture restaurants.

Medical survey shows the usage of one the most unsafe drug for vultures 'Ketoprofen' was readily available in the market and some vets even informed the drug is one of the most recommended drugs by them. The presence of this kind of drugs in the market is dangerous to vultures. Even though the vultures are wild species and not seen outside the sanctuary, there are chances of encountering carcasses of live stocks which are not properly buried near the sanctuary. Ketoprofen which is proved to be of the same effect as diclofenac should also be banned and have to take strict control of other NSAID's for treating live stocks near the sanctuary. Also the usage of other NSAID's should be strictly controlled to treat live stocks which are using the sanctuary for grazing.

Also, some vets informed that Diclofenac was not the only reason for the decline of Vulture. Some suspect that the reason for the decline of Vulture can be also due to pesticides such as benzene hexachloride, DDT (before ban) and other organophosphorus compounds for crop

production in the cultivated area and extensive usage of glyphosate marketed in the name of Roundup or Glycil. According to them the pesticides and herbicides drained through water flow act as a killing agent to the wild animals including vultures. According to them vultures drinking this water can affect its egg production.

No cases were reported in the sanctuary so far in relation with vultures. This indicates that there are no direct threats from humans to vultures in the sanctuary.

From the information by a local from Gundalpett, that vulture presence was there in the Karadimunda, a waste dumping ground near Gundalpett, Karnataka. He also told us that dead carcasses of livestock are being dumped in this area. I have inspected the place. But didn't find any vultures. But there were presence of other members in the family Accipitridae such as Brahminy kite and Parah kite. Also found a dead brahminy kite. After close observations, I have merely found any injuries in the body of the brahminy kite. Most probably it had died due to the consumption of chicken wastes in the dumping ground.

When further moved on inspecting the dumping grounds I have found a small hut where a dead cow was being butchered. It is a cow which was dead due to some disease. I suspect that this was the reason why there are no vultures in the area. They will process it and pack them to some of the food industries in Mysore. All the carcasses dumped here have new dealers and awaits a new market. Vultures are safe as there are no carcasses left in that area even though the humans are not.

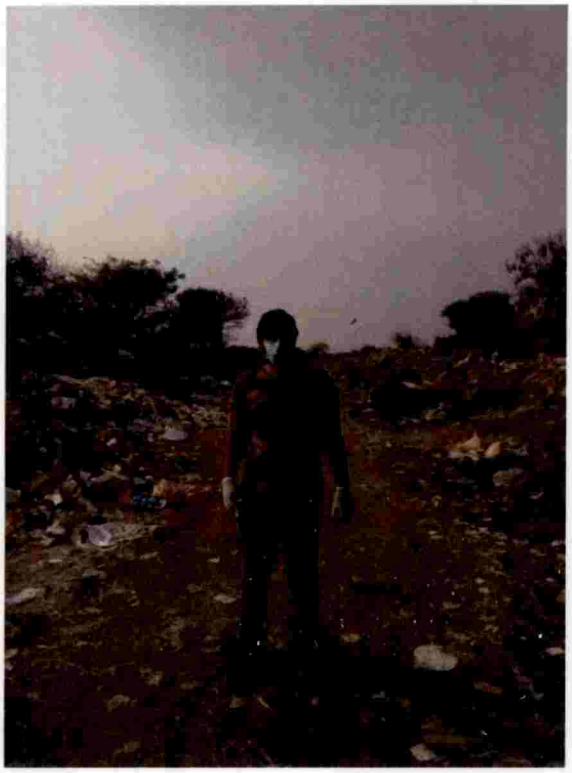

**Plate 37: Inspecting the waste dumping ground, Karadimunda, Gundalpett**

**Plate 38: Observing dead carcass of Brahmini Kite found in Karadimunda, Gundalpet.**

**Plate 39: Processing the dead cow to sell in the market**

**Plate 40: Drying site of the processed meet of the livestock.**

### 5.6 Constrains for the present vulture study in the sanctuary

While observing the feeding sites initially installed only one camera trap in the feeding ground. But the result was not good enough as it only covered a small portion as it was an open area. So, only three cameras at a point in three directions were installed. It gave better results.

Most of the nesting colonies of Vultures were in the state borders which are the parts of Bandipur Tiger Reserve and Nagarhole National Park. So searching for more nests was not possible in these colonies because of the restricted study area.

### 5.7 Suggestions for conservation of vultures

Most of the nesting colony's where in the exact boarders of the sanctuary. So we can't cover throughout the entire area of the colony for vultures. That was the case in 3 of the nesting sites Doddadi, Kaithallam and Karamukku. So for any future study of nesting in Wayanad WLS, joint efforts should be taken from Kerala Forest Department and Karnataka Forest Department for the intensive protection and monitoring of the nesting sites

Waste dumping sites like Karadimunda situated near mysore-kozikode highway, should be closed and wastes in this area should be scientifically disposed as this place is only 6 km from the Bandipur tiger reserve and there is a chance of encounter of dumped carcass of live stocks by Vultures. Fire lines should be taken regularly to protect large trees from fire near Vulture colonies to increase the possibility of nesting in the sanctuary.

Vulture in Nagarhole National Park, Bandipur Tiger Reserve and Mudhumalai Tiger Reserve are almost the same population as we see in Wayanad Wildlife Sanctuary. So they should be jointly managed and studied under same long-term projects for better conservation. Vulture restaurants have to be scientifically managed as they are highly concentrated to specific areas. This can influence the foraging range of Vultures as well as the behavior of other predators including Tiger.

Tourists should be strictly prohibited to visit during the feeding of vultures particularly in the vulture feeding ground at Kakkapadam, Muthanga range.

54% of the previous and current year nests belonged to *Haldina cordifolia.* But the regeneration is very low for this species and need special attention to conserve them.

More awareness should be given to the local and tribal people regarding diclofenac and its harmful effects and make sure that the dead livestocks are not left behind the forest as such. Harmful NSAID's like Ketoprofen should be banned from the medical shops in Wayanad and strictly avoid the usage of harmful NSAID's to treat live stocks in and around the sanctuary.

# *Summary*

## SUMMARY

Vultures are one of the least explored taxa and do not have a comprehensive inventory. Very few information is available about the ecology, behaviour, habits, taxonomy, conservation threats etc. of the vultures. In Kerala, only very few studies are done in the case of vultures. The objectives of the study were to understand the status, nesting habitat characterization and feeding observations of White-rumped Vulture (*Gyps bengalensis)* of Wayanad Wildlife Sanctuary. The conservation challenges of the vultures of Wayanad Wildlife Sanctuary were also studied.

To determine the population of Gyps sp., the methods applied includes direct sightings, feeding ground and nest observations and camera trap survey. Also, observations were made from watchtowers in the sanctuary. A total of 84 camera-trap days with 2016 trapping hours were carried out in the Wayanad WLS. Microhabitat parameters were measured and floristic diversity was estimated for the nest identification and habitat characterization of vultures. The interview was conducted in 3 sections. It includes NGO's and other stakeholders including forest officials, local and tribal People, Veterinary doctors and medical shops. The salient findings are summarized below.

1. All the 3 resident species of vultures were recorded: White-rumped Vulture (*Gyps bengalensis),* Indian Vulture *(Gyps indicus),* and Red-headed Vulture *(Sarcogyps calvus).*
2. An estimated encounters of about 250-300 vultures are recorded from the sanctuary. As their foraging range is very high, seasonal variation and availability of food are some of the factors that affect their population. Three species of vultures were identified; *Gyps bengalensis, Gyps indicus*, and *Sarcogyps calvus.*
3. Nests of vulture in Wayanad WLS are decreasing yearly. Only four active nests were identified in 2017-2018 nesting season of which three nests belongs to *Gyps bengalensis* and one nest is of *Sarcogyps calvus.*
4. Thirty species of trees were identified belonging to 17 different families from the 44 circular plots surveyed in the nesting colony of Wayanad Wildlife Sanctuary.
5. The species-wise Important Value Index has been maximum in *Terminalia elliptica* (62.47) followed by for *Haldina cordifolia* (49.03) and *Tectona grandis* (31.22).

6. The Simpson's diversity index of the nesting site is 0.91 and the Shannon diversity index comes to 1.1. The Simpson's index of the non-nesting site is 0.89 and Shannon diversity index is 1.12.
7. Active and old nests were found in 6 tree species in the nesting colony. Out of the six, only *Haldina cordifolia* have active nests and the other tree species are; *Tectona grandis, Stereospermum chelonoides, Dalbergia latifolia, Lagerstroemia lanceolata* and *Terminalia elliptica*.
8. 54% of the previous and current year nests belonged to *Haldina cordifolia.* But the regeneration is very low for this species and need special attention to conserve them.
9. 4 out of 4 nestings were found in 2 different locations in Kurichiyad range. Kazukankolli is an important nesting area of *Gyps bengalensis.* 3 out of 4 active nests in this year are present in this area.
10. 1 out of 4 active nests belongs to *Sarcogyps calvus*, which was found in Karamukku, Kurichiyad. It is the 1st report of nesting of this species in the sanctuary.
11. Most of the nesting trees are having height between 25-35 m and girth more than 300 cm. Mostly heights of the nests are in between 23 m – 26 m of the nesting trees.
12. The average canopy cover in the nesting area is 65%.
13. The vegetation parameters that influence the nesting habitat of vultures are the girth of the tree, height of the tree and the tree species diversity in the area.
14. The overall success rate of camera traps in case of vultures in Wayanad WLS is 34.09% (295 images of vultures from 84 camera trap days), recording 3 species of vultures.
15. The high success rate is present only because it is a dumping ground of carcass. All the carcasses observed belongs to Spotted deer and Sambar deer which were dead due to road kills.
16. Vultures on the 7 carcasses monitored using camera trap mostly feed between 7-8 in the morning hours, 12-13 in the afternoon hours and 17-18 in the evening hours.
17. Other species recorded from Kakkapadam includes Spotted deer, Indian peafowl, Elephant, Wild boar, Sambar deer, Black-naped hare, Tiger, Indian Crested Porcupine, Stripe-necked mongoose, Wild Dog, Jungle Crow, Common Myna, Bee-eater sps, and Gaur.
18. Interview depicts that tribals and local people are not much aware about vultures and their importance.

19. The use of the veterinary diclofenac was nil at Wayanad district.
20. However, some of the medical practitioners were found using the human diclofenac for treating livestock at Wayanad.
21. The survey conducted among the veterinarians and the medical shops it was found that the harmful NSAID's such as Ketoprofen are being used to treat livestock, which could be a problem for the long-term conservation of the vultures.
22. Waste dumping sites very close to the sanctuary like Karadimunda and Gundalpett are threat to wildlife as well as humans.



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# Status and habitat preferences of White-rumped Vulture (*Gyps bengalensis*) population of Wayanad Wildlife Sanctuary, Kerala

**By**

**VISHNU M (2016-17-004)**

**ABSTRACT**

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**Faculty of Forestry**

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**DEPARTMENT OF WILDLIFE SCIENCES**

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## ABSTRACT

The research work entitled "Status and habitat preferences of White-rumped Vulture (*Gyps bengalensis*) population of Wayanad Wildlife Sanctuary, Kerala" was studied during August 2017 to April 2018. It was carried out in four study locations *viz.*, Kurichiat, Muthanga, Sulthan Bathery and Tholpetty. The main objective of the study was to find out the status, nesting characteristics, feeding observations and interview of various stakeholders.

Three species of vultures included in the family Accipitridae were reported from the current study in Wayanad WLS *viz., Gyps bengalensis, Gyps indicus*, and *Sarcogyps calvus.* Total of 4 active nesting trees were identified from two different colonies this year. All the 4 nest were present in *Haldina cardifolia.* Out of the 4 nests, 3 nests belongs to *Gyps bengalensis* located in Kazukankolli and 1 nest belongs to *Sarcogyps calvus* which was the 1st report of nesting of this species in the sanctuary located in Karamukku, Kurichiyad. Apart from this, 9 nests of the previous years on 6 different tree species were also studied. Other nesting tree species were *Terminalia elliptica, Lagerstroemea microcarpa, Dalbergia latifolia, Stereospermum chelenoides* and *Tectona grandis.*

Thirty species of trees were identified belonging to 17 different families from the 44 circular plots surveyed in the nesting colony of Wayanad Wildlife Sanctuary. Most of the nesting trees are having height between 25 m – 35 m and girth more than 300 cm. Mostly height of the nests are in between 23 m – 26 m of the nesting trees. IVI of the nesting trees are comparatively higher than the other tree species got from the plots. The vegetation parameters that influence the nesting habitat of vultures are the girth of the tree, height of the tree and the tree species diversity in the area.

The camera trapping has been found to be a useful technique for the population estimation of the vultures at the vulture restaurants in Wayanad. The camera trap success rate of vultures observed in Kakkappadam is 34.09%. The high success rate is because it is a dumping ground of carcass. Carcass monitored was of Elephant, Sambar Deer and Spotted deer. The most preferred feeding hours by the vultures were 7-8 hours and 12-13 hours.

From the survey conducted among the veterinarians and the medical shops it was found that the harmful NSAID's such as Ketoprofen are being used to treat livestock, which could be a problem for the long-term conservation of the vultures. The use of the veterinary diclofenac was nil at Wayanad District. However, some of the medical practitioners were found using the human diclofenac for treating livestock.

# *Appendix*

**APPENDIX 1**

| Date | Location | Vulture species | Tree Species | Tree Position | Height (m) | GBH (cm) | Lattitude (N) | Longitude (N) | Nest Height (m) | Canopy cover |
|---|---|---|---|---|---|---|---|---|---|---|
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree | 27 | 350 | 11°46.496' | 076°15.558' | 14 | 62% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Dalbergia latifolia* | Nesting Tree Plot | 17 | 240 | 11°46.496' | 076°15.558' | | 62% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree Plot | 24 | 190 | 11°46.496' | 076°15.558' | | 62% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Cassia fistula* | Nesting Tree Plot | 7.8 | 53 | 11°46.496' | 076°15.558' | | 62% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Nesting Tree Plot | 19 | 140 | 11°46.496' | 076°15.558' | | 62% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Nesting Tree Plot | 24 | 220 | 11°46.496' | 076°15.558' | | 62% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Schleichera oleosa* | Nesting Tree Plot | 25 | 280 | 11°46.496' | 076°15.558' | | 62% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree | 29 | 360 | 11°46.887' , | 076°15.832' | | 76% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Schleichera oleosa* | Nesting Tree Plot | 22 | 155 | 11°46.887' , | 076°15.832' | | 76% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Lannea coromandelica* | Nesting Tree Plot | 5.2 | 390 | 11°46.887' , | 076°15.832' | | 76% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Dalbergia latifolia* | Nesting Tree | 27 | 225 | 11°46.514' | 076°15.544' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree Plot | 25 | 141 | 11°46.514' | 076°15.544' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Cassia fistula* | Nesting Tree Plot | 8 | 152 | 11°46.514' | 076°15.544' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 22 | 130 | 11°46.514' | 076°15.544' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree Plot | 20.7 | 180 | 11°46.514' | 076°15.544' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree Plot | 17.6 | 130 | 11°46.514' | 076°15.544' | | 60% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree | 23 | 180 | 11°46.867' | 076°15.833' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 19 | 166 | 11°46.867' | 076°15.833' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 14 | 110 | 11°46.867' | 076°15.833' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 17 | 127 | 11°46.867' | 076°15.833' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 11 | 82 | 11°46.867' | 076°15.833' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Bombax ceiba* | Center Tree Plot | 14.5 | 114 | 11°46.867' | 076°15.833' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Stereospermum chelonoides* | Center Tree Plot | 15.8 | 119 | 11°46.867' | 076°15.833' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 9 | 38 | 11°46.867' | 076°15.833' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Center Tree | 18.9 | 160 | 11°46.886' | 076°15.857' | | 76% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 20.6 | 170 | 11°46.886' | 076°15.857' | | 76% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Center Tree Plot | 16.2 | 145 | 11°46.886' | 076°15.857' | | 76% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Alstonia scholaris* | Center Tree Plot | 4.5 | 12 | 11°46.886' | 076°15.857' | | 76% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 8.7 | 48 | 11°46.886' | 076°15.857' | | 76% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree | 22.3 | 170 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 18.9 | 154 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 14.5 | 123 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 12.6 | 119 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 24.5 | 160 | 11°46.901' | 076°15.796' | | 75% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Grewia tilifolia* | Center Tree Plot | 21.3 | 165 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 6.3 | 35 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Aegle marmelose* | Center Tree Plot | 7.6 | 44 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 15.9 | 115 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Center Tree Plot | 18.9 | 138 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 25.7 | 166 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 5.5 | 12 | 11°46.901' | 076°15.796' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Center Tree | 17 | 145 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 18 | 139 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 19.5 | 123 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 19.1 | 119 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 22.1 | 141 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 26.5 | 165 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 23.6 | 168 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 14.7 | 99 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 11.1 | 65 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 12.9 | 78 | 11°46.907' | 076°15.812' | | 75% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Dalbergia latifolia* | Center Tree Plot | 13.1 | 97 | 11°46.907' | 076°15.812' | | 75% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree | 22 | 126 | 11°46.781' | 076°15.726' | | 55% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 12.6 | 111 | 11°46.781' | 076°15.726' | | 55% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 11.5 | 105 | 11°46.781' | 076°15.726' | | 55% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Haldina cordifolia* | Center Tree Plot | 12.3 | 81 | 11°46.781' | 076°15.726' | | 55% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 14.5 | 83 | 11°46.781' | 076°15.726' | | 55% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 13 | 94 | 11°46.781' | 076°15.726' | | 55% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Aegle marmelose* | Center Tree Plot | 13.5 | 88 | 11°46.781' | 076°15.726' | | 55% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree | 22 | 168 | 11°46.362' | 076°15.421' | | 65% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 18 | 148 | 11°46.362' | 076°15.421' | | 65% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 19 | 135 | 11°46.362' | 076°15.421' | | 65% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 15 | 103 | 11°46.362' | 076°15.421' | | 65% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 14 | 110 | 11°46.362' | 076°15.421' | | 65% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 16 | 120 | 11°46.362' | 076°15.421' | | 65% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 9.1 | 55 | 11°46.362' | 076°15.421' | | 65% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree | 29 | 376 | 11°46.482' | 076°15.501' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree Plot | 25 | 275 | 11°46.482' | 076°15.501' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree Plot | 22 | 155 | 11°46.482' | 076°15.501' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Tectona grandis* | Nesting Tree Plot | 24 | 130 | 11°46.482' | 076°15.501' | | 58% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 13 | 91 | 11°46.482' | 076°15.501' | | 58% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree | 25 | 285 | 11°46.467' | 076°15.509' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 21 | 180 | 11°46.467' | 076°15.509' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 13 | 110 | 11°46.467' | 076°15.509' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree Plot | 19 | 165 | 11°46.467' | 076°15.509' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Elaeocarpus serratus* | Nesting Tree Plot | 3.9 | 12 | 11°46.467' | 076°15.509' | | 60% |
| 23/10/2017 | Kazhukankolli | *Gyps bengalensis* | *Elaeocarpus serratus* | Nesting Tree Plot | 4.4 | 17 | 11°46.467' | 076°15.509' | | 60% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree | 31 | 492 | 11°44.215' | 76°24.35.8' | 24 | 70% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Anogeissus latifolia* | Nesting Tree Plot | 13 | 108 | 11°44.215' | 76°24.35.8' | | 70% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Pterygota elliptica* | Nesting Tree Plot | 14 | 130 | 11°44.215' | 76°24.35.8' | | 70% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Anogeissus latifolia* | Nesting Tree Plot | 12.5 | 109 | 11°44.215' | 76°24.35.8' | | 70% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Butea monosperma* | Nesting Tree Plot | *9.5* | 75 | 11°44.215' | 76°24.35.8' | | 70% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Butea monosperma* | Nesting Tree Plot | *10.3* | 74 | 11°44.215' | 76°24.35.8' | | 70% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Dalbergia latifolia* | Nesting Tree Plot | 16 | 113 | 11°44.215' | 76°24.35.8' | | 70% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree | *27* | 390 | 11°44.243' | 76°24.409' | | 65% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | *12.1* | 96 | 11°44.243' | 76°24.409' | | 65% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Anogeissus latifolia* | Nesting Tree Plot | *8.8* | 85 | 11°44.243' | 76°24.409' | | 65% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Dalbergia latifolia* | Nesting Tree Plot | 12.9 | 83 | 11°44.243' | 76°24.409' | | 65% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 14.5 | 99 | 11°44.243' | 76°24.409' | | 65% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 9.9 | 69 | 11°44.243' | 76°24.409' | | 65% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Phyllanthus emblica* | Nesting Tree Plot | 5 | 44 | 11°44.243' | 76°24.409' | | 65% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Lagerstroemia reginae* | Nesting Tree Plot | 11 | 83 | 11°44.243' | 76°24.409' | | 65% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree | 32 | 315 | 11°44.210' | 76°24.446' | | 76% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree Plot | 25 | 110 | 11°44.210' | 76°24.446' | | 76% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Phyllanthus emblica* | Nesting Tree Plot | 5.9 | 60 | 11°44.210' | 76°24.446' | | 76% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Olea dioica* | Nesting Tree Plot | 10.3 | 89 | 11°44.210' | 76°24.446' | | 76% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Haldina cordifolia* | Center Tree | 33 | 520 | 11°44.134' | 76°24.432' | | 63% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Haldina cordifolia* | Center Tree Plot | 24 | 277 | 11°44.134' | 76°24.432' | | 63% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Stereospermum chelonoides* | Center Tree Plot | 15 | 119 | 11°44.134' | 76°24.432' | | 63% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Olea dioica* | Center Tree Plot | 7.9 | 58 | 11°44.134' | 76°24.432' | | 63% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Dalbergia latifolia* | Center Tree Plot | 16.5 | 90 | 11°44.134' | 76°24.432' | | 63% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Stereospermum chelonoides* | Center Tree Plot | 14.3 | 117 | 11°44.134' | 76°24.432' | | 63% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Haldina cordifolia* | Center Tree | 26 | 375 | 11°44.148' | 76°24.549' | | 55% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 18 | 130 | 11°44.148' | 76°24.549' | | 55% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 11 | 103 | 11°44.148' | 76°24.549' | | 55% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 13 | 85 | 11°44.148' | 76°24.549' | | 55% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree | 14.5 | 79 | 11°44.148' | 76°24.549' | | 55% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 12.5 | 96 | 11°44.148' | 76°24.549' | | 55% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Aegle marmelose* | Center Tree Plot | 6.4 | 17 | 11°44.148' | 76°24.549' | | 55% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Aegle marmelose* | Center Tree Plot | 9.5 | 55 | 11°44.148' | 76°24.549' | | 55% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree | 28 | 326 | 11°44.263' | 76°24.402' | | 69% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Dalbergia latifolia* | Center Tree Plot | 17 | 135 | 11°44.263' | 76°24.402' | | 69% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Butea monosperma* | Center Tree Plot | 18 | 162 | 11°44.263' | 76°24.402' | | 69% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Butea monosperma* | Center Tree Plot | 14 | 110 | 11°44.263' | 76°24.402' | | 69% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Stereospermum chelonoides* | Center Tree Plot | 19 | 199 | 11°44.263' | 76°24.402' | | 69% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Stereospermum chelonoides* | Center Tree Plot | 11 | 121 | 11°44.263' | 76°24.402' | | 69% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia paniculata* | Center Tree | 13 | 107 | 11°44.286' | 76°24.361' | | 64% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 17 | 139 | 11°44.286' | 76°24.361' | | 64% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Dalbergia latifolia* | Center Tree Plot | 11 | 101 | 11°44.286' | 76°24.361' | | 64% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 8 | 77 | 11°44.286' | 76°24.361' | | 64% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Lannea coromandelica* | Center Tree Plot | 8.5 | 59 | 11°44.286' | 76°24.361' | | 64% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Mangifera indica* | Center Tree | 19 | 514 | 11°44.372' | 76°24.429' | | 70% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Mangifera indica* | Center Tree Plot | 18 | 357 | 11°44.372' | 76°24.429' | | 70% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 10.2 | 97 | 11°44.372' | 76°24.429' | | 70% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Haldina cordifolia* | Center Tree | 28.7 | 339 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 11.7 | 95 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 12 | 104 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 11 | 88 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Bombax ceiba* | Center Tree Plot | 14.5 | 116 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Tectona grandis* | Center Tree | 17 | 137 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 11.7 | 95 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 12 | 68 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Bauhinia racemosa* | Center Tree Plot | 7.8 | 59 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 11 | 104 | 11°44.305' | 76°24.195' | | 62% |
| 11/10/2017 | Kaithallam | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 7 | 38 | 11°44.305' | 76°24.195' | | 62% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Stereospermum chelonoides* | Nesting Tree | 29.6 | 329 | 11°55.113' | 76°05.587' | 25.9 | 70% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Cassia fistula* | Nesting Tree Plot | 5.1 | 35 | 11°55.113' | 76°05.587' | | 70% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Cassia fistula* | Nesting Tree Plot | 5.5 | 36 | 11°55.113' | 76°05.587' | | 70% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 19.8 | 215 | 11°55.113' | 76°05.587' | | 70% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree Plot | 17.4 | 129 | 11°55.113' | 76°05.587' | | 70% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree Plot | 17.1 | 132 | 11°55.113' | 76°05.587' | | 70% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree Plot | 18.7 | 174 | 11°55.113' | 76°05.587' | | 70% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Gmelina arborea* | Nesting Tree Plot | 12.4 | 73 | 11°55.113' | 76°05.587' | | 70% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Tectona grandis* | Nesting Tree | 21.8 | 258 | 11°55.07.7' | 76°05.55.8' | | 63% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Tectona grandis* | Nesting Tree Plot | 22 | 261 | 11°55.07.7' | 76°05.55.8' | | 63% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Grewia tilifolia* | Nesting Tree Plot | 14.5 | 175 | 11°55.07.7' | 76°05.55.8' | | 63% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree Plot | 13.7 | 98 | 11°55.07.7' | 76°05.55.8' | | 63% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 16.8 | 265 | 11°55.07.7' | 76°05.55.8' | | 63% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Schleichera oleosa* | Nesting Tree Plot | 12.6 | 194 | 11°55.07.7' | 76°05.55.8' | | 63% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Haldina cordifolia* | Nesting Tree | 31.7 | 453 | 11°55.15.4' | 76°05.41.2' | | 58% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 13.9 | 156 | 11°55.15.4' | 76°05.41.2' | | 58% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Cassia fistula* | Nesting Tree Plot | 4.2 | 43 | 11°55.15.4' | 76°05.41.2' | | 58% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Stereospermum chelonoides* | Nesting Tree Plot | 9.3 | 92 | 11°55.15.4' | 76°05.41.2' | | 58% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Stereospermum chelonoides* | Nesting Tree Plot | 7.8 | 72 | 11°55.15.4' | 76°05.41.2' | | 58% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Tectona grandis* | Center Tree | 16.3 | 261 | 11°55.17.1' | 76°05.56.7' | | 60% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 12.4 | 179 | 11°55.17.1' | 76°05.56.7' | | 60% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 13.1 | 171 | 11°55.17.1' | 76°05.56.7' | | 60% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Grewia tilifolia* | Center Tree Plot | 18.5 | 262 | 11°55.17.1' | 76°05.56.7' | | 60% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree | 17.1 | 156 | 11°55.14.2' | 76°05.57.2' | | 72% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Grewia tilifolia* | Center Tree Plot | 13.4 | 142 | 11°55.14.2' | 76°05.57.2' | | 72% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Dalbergia latifolia* | Center Tree Plot | 8.5 | 86 | 11°55.14.2' | 76°05.57.2' | | 72% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 17.8 | 131 | 11°55.14.2' | 76°05.57.2' | | 72% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Phyllanthus emblica* | Center Tree Plot | 6.1 | 78 | 11°55.14.2' | 76°05.57.2' | | 72% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 15.8 | 115 | 11°55.14.2' | 76°05.57.2' | | 72% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 21.2 | 211 | 11°55.14.2' | 76°05.57.2' | | 72% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Tectona grandis* | Center Tree | 17.9 | 177 | 11°55.15.4' | 76°05.41.2' | | 56% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Bauhinia malabarica* | Center Tree Plot | 10.7 | 91 | 11°55.15.4' | 76°05.41.2' | | 56% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Bauhinia malabarica* | Center Tree Plot | 9.3 | 86 | 11°55.15.4' | 76°05.41.2' | | 56% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Grewia tilifolia* | Center Tree Plot | 16.8 | 160 | 11°55.15.4' | 76°05.41.2' | | 56% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree | 34.8 | 438 | 11°55.20.2' | 76°05.56.2' | | 73% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Dalbergia latifolia* | Center Tree Plot | 2.3 | 16 | 11°55.20.2' | 76°05.56.2' | | 73% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 5.8 | 33 | 11°55.20.2' | 76°05.56.2' | | 73% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Aegle marmelose* | Center Tree Plot | 10.4 | 67 | 11°55.20.2' | 76°05.56.2' | | 73% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Anogeissus latifolia* | Center Tree Plot | 3.9 | 18 | 11°55.20.2' | 76°05.56.2' | | 73% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Stereospermum chelonoides* | Center Tree | 12.3 | 53 | 11°55.20.2' | 76°05.56.2' | | 73% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Center Tree Plot | 24.1 | 189 | 11°55.20.2' | 76°05.56.2' | | 73% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 7.7 | 42 | 11°55.20.2' | 76°05.56.2' | | 73% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Haldina cordifolia* | Center Tree | 26 | 420 | 11°55.079' | 76°05.574' | | 51% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Center Tree Plot | 17.8 | 240 | 11°55.079' | 76°05.574' | | 51% |
| 1/12/2017 | Doddadi | *Gyps bengalensis* | *Cassia fistula* | Center Tree Plot | 7.1 | 29 | 11°55.079' | 76°05.574' | | 51% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree | 29.9 | 390 | 11°55.14.4' | 76°05.39.9' | | 67% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Dalbergia latifolia* | Nesting Tree Plot | 15.1 | 123 | 11°55.14.4' | 76°05.39.9' | | 67% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Schleichera oleosa* | Nesting Tree Plot | 23.5 | 186 | 11°55.14.4' | 76°05.39.9' | | 67% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Dalbergia latifolia* | Nesting Tree Plot | 22 | 169 | 11°55.14.4' | 76°05.39.9' | | 67% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Terminalia elliptica* | Nesting Tree Plot | 25 | 158 | 11°55.14.4' | 76°05.39.9' | | 67% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Lagerstroemia lanceolata* | Nesting Tree Plot | 18 | 122 | 11°55.14.4' | 76°05.39.9' | | 67% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Cassia fistula* | Nesting Tree Plot | 6.6 | 48 | 11°55.14.4' | 76°05.39.9' | | 67% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Dalbergia latifolia* | Nesting Tree Plot | 4.5 | 24 | 11°55.14.4' | 76°05.39.9' | | 67% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree | 20.4 | 360 | 11°55.16.3' | 76°05.37.6' | | 60% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 16.6 | 220 | 11°55.16.3' | 76°05.37.6' | | 60% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Terminalia elliptica* | Center Tree Plot | 13.2 | 109 | 11°55.16.3' | 76°05.37.6' | | 60% |
| 1/12/2017 | Ayyappanpara | *Gyps bengalensis* | *Tectona grandis* | Center Tree Plot | 19.5 | 148 | 11°55.16.3' | 76°05.37.6' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Haldina cordifolia* | Nesting Tree | 25.1 | 322 | 11°47.59.16' | 76°14.33.99' | 24 | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Olea dioica* | Nesting Tree Plot | 12 | 92 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Nesting Tree Plot | 17 | 125 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Nesting Tree Plot | 16.5 | 110 | 11°47.59.16' | 76°14.33.99' | | 60% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Elaeocarpus serratus* | Nesting Tree Plot | 7.1 | 21 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Lagerstroemia lanceolata* | Center Tree | 23 | 230 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Tectona grandis* | Center Tree Plot | 18 | 132 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree Plot | 14 | 120 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree Plot | 12 | 89 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Haldina cordifolia* | Center Tree | 31 | 470 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Haldina cordifolia* | Center Tree Plot | 25 | 310 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Dalbergia latifolia* | Center Tree Plot | 11 | 48 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 7.1 | 61 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Syzigium cumini* | Center Tree | 16 | 139 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree Plot | 17 | 169 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree Plot | 9 | 40 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 13.9 | 96 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree Plot | 21 | 169 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Vitex altissima* | Center Tree Plot | 6 | 31 | 11°47.59.16' | 76°14.33.99' | | 55% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree | 29 | 299 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Aegle marmelose* | Center Tree Plot | 5 | 41 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 14.4 | 105 | 11°47.59.16' | 76°14.33.99' | | 65% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia bellerica* | Center Tree Plot | 13.8 | 114 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Olea dioica* | Center Tree Plot | 10.7 | 96 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 17 | 141 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 12 | 102 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Grewia tilifolia* | Center Tree | 15 | 128 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Phyllanthus emblica* | Center Tree Plot | 5.6 | 23 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Lagerstroemia lanceolata* | Center Tree Plot | 9 | 66 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Butea monosperma* | Center Tree Plot | 11 | 98 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Lagerstroemia lanceolata* | Center Tree Plot | 19 | 180 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Tectona grandis* | Center Tree | 29 | 304 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Tectona grandis* | Center Tree Plot | 16 | 161 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Mytragyna parviflora* | Center Tree Plot | 11 | 77 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 7 | 45 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Pongamia pinnata* | Center Tree Plot | 12 | 73 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Haldina cordifolia* | Center Tree Plot | 18 | 123 | 11°47.59.16' | 76°14.33.99' | | 65% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree | 25 | 220 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 17.2 | 123 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 18 | 144 | 11°47.59.16' | 76°14.33.99' | | 60% |

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|---|---|---|---|---|---|---|---|---|---|---|
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 11 | 97 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Phyllanthus emblica* | Center Tree Plot | 4.5 | 27 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Phyllanthus emblica* | Center Tree Plot | 10.9 | 67 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Lagerstroemia lanceolata* | Center Tree | 17 | 145 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Tectona grandis* | Center Tree Plot | 14 | 121 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Lagerstroemia lanceolata* | Center Tree Plot | 13 | 99 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 16 | 104 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Haldina cordifolia* | Center Tree | 27 | 243 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Lagerstroemia lanceolata* | Center Tree Plot | 21 | 175 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Bauhinia racemosa* | Center Tree Plot | 6.3 | 43 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree Plot | 14.2 | 69 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 11 | 76 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree Plot | 19 | 192 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree | 18 | 187 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Terminalia elliptica* | Center Tree Plot | 9 | 63 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Anogeissus latifolia* | Center Tree Plot | 15.7 | 117 | 11°47.59.16' | 76°14.33.99' | | 60% |
| 10/3/2018 | Karamukku | *Sarcogyps calvus* | *Aegle marmelose* | Center Tree Plot | 5.9 | 38 | 11°47.59.16' | 76°14.33.99' | | 60% |

**APPENDIX 2**

| Date of Installation | Latitude | Longitude | Altitude | Date of Photographing | Time | Species | Individual |
|---|---|---|---|---|---|---|---|
| 12/11/2017 | 11°39.910' | 76°23.381' | 750 m | 1/21/2018 | 12:45 PM | White-rumped vulture | 1 |
| 12/11/2017 | 11°39.910' | 76°23.381' | 750 m | 1/21/2018 | 12:45 PM | Gyps sp. | 1 |
| 12/11/2017 | 11°39.910' | 76°23.381' | 750 m | 1/23/2018 | 5:44 PM | Gyps sp. | 3 |
| 12/11/2017 | 11°39.910' | 76°23.381' | 750 m | 12/12/2017 | 7:49 AM | Gyps sp. | 1 |
| 1/2/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 11:57 AM | Gyps sp. | 1 |
| 1/2/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 12:09 PM | White-rumped vulture | 3 |
| 1/2/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 12:09 PM | Gyps sp. | 7 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/21/2018 | 12:45 PM | Gyps sp. | 2 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/23/2018 | 5:44 PM | Gyps sp. | 3 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/10/2018 | 6:00 PM | Gyps sp. | 4 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 8:51 AM | White-rumped vulture | 3 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 8:51 AM | Gyps sp. | 10 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 11:05 AM | Red-headed Vulture | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 12:08 PM | Gyps sp. | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 12:26 PM | Gyps sp. | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 12:26 PM | Gyps sp. | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 12:31 PM | Gyps sp. | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 12:37 PM | White-rumped vulture | 3 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/4/2018 | 12:55 PM | Gyps sp. | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 1:57 PM | Indian vulture | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 1:59 PM | Gyps sp. | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 2:08 PM | Gyps sp. | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 2:14 PM | White-rumped vulture | 4 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 2:17 PM | Gyps sp. | 5 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 2:35 PM | Red-headed Vulture | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 2:35 PM | Gyps sp. | 4 |



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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 3:13 PM | Gyps sp. | 13 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 4:08 PM | Gyps sp. | 16 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 5:08 PM | Gyps sp. | 18 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 5:19 PM | Red-headed Vulture | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/9/2018 | 6:14 PM | White-rumped vulture | 4 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/10/2018 | 6:46 AM | Gyps sp. | 6 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/10/2018 | 7:10 AM | Gyps sp. | 14 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/10/2018 | 7:47 AM | Gyps sp. | 10 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/10/2018 | 8:05 AM | Red-headed Vulture | 3 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/10/2018 | 1:00 PM | Gyps sp. | 2 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/10/2018 | 2:33 PM | Gyps sp. | 8 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/10/2018 | 4:39 PM | Red-headed vulture | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/10/2018 | 6:15 PM | Gyps sp. | 8 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 6:46 AM | Indian vulture | 2 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 7:02 AM | Gyps sp. | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 7:15 AM | Gyps sp. | 10 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 7:47 AM | Red-headed vulture | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 9:31 AM | Red-headed vulture | 1 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 12:45 PM | Gyps sp. | 10 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 3:50 PM | Gyps sp. | 3 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/11/2018 | 5:55 PM | Gyps sp. | 4 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/12/2018 | 6:55 AM | Gyps sp. | 8 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/12/2018 | 7:35 AM | Gyps sp. | 5 |
| 1/3/2018 | 11°39.910' | 76°23.381' | 750 m | 1/12/2018 | 8:35 AM | Gyps sp. | 1 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 1/29/2018 | 11:48 AM | Gyps sp. | 2 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 1/30/2018 | 12:27 PM | Gyps sp. | 2 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 1/31/2018 | 12:17 PM | White-rumped vulture | 2 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 1/31/2018 | 6:21 PM | Gyps sp. | 1 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/3/2018 | 12:49 PM | White-rumped vulture | 4 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/14/2018 | 11:03 AM | Gyps sp. | 1 |



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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/14/2018 | 12:12 PM | Indian vulture | 2 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/18/2018 | 12:10 PM | Gyps sp. | 1 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/21/2018 | 12:13 PM | Gyps sp. | 7 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/21/2018 | 1:24 PM | Gyps sp. | 1 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 3/1/2018 | 1:59 PM | Indian vulture | 3 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 1/31/2018 | 12:37 PM | Gyps sp. | 5 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 1/31/2018 | 6:12 PM | Gyps sp. | 1 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/1/2018 | 7:47 AM | Gyps sp. | 4 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/2/2018 | 5:32 AM | Indian vulture | 1 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/3/2018 | 12:44 PM | Gyps sp. | 6 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/8/2018 | 11:26 AM | Gyps sp. | 5 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/15/2018 | 12:12 PM | Gyps sp. | 2 |
| 1/28/2018 | 11°39.910' | 76°23.381' | 750 m | 2/3/2018 | 12:24 PM | Gyps sp. | 2 |

**Appendix 3: Interview schedule -1 (NGO's and other stakeholders including forest officials).**

1. **Basic details**

Date: Location:

Name & address of person: Sign:

2. **Conservation Aspects**

A. Is there any threat faced by vultures in the sanctuary? YES NO observation on:

| | |
|---|---|
| Loss of habitat | |
| Use of NSAID's to treat live stocks | |
| Loss of available safe food | |
| Incorrect management of vulture restaurants | |
| Hunting and poaching | |
| Threats at the breeding site | |

B.Is there any case registered in the past regarding vultures in the sanctuary? If yes,

| | |
|---|---|
| What was their purpose? | |
| When did it happen? | |
| What was the status of the offenders? (Tribals or others) | |

C. Do you think anyone is misusing the Diclofenac available in the market for veterinary use?

D. Any suggestion to improve the condition of vultures in the sanctuary?

| | |
|---|---|
| Vulture awareness programme | |
| Breeding programme | |
| Improving conditions of the nesting sites | |
| Scientific management on vulture feeding sites | |
| Others | |

E. Vulture population statistics in Wayanad Wildlife Sanctuary over the last available years?

**3. Please share if there are any memorable experience happened with vulture/wildlife in your career**

**Researcher's observations regarding the stakeholders perception regarding the significance of vulture in Wayanad Wildlife Sanctuary**

**Appendix 4: Interview schedule -2 (Local people)**

1. **Basic details**

Date: Forest Range: Location:

Name & Address Age Occupation

**2. Attitude towards Wildlife/Vulture**

A.

| Statement | Strongly agree | Agree | Neutral | Disagree |
|---|---|---|---|---|
| Vulture should be conserved for future generation | | | | |
| They have as much right to live as we do | | | | |
| Conservation Policies of Government is not up to the mark | | | | |
| Wildlife is getting more priority than the human | | | | |

B. Awareness about Forest and Related Biodiversity Laws

| Question | Not aware | Somewhat aware | Reasonably aware |
|---|---|---|---|
| Name the Forest related laws and rules that you have heard and are aware of? | | | |
| As per the wildlife protection act 1972 what is hunting? | | | |
| Are you aware of Diclofenac and decline of vulture population? | | | |
| Can you identify the Vulture species shown in the pictures? | | | |

C. Does your community have any cultural/ritualistic link with vulture? YES NO

If yes, please specify?

**3. Livestock Population and Details**

A. No: of livestock population in your colony or locality? Yes/no if so please specify?

| Number of live stocks | 1-20 | 20-50 | 50-80 | 80+ |
|---|---|---|---|---|
| Livestock carcasses are | Buried | Left in Forest | Used for food | Others |
| Diclofenac | Useful | More useful than harmful | More harmful than useful | Harmful |

B. Which are the common medicines used? Has the price of veterinary medicines increased over the past years?

**4. Have you observed the vultures? What are your deductions about their behavior during the recent years?**

**Appendix 5: Interview schedule -3 (Veterinary doctors and Medical shop owners)**

Date: Name of medical shop:

Location Name & details of owner/staff:

**1. Non steroid anti-inflammatory drugs (NSAID) available for veterinary use in the market?**

| NSAID'S | Available | Not Available |
|---|---|---|
| Ketoprofen | | |
| Aceclofenac | | |
| Carprofen | | |
| Flunixin | | |
| Nimesulide | | |
| Piroxicam | | |
| Ibuprofen | | |
| Analgin | | |
| Neproxen | | |
| Aspirin | | |
| Mefenamic acid | | |
| Tolfenamic acid | | |
| Phenyl-butazone | | |
| Meloxicam | | |
| Other's | | |

**2. Do you think anyone is misusing the Diclofenac available in the market for veterinary use?**