

**A Study on Breeding Behaviour of Oriental White-backed
Vulture (*Gyps bengalensis*) in Anjarle & Deobag,
Maharashtra**

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By

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SUMMARY

1. This study was aimed to understand the current status, distribution pattern, habitat characteristics, nesting success and nesting behaviour of Oriental White-backed Vulture in the Konkan coast during a breeding season between December 2010 and May 2011.
2. A total of 24 sites either nesting or feeding were located all along the Konkan coasts of Maharashtra during the survey using area search method as well as interview based technique. Of these, in four sites birds have been sighted directly.
3. A total of 26 vultures have been recorded. Of these, three were chicks. Of the 26 vultures, 25 were sighted in the nesting sites and only one in a feeding site. Based on interview with local people we could assume that about 75 to 150 vultures may be present in the entire Konkan coast.
4. Of the 24 potential nesting and feedings sites of OWBV located in the Konkan coast, 10 sites were identified as potential nesting sites. Of the identified nesting sites, 30% of nesting sites were active and used for nesting in 2011 and remaining 70% nesting sites were inactive and abandoned by vultures. Signs of old nests were also observed in all these 70% old nesting sites.
5. Therefore, it may be prudent to conclude that the Konkan coast also witnessing the drastic decline of nesting population but there are hope to recover species through innovative conservation plan such as opening more vulture restaurants, better compensation to farmers etc.
6. Of the 15 potential feeding sites, 11 sites were active and vultures uses these sites whenever carcasses were kept on the ground but other four old feeding sites were completely abandoned by the vultures now.
7. Study shows that there was no significant difference in the habitats of both active and inactive nesting sites in the Konkan coast (Ratnagiri and Sindhudurg District) which indicates that the decline of nesting population of vultures in the region may not be exclusively due to habitat destruction.

8. Several similarities among all nesting colonies which include presence in the coconut plantation areas, proximity to sea shore, flat terrain, proximity to fresh water, forests, human habitation and also to carcasses dumping ground.
9. There was a significant difference in the tree heights of between nesting and non-nesting areas. OWBV largely preferred an area with tree heights between 12 m to 30 m with an average height of 16 m. However, vultures preferred a tree with height of 25 m to nest and avoided the tree with taller than 28 m.
10. Most of nesting trees were either close to road, well or houses. This might be to avoid predation of nests or easy to approach the nest from foraging or for better vigilance by parents.
11. There was a shift in the nest site selection of OWBV due to non-availability of large sized natural nesting trees such as *Ficus bengalensis*, *F. religiosa* and mango in this region. Since there is no option available for breeding vulture to choose nesting trees in the coconut dominated landscape they prefer the coconut trees for nesting, which resulted conflict between farmers and vulture in the Konkan coast.
12. Colonial nesting is the norm, with up to 15 nests in a tree, and up to 100 nests in a 250 m diameter circle (Hume and Oates 1889–1890), therefore, it is prudent to conclude that there was no colonial nesting observed during 2011 in the Konkan coast as maximum number of active nests observed in a single site was four in Anjarle.
13. Earlier, breeding peak of vulture used to be in October–January in south Konkan district, Maharashtra during 1880s but this study could observe the breeding peak during January and March. Continuous observation on breeding peaks of vultures covering several years of observations in Konkan coast is required to check whether there is a shift in the breeding peak or not.
14. During the observation on nesting behaviour, the adult birds were observed leaving the nest for a longer period of time as weeks progressed, that might be due to non-availability of food nearby or diminishing fear of chick predation as chick grown bigger.

15. Major activity of the chick was resting in the nest but it had gradually changed as time progressed. Preening was the second major activity that was mostly observed followed by looking around, resting on perch, etc. Chicks were observed with tranquil and resting during the first 3-4 weeks and then later they came out of the nest and started to perch on the leaf of the coconut.
16. Since birds were not tagged, differences in the activities of parents and interactions between two nesting adults etc could not observe which needs to be studied to understand the cost and benefits of parental care.
17. Major threats were observed for the nesting population of vultures in the Konkan coasts include the nest destruction by coconut farmers due to inadequate or lack of compensation. People in the region have started burying or burning cattle carcass to keep their villages clean which had resulted diminishing food sources for vultures. Fishermen were also observed throwing their cattle carcasses in the sea. Vultures may not be comfortable feeding the floating carcasses that too in sea. However, this may also be argued in other way that the people have started burying the cattle carcass because there were no enough vultures to feed on them. Whatsoever it may be, the shortage of cattle carcasses seems to be one of the major threats to nesting population of vultures in the Konkan coasts.
18. Initially this study was proposed to study the success of vulture restaurant in the region, however, that failed because of non-availability of cattle carcasses for the vulture restaurant during the study period. Vulture restaurant collect the cattle carcasses from nearby villages and keep it for 72 hours assuming that the diclofenac present in the carcass will disintegrate fully within 48 hours of time. After preserving the carcasses for 72 hours they keep the diclofenac free carcasses on the ground near nesting colony for vultures to feed. Since there was a shortage of cattle carcasses for vultures in the region, it would be prudent to open vulture restaurants near nesting colonies such as Anjarle, Murud and Deobag.

Coconut farmers strongly believe that their crop yield drastically comes down when vultures start using their palm for nesting. Therefore, they have started destroying the nest at beginning itself. In this connection, it would be better to adequately compensate the farmers which would

enhance the nesting success of this critically endangered vulture. A scheme to provide compensation to the Coconut tree owners on whose tree the vulture builds a nest has been launched by the Govt. of Maharashtra recently, but it is still to get implemented properly.

Chapter 1

INTRODUCTION AND REVIEW OF LITERATURE

1.1. Introduction and Review of Literature

Raptor is a very diverse group of birds and found in almost every kind of habitat in the world. The Oriental White-backed Vulture (*Gyps bengalensis*) belongs to the order Accipitriformes in which it belongs to the family Accipitridae. The Vultures of the world have been divided into two basic categories viz. old world and new world vultures. The study species comes under the old world category, because they lack the sense of smell. But they have powerful sense of sight which helps them to find their food across a vast landscape. India has nine species of vultures that are as follows;

1. Oriental White-backed Vulture (*Gyps bengalensis*)
2. Long-billed Vulture (*Gyps indicus*)
3. Himalayan Vulture (*Gyps himalayensis*)
4. Griffon Vulture (*Gyps fulvus*)
5. Slender-billed Vulture (*Gyps tenuirostris*)
6. Egyptian Vulture (*Neophron percnoptreus*)
7. Red Headed Vulture (*Aegyptius Calvus*)
8. Cinereous Vulture (*Aegyptius monachus*)
9. Lammergeier (*Gypaetus barbatus*)

The Oriental White-backed Vulture (OWBV) was once considered as probably the most abundant largest bird of prey in the world. Similarly, this species has also been described as the commonest vulture in the Indian subcontinent, with a range extending to South Vietnam and the Malay Peninsula (Ali and Ripley 1968). Adult OWBV is heavy brownish black in colour. It has naked neck with no feathers and head sunk into shoulders when the bird is resting. A whitish ruff of soft feathers is present around the base of the neck, broken in front by black crop patch. Sexes are alike. White lower back can be seen when perched or observed in flight below eye level. Also a whitish band along underside of wings distinguishes this species. Young one is browner

in colour than black. Head and neck mostly covered with dirty white fluffy down feathers (Ali and Ripley, 1978).

1.1.1 Distribution: OWBV is found more or less throughout the area from West Pakistan (Baluchistan) east through Assam and Manipur; south from Kashmir and along the Himalayas up to 1500 and 2500 m. elevation (including Nepal), through the peninsula to Kanyakumari (Ali and Ripley, 1978). They generally tend to live near the human settlements due to availability of food.

1.1.2. Breeding Season: Breeding season for this species is principally from October to March. Nest is made from sticks and twigs also some time green leaves are placed. The nest is generally present on the top of a tree. A variety of species are utilized for this purpose, eg. Peepal (*Ficus bengalensis*), Mango (*Mangifera indica*) and Sheesham (*Dalbergia sissoo*). Normally, in a colony the nests are located near each other. Each pair usually lays only one egg but sometimes two eggs which are rare. Incubation period is for 45 days approximately (Ali and Ripley, 1978).

1.1.3. Population: Once, one of the most common vulture species in India, the OWBV is now listed as critically endangered species as per IUCN (2010). The population of resident Gyps vultures (Oriental White-backed Vulture *Gyps bengalensis*, Long-billed Vulture *Gyps indicus* and Slender-billed Vulture *Gyps tenuirostris*) in the Indian subcontinent crashed during the 1990s. This was first reported in the media in 1996-97 and later documented by the Bombay Natural History Society (BNHS), whilst monitoring raptor numbers in Keoladeo National Park, at Bharatpur in Rajasthan (Prakash *et al*, 2007).

1.1.4. Threats: The main reason behind the population decline was found to be a non steroidal anti-inflammatory drug (NSAID) called diclofenac (Oaks *et al*, 2004 and Shultz *et al*, 2004). This drug is widely used for curing the cattle. After death, the drug remains inside the body of the cattle. Such cattle carcasses when dumped are consumed by vultures. This leads to renal failure in birds (Oaks *et al*, 2004). Declining in number of nests and breeding success of OWBV were also observed in various parts of India (Gilbert *et al*, 2002). Many factors have been shown

to contribute to breeding success in birds. These include age and the physical condition of individual, time of breeding, and the position of the nest in the colony, colony size and density. Other factors include the availability of food, competition, predation, social behaviour, nest-site and habitat quality (Birkhead 1977; Steenhof *et al.* 1982; Watson *et al.* 1992; Baral *et al.* 2005)

To recover the population of OWBV along with two other species viz. long billed & Slender Billed Vulture, a conservation breeding programme was started in the country. Three breeding facilities were established in Pinjore (Haryana), Raja Bhat Khawa (West Bengal) and Rani (Assam).

Along with efforts of captive breeding, vulture restaurants have also been established to recover the OWBV population in many parts of India. Many of them have been established by non-governmental organizations or some are community/government based. Vulture restaurant near the vulture colony had influenced the home ranges of OWBV in Pakistan; however, the impact of vulture restaurant on the nesting behavior of vulture was not studied in detail so far. Moreover, quantitative studies of habitat selection for nests, as a way to predict species requirements, are frequently used to design strategies for the conservation of endangered bird species. Further, the Konkan coast known to be an important landscape of vulture (Hume and Oates 1889–1890), however, there was no information about the status and distribution of this species in this landscape for more than a century.

1.2. Objectives:

The population of Oriental White-backed Vulture is decreasing throughout its geographical range and become rare in most of its range. The Konkan Coast of Maharashtra was believed to be supporting a good breeding population of this species; however, there was no information about their status, distribution, and habitat and nesting ecology of this species in this landscape for more than a century. In this connection, this study was conducted to understand the status, distribution pattern, habitat, nesting success and nesting behaviour of this species in the Konkan coast (Ratnagiri and Sindhudurg District). This study has tried to find the answers for following research questions; what are the most preferred habitat for nesting and feeding vultures

in the Konkan coast? What is the current status of vultures in the Konkan coast? To answer these questions, the following objectives were proposed.

Objective 1 –

To study the status and distribution of OWBV along the southern coast of Maharashtra (Southern Konkan Belt)

Research Question: What is the status and distribution of OWBV in the study area?

This objective was considered to check the population status along the coastal belt of Maharashtra (Ratnagiri and Sindhudurg District). There is not much literature available from this area (Hume and Oates 1889–1890, Ali and Ripley, 1978).

Objective 2 –

To study the nest site selection and habitat characteristics of two different nesting colonies of Oriental White-backed Vulture.

Research Question: Is there any difference in the habitat between nesting and non nesting sites?

Understanding the nest site selection and nesting habitat requirement of critically endangered OWBV in the Konkan Coast is become crucial for their long term conservation, therefore, this objective was taken into this study. As discussed earlier, there was no detailed information available on this aspect.

Objective – 3

To study the breeding success of OWBV in nesting colonies at Anjarle, Deobag and Murud

The main aim of this objective was to observe the breeding behavior and estimating the nesting success of Oriental white backed vulture in the Konkan coast so that this information would be useful for the ex-situ conservation programme or conservation breeding programme which are proposed by the government.

2. Study Area

This study was conducted in the 2 districts viz. Ratnagiri and Sindhudurg of Konkan coast of Maharashtra. Breeding success and behaviour observations were carried out in 3 small villages and its vicinity called as 'Anjarle', 'Deobag' and 'Murud'. This coastal belt is also called as 'Konkan'. The study area comes under bio-geographic province 8A (Rodgers & Panwar 1988). This area is very close to Western Ghats on eastward and Arabian Sea on westwards side. The study area show three distinct seasons viz. summer, monsoon and winter.

The major habitat type of this area is 'southern moist dry deciduous forest' (Champion and Seth, 1968). Also there are few patches of mangroves along the river Jog (Anjarle) and Karli (Deobag). The hilly area has grasslands on the top with exposed basaltic rock formations. Surrounded by such vegetation, the nesting site of Oriental White-backed Vulture (*Gyps bengalensis*) is actually situated in the village itself. Both sites are having similar vegetation characteristics. The vegetation in the nesting site is dominated by coconut plantations followed by areca nut plantation. The Coast shows vast plantations of Casuarina (*Casuarina equisetifolia*) trees.

Other species of raptor found here are white-bellied sea eagle (*Haliaeetus leucogaster*), oriental honey-buzzard (*Pernis ptilorhynchus*), black kite (*Milvus migrans*), etc. In winter season, the area harbours a variety of migratory waterfowl species.

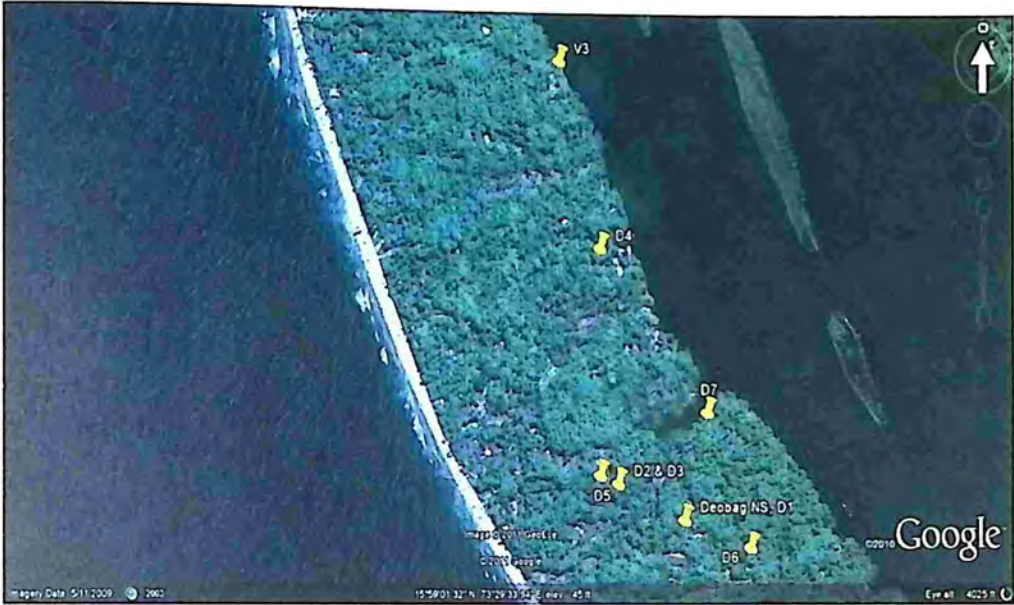


Fig. 2.1. Map of the study area showing two nesting sites viz. Deobag and Anjarle (Placemarks shows individual nest locations of OWBV)

3. Methods

3.1. Status and distribution of Oriental white-backed vulture in the study area

OWBV largely live in colonies and rarely in single that too during breeding season. Since the month of February and March are peak period of breeding season of this species in the Konkan coasts, a survey was carried out during this period to estimate their status and also to understand their distribution pattern in the coconut palm dominated Konkan coasts. After a rapid reconnaissance survey, this species was found to be very rare to sight in this region. Therefore, area search method following Prakash (1999) was used to locate the nesting as well as feeding sites of OWBV in all coastal taluks of two districts of Maharashtra viz. Ratnagiri and Sindhudurg.

Landscape and habitat of both Ratnagiri and Sindhudurg districts are more or less similar and having mostly mountainous habitat. The available flat coastal areas are limited that too with human habitation. Most of the coastal belt was planted with coconut which turned out be the best nesting habitat of the OWBV.

All taluks of these two districts were surveyed to locate the feeding and nesting sites of this species. Local people, graziers, panchayat leaders, fishermen etc were interviewed to locate the old as well as active nesting and feeding sites of the vulture in this region. After locating the sites, each site was visited and recorded the nearest habitat characteristics features and counted the birds if they were present during our visit. Number of individuals sighted by the local people in the recent past was also recorded along with information of date of sighting.

Apart from this local people were also interviewed to gather the following information;

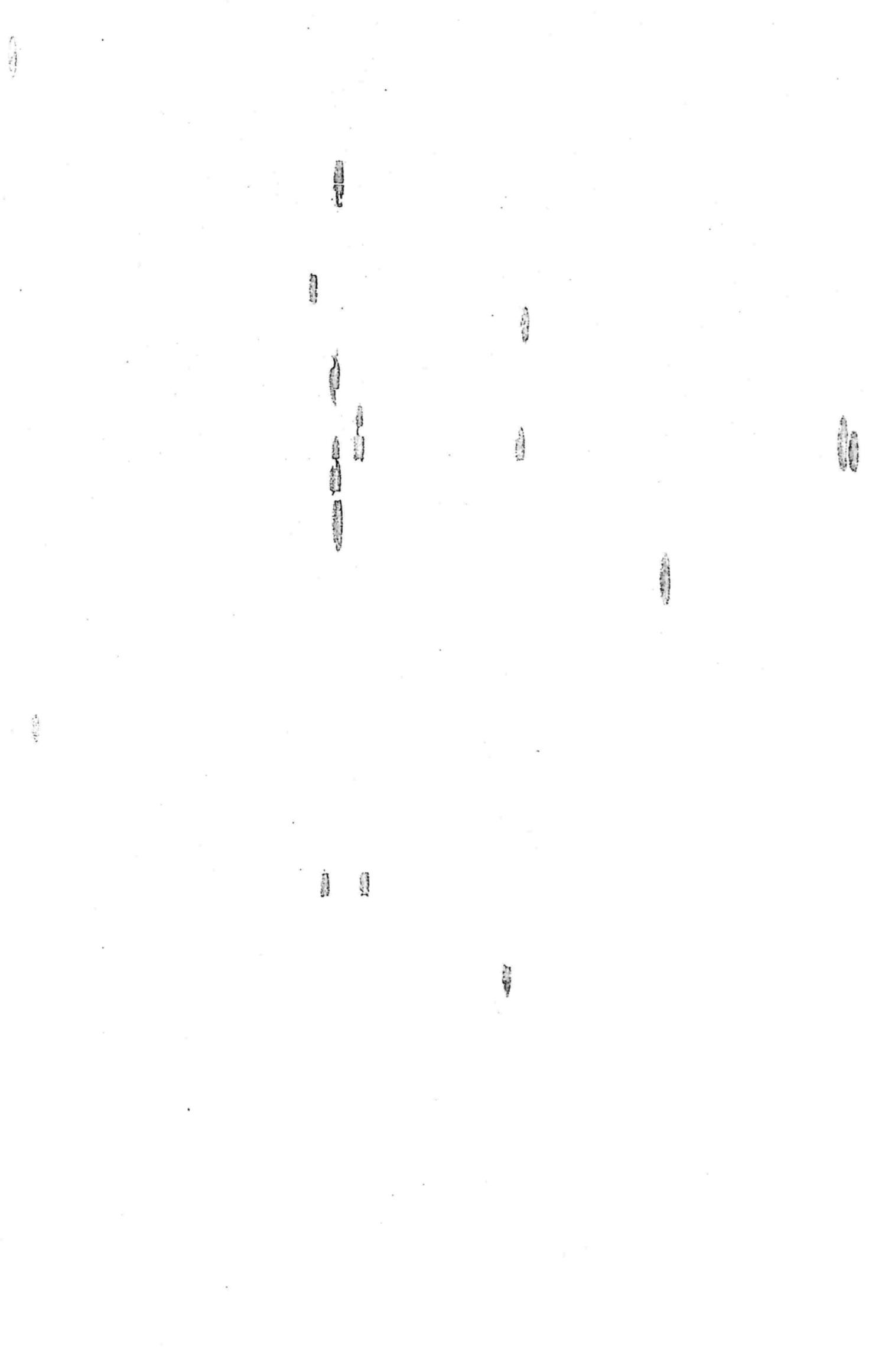
1. Past population trends
2. Current population status
3. Reasons of decline
4. Social issues regarding to the damage caused by vulture nesting on coconut trees

All the active and inactive of both nesting and feedings sites of vulture are plotted in the maps using GPS. The survey was conducted from 16 the February, 2011 to 22nd February, 2011.

3.2. Nest site selection and habitat characteristics of nesting colonies of OWBV

Various factors are involved in determining nest site selection and are mostly related with habitat in which the species lives. Availability of nesting trees, low predator pressure, less human disturbance and availability of food are major factors which would determine the nest site selection of any bird species. Therefore, a total of 31 variables including habitat characters, prevailing threats etc have been collected in each nesting sites available in the Konkan coast (Table 3.1.)

Sr.No.	Habitat Variables
1	Name of Nesting/Feeding Colony
2	Number of birds/nests
3	Location
4	Approximate area of colony (ha)
5	Name of District
6	Name of Taluk
7	No. of villages around colony within radius of 15 kms.
8	Name of villages
9	Total No. of people in those villages
10	Is it forested landscape?
11	Physiography(hilly/undulating/flat)
12	Is it agricultural landscape?
13	Major habitat type of colony
14	Major land use pattern in the region
15	Major crops grown in the region
16	Major profession of people around
17	Major plantation grown
18	Nearest forest
19	Nearest town/city
20	Nearest vulture restaurant
21	Nearest carcass dumping site
22	Nearest water bodies
23	Nearest garbage dumping site
24	Nearest seashore
24	Annual precipitation (cm)
26	Temperature
27	Threats



3.3.1. Breeding Success:

All discovered nests were monitored continuously throughout the breeding season and calculated their nesting success. Due to constrain of time, this work was started in the month of December, 2010. When the field work began some of nests already had eggs. Therefore exact time of egg laying could not be ascertain. But after hatching of the egg, the rough date of egg laying was calculated by subtracting the number of observed days with average days of incubation following literature (Baker 1928, Brown and Amadon 1968, Sarker and Iqbal 1997).

Breeding success was calculated by using Mayfield's estimate of breeding success on the basis of exposure days (Mayfield, 1961). It basically calculates the survival rates of the nest at each stage by using the exposure days, which are the continuous days of observation. The estimate calculates following stages of the breeding season.

To estimate following values, continuous observations were used. To do this, the exact number of days are required like day when egg was laid, day when egg hatched, day when chick reached fledgeling stage, etc.

- Nest mortality rate during incubation: This rate tell about the survival of each nest per day throughout the incubation period. The formula used to calculate the nest mortality rate was:

Nest mortality rate during incubation = $\frac{\text{Lost nests}}{\text{Total Exposure Days during incubation}}$

- Nest Survival during Incubation: This is the rate that tells that, at the end of incubation period, how many nests are survived.

Nest Survival during Incubation = Nest survival rate^{Incubation Period}

- Nest Survival during Nestling Period: This shows the survival of hatchlings that reach up to the fledgling stage.

Nest Survival during Nestling Period = Total nest lost/ Total exposure days during nestling period.

- Nest Survival from incubation to fledgling: This shows survival of the nest from incubation to fledgling stage.

Nest Survival from incubation to fledgling = Nest survival during incubation × Nest Survival during nestling period

- Nestling Survival: It calculates the survival of nestling. It is basically similar to nest survival during nestling period.
- Egg Survival during Incubation: It tells about the survival of eggs throughout the incubation period.

Egg Survival during Incubation = Survival rate^{Incubation Period}

3.3.2. Breeding Behaviour:

Breeding behaviour of Oriental White-backed Vulture was studied by using focal animal sampling technique (Altman, 1971). In this scenario the one nest was a whole sample. It includes the pair and the hatchling.

In Konkan region, this species built the nest on the coconut tree, which makes it difficult to observe from the ground. But, fortunately the nests found were in such a position that they were easily observable from the ground by using a pair of binoculars (Olympus 7×35).

To observe various behavioural activities throughout the day, the day was divided into 4 time frames. Each frame was comprised of 3 hours of observation.

- a. Morning 6:00 a.m. to 9:00 a.m.
- b. Morning 9:00 a.m. to 12:00 p.m.
- c. Afternoon 12:00 p.m. to 3:00 p.m.
- d. Afternoon 3:00 p.m. to 6:00 p.m.

This was done to get maximum behavioural activities of the species. In one day 2 alternate time frame were chosen. So, daily 6 hours of observations were recorded till the end of the breeding season.

The activities were recorded from a safe distance without disturbing the natural activities of the birds. Each activity was recorded along with its time which required performing that particular activity. Videography was also done to get some peculiar behavior of the nestling. This was done on only 2 times. So, this has been not used for making any conclusion in the thesis.

4. Results

4.1. Status and distribution of Oriental white-backed vulture in the study area

A total of 24 sites either nesting or feeding were located all along the Konkan coasts of Maharashtra during the survey. Of these, in four sites birds were sighted directly (Table 4.1). In Anjarle, which was the largest active nesting site present in the Ratnagiri District, a minimum of 15 individuals were observed, which included a month old chick. Of these 15 individuals, four pairs were looking for nesting but did not nest in Anjarle and left the colony after spending two weeks over there. Three active nests were found in the Anjarle, each nest was with a pair and one nest with one month old chick. Therefore, total number of vultures recorded in the Anjarle alone became 15 birds. All sightings and nests were in the coconut plantation areas. In Anjarle, one nest was observed with dead bird and an egg. This bird might have died while incubating her egg due to unknown reason. Local people revealed that more than 100 pairs use to nest here till 2008 thereafter, the vulture population drastically reduced here due to various reasons. Of these, non-availability of cattle carcass which is now buried to keep village clean, destroying nests at beginning to safeguard the coconut yield were the prominent causes for the declining of vulture in Anjarle as told by the villagers.

District	Place	Type	Status	No. of birds
Ratnagiri	Jaigarh	Feeding		
Ratnagiri	Anjarle	Nesting	Active	15 (1 chick)
Ratnagiri	Murud	Nesting	Active	5 (1 chick)
Ratnagiri	Anjarle	Feeding	Active	
Ratnagiri	Ratnagiri Feeding Site	Dumping Site		
Ratnagiri	Dhokamle	Temporary Feeding		
Ratnagiri	Malgund	Temporary Feeding		
Ratnagiri	Dabhol	Temporary Feeding, Old Nesting Site		
Ratnagiri	Waravde	Temporary Feeding		

Ratnagiri	Burondi	Feeding		
Ratnagiri	Guhagar	Feeding		
Ratnagiri	Palshet	Feeding		
Ratnagiri	Newre	Old Nesting Site		
Ratnagiri	Ganpatipule	Old Nesting Site		
Ratnagiri	Ranpur	Feeding		
Ratnagiri	Purnagarh	Past Nesting, Current Feeding		
Ratnagiri	Jaitapur	Past Nesting,		
Sindhudurg	Deobag	Nesting	Active	5 (1 chick)
Sindhudurg	Shiroda	Feeding		
Sindhudurg	Malvan Plateau	Feeding		1
Sindhudurg	Mithbaao	Old Nesting and Feeding Site		
Sindhudurg	Kunakeshwar	Feeding		
Sindhudurg	Devgarh	Feeding		
Sindhudurg	Reddy	Absence of both		

Table 4.1. Details of survey of OWBV nesting and feeding sites in the study area in 2011.

Another nesting colony in the village Murud, which is located about 20 km away from the Anjarle towards south in the same district, was recorded with two pairs of vulture. Both pairs were observed with active nests in the coconut plantation area. One pair was sighted with a chick in a nest. Murud was also known to be a major nesting colony in the past along with Black (*Milvus migrans*) and Brahminy kites (*Haliastur Indus*). Local people have informed that the vulture population has drastically declined here although the habitat is available. However, local people mentioned that still about 20-30 birds arrive here if they keep cattle carcass on the ground without burying/burning them.

There was no vulture found in other coastal villages of Ratnagiri districts except Anjarle and Murud. However, people from all coastal villages in this district mentioned that the vultures arrive here if cattle carcass kept on the ground without burying them.

There was no direct sighting of vulture all along the northern coasts of Sindhudurg district. However, one active nesting colony was located in the village Deobag near Malvan.

was used for nesting by Oriental white backed vultures in large numbers in olden days. However, during this study period, only two pairs were sighted that too in one nesting coconut palm. One pair sighted with a chick in the nest and another pair began the nesting during the third week of February 2011. In total, five individuals sighted in the Deobag village. As like Anjarle, Deobag also used to be larger nesting site for OWBV but their population drastically reduced since 2005 as revealed by local people.

During entire survey, only one feeding site near Malvan (Malvan plateau) sighted with solitary OWBV. However, 10-15 vultures were sighted in the municipal waste dumping ground in Ratnagiri on 18th February 2011 by local people and bird watchers. Ratnagiri garbage dumping ground used to be a major feeding ground of vultures. Since the Municipality has started burning the cattle carcass the vultures have now stopped to visit this feeding site.



Figure 4.1. Location of feeding and nesting sites of Oriental White backed vultures in the study area. (NS – Nesting Sites, FS – Feeding sites)

Image Courtesy - Google

In general, a total of 26 vultures have been sighted directly. Of these, three were chicks. Of the 26 vultures, 25 were sighted in the nesting sites and only one in a feeding site. As per the recent sightings of local people there are about 75 to 150 vultures may be present in the Konkan coast. Therefore, it may be prudent to conclude that the Konkan coast also witnessing the drastic decline of nesting population but there are hope to recover species through innovative conservation plan such as opening more vulture restaurants, better compensation to farmers etc.

4.2. Nest site selection and habitat characteristics of nesting colonies of OWBV

4.2.1. Nest colony selection of OWBV

There were a total of 10 nesting colonies located in the Konkan coasts, of these, three were active and seven were inactive or abandoned by the vultures (Table 4.7.). There was no significant difference in the habitats of both active and inactive nesting colonies (ANOVA, $p=0.39$). However, there were several similarities among all nesting colonies which include all nesting colonies were in the coconut plantation areas, close to sea shore (within 100 m), flat terrain, close to fresh water (mostly river, within 5 km), close to forests (within 1 km), close to human habitation that too within 200 m and also close to carcasses dumping ground (mean=1.5 km, $N=10$).

4.2.2. Nest Site Selection of OWBV

A total of seven active nests were found during the study period in three nesting sites namely Anjarle, Murud and Deobag. However, more than 75 old or inactive nests were found in these colonies. Circular plots were laid to study the vegetative structure and other habitat characters of nearest nesting areas and non-nesting areas of the nesting colony. There was no significant difference in the tree heights of nesting and non-nesting areas (Independent sample t test, $t = -0.406$, $p > 0.05$) and also there was no difference in the GBH of trees ($p > 0.05$). Oriental white- backed vultures largely preferred an area with tree heights between 12 m to 30 m with an average height of 16 m in both Anjarle and Deobag. However, vultures preferred a tree with height of 25 m to nest and avoided the trees taller than 28 m (S.E. 0.94, Mean – 29.72). This might be to protect nests from predators as nest in taller trees are more exposed to predators and

vulnerable to wind as all nesting colonies are on the windy sea shore. Similarly, vultures may be avoiding smaller trees since they are difficult to approach.

Interestingly most of nesting trees were either close to road, well or house. This might be due to avoid predation of nests or easy to approach the nest from foraging or for better vigilance by parents.

Table 4.2, 4.3, 4.4 and 4.5. shows descriptive statistics of nesting site and non nesting sites in Anjarle and Deobag site.

	N	Minimum	Maximum	Mean	Std. Deviation
Height (m)	344	5.00	35.00	16.0756	6.61742
GBH (m)	344	.06	2.01	.5960	.34886
Valid N (listwise)	344				

Table 4.2. Descriptive Statistics of Trees at Anjarle Nesting Site

	N	Minimum	Maximum	Mean	Std. Deviation
Height	139	5.00	25.00	16.2518	5.00303
GBH_Met	139	.13	2.01	.6710	.41136
Valid N (listwise)	139				

Table 4.3. Descriptive Statistics of Trees at Anjarle Non Nesting Site

	N	Minimum	Maximum	Mean	Std. Deviation
Height	128	3.00	33.00	16.7891	7.98587
GBH	128	.13	3.10	.8037	.38699
Valid N (listwise)	128				

Table 4.4. Descriptive Statistics of Trees at Deobag Nesting Site

	N	Minimum	Maximum	Mean	Std. Deviation
Height_Deobag	78	3.00	30.00	14.6923	7.34017
GBH_Met_Deobag	78	.14	2.30	.7835	.30656
Valid N (listwise)	78				

Table 4.5. Descriptive Statistics of Trees at Deobag Non Nesting Site

Both the table shows almost similar values revealing that both the sites have similar habitat characteristics. e.g. Mean height of trees in Anjarle is 16.07 in Deobag it is 16.78

Table 4.6. Major habitat variables of nesting colonies in the study area (All sites comes under Panchayat Area)

Nesting/Feeding Colony	Location		Area	District	Taluk	Is it forested landscape? Yes, adjoining to the coconut grove towards West of the Anjarle village	Physiography (hilly/undulating /flat)	Is it agricultural landscape?	Major habitat type of colony
	Latitude	Longitude							
Anjarle	17° 51' 12.3"	73° 05' 14.3"	100 ha	Ratnagiri	Dapoli	No	Flat	Yes	Coconut Grove
Deobag	15° 58' 53.7"	73° 29' 42.1"	100 ha	Sindhudur	Malvan	No	Flat	Yes	Coconut grove
Murud	17° 45' 57.9"	73° 07' 09.4"	75 ha	Ratnagiri	Dapoli	No	Flat	Yes	Coconut grove
Dabhol	17° 35' 23.0"	73° 09' 48.3"	10 ha	Ratnagiri	Dapoli	Yes	Flat and hilly	No, few coconut plantation	Backwater area
Mithbaao	16° 17' 43.9"	73° 25' 06.4"	10 ha	Sindhudur	Devgarh	Yes, dry deciduous	Flat	Yes, few coconut plantation	Dry deciduous forest
Newre	17° 06' 53.2"	73° 17' 47.8"	150 ha	Ratnagiri	Sangameshw ar	Yes, dry deciduous	Flat	Yes	Coconut grove
Ganpatipule	17° 09' 12.4"	73° 16' 16.4"	105 ha	Ratnagiri	Sangameshw ar	Yes, dry deciduous	Flat	Yes	Coconut grove
Purnagarh	17° 48' 37.0"	73° 19' 11.8"	75 ha	Ratnagiri	Rajapur	Yes, dry deciduous	Flat	Yes	Coconut grove
Jaitapur	17° 37' 38.1"	73° 22' 14.7"	140 ha	Ratnagiri	Rajapur	Yes, dry deciduous	Flat	Yes	Coconut grove
Malvan Adari Beach	16° 04' 06.6"	73° 27' 56.6"	200 ha	Sindhudur	Malvan	No	Flat	Yes	Coconut grove

Contd. (Table 4.6.)

Nesting/Feeding Colony	Major landuse pattern in the region	Major profession of people around	Nearest forest		Nearest town/city			Nearest water bodies	
			Name	Distance	Name	Distance	Distance	Name	Distance
Anjarle	Horticulture (Coconut and Arecanut)	Agriculture and Fishery	Anjarle moist deciduous	200 m	Dapoli	21 km		Jog River	1 km
Deobag	Plantation, tourism facilities	Fishing, tourism	Malvan moist deciduous	15 kms	Malvan	10 kms	15 kms	Karli River	1 km
Murud	Horticulture (Coconut, Arecanut)	Fishing, Horticulture, Tourism	Murud	500 m	Dapoli	15 kms	3 kms	Jog River	4 kms
Dabhol	Harbor	Fishing, horticulture	Dabhol	200 m	Dabhol	0 m	0 m	Washishti river	100 m
Mithbaao	Coconut plantation	Horticulture	Malvan	50 m	Malvan	6 kms	0 m	Karli River	4 kms
Newre	Coconut plantation	Fishing, horticulture							
Ganpatipule	Coconut plantation	Fishing, horticulture							
Purnagarh	Coconut plantation	Fishing, horticulture							
Jaitapur	Coconut plantation	Fishing, horticulture							
Malvan Adari Beach	Coconut plantation	Fishing, horticulture							

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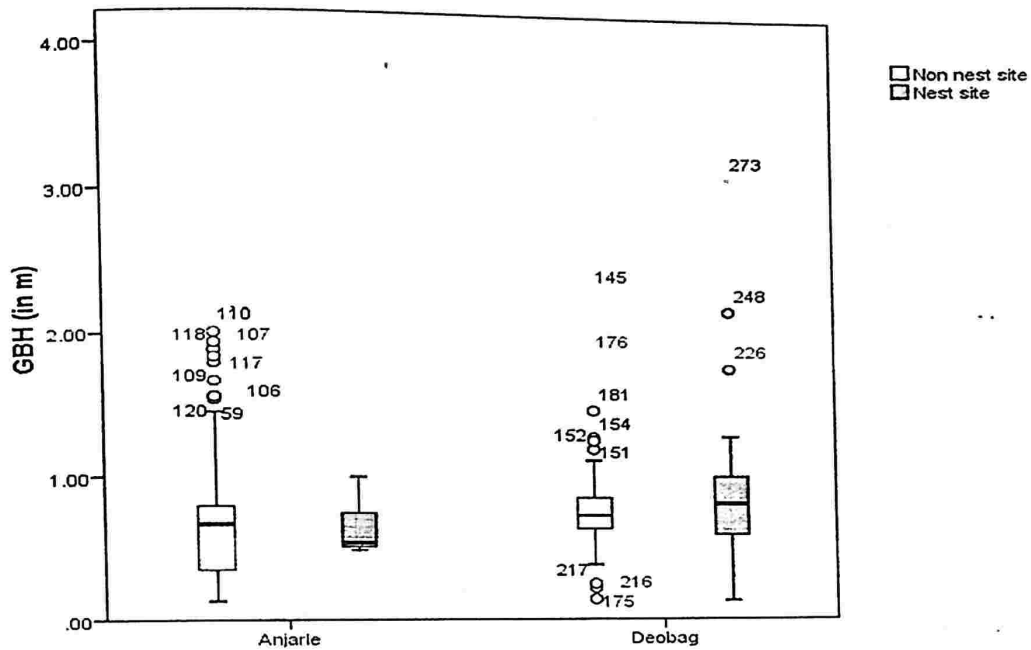


Fig. 4.2. Box plot showing GBH (in m) in the two sites

The box plot (Fig 4.2.) shows that both nesting sites and non-nesting sites in Anjarle and Deobag having more or less similar GBH. Normally, the GBH of coconut trees is more or less same in almost all age groups.

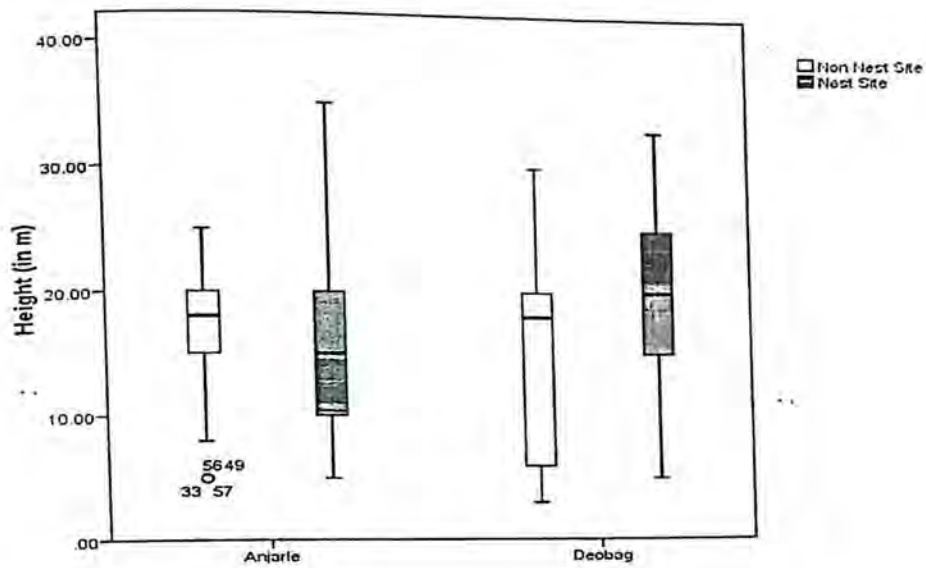


Fig. 4.3. Box plot showing Height (in m) in the two sites

The plot shows that, Deobag site has nest built up on a bit higher trees than in Anjarle. While non-nesting plots doesn't show much variation in the height of the trees. This is due to the age of the plantation, as they are generally planted at the same time and treated with same efforts causing almost equal growth in every plot.

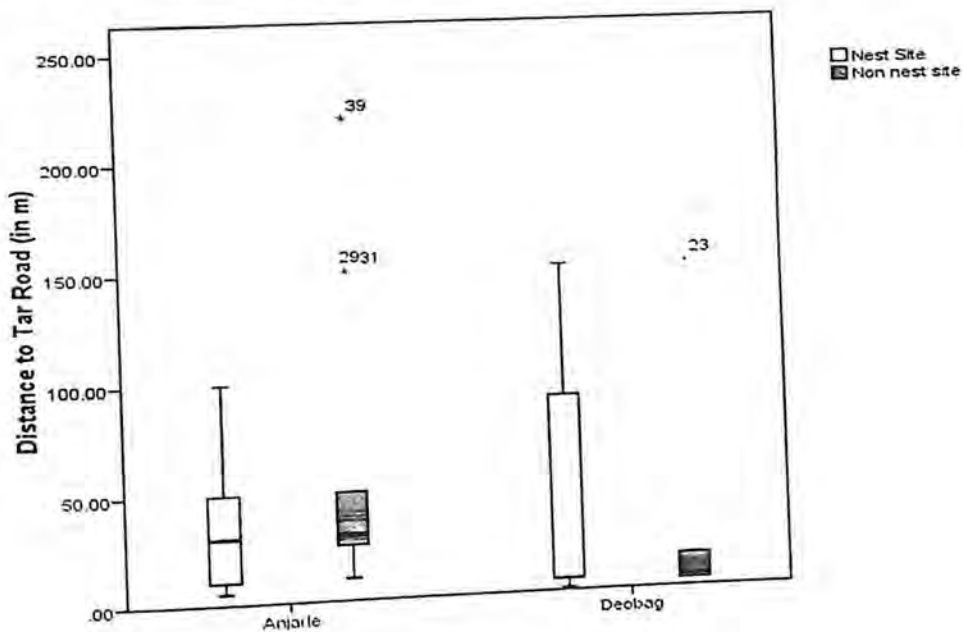


Fig. 4.4. Box plot showing Distance to the Tar Road (in m) in the two sites

Deobag site has nests which are more close to the motor able road than in Anjarle. The same results were found in Anjarle. This is because the study area had coconut plantation in a narrow strip (Maximum width of the strip is 200 m in both sites) which makes the plots very close to the tar road.

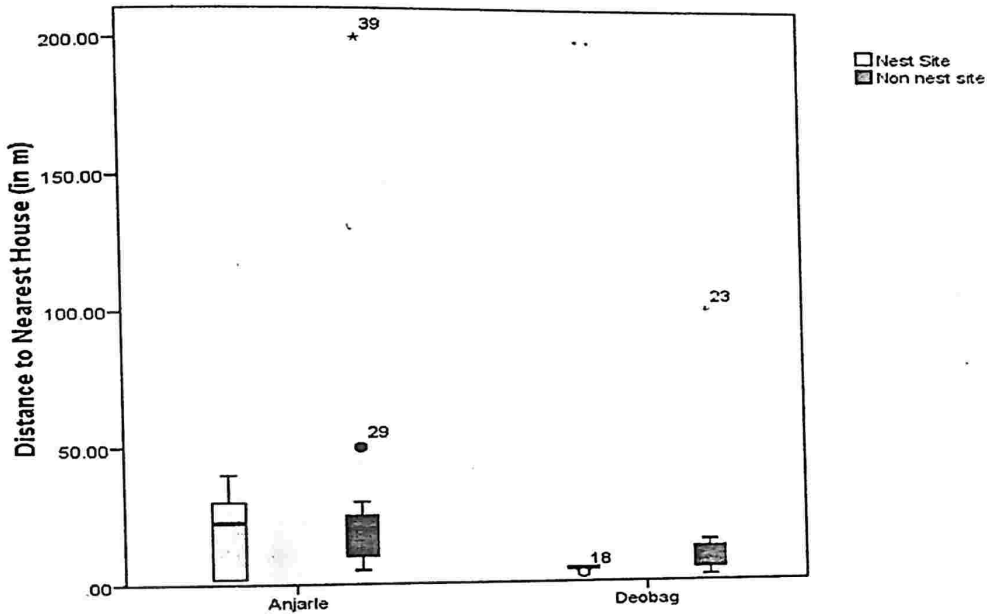


Fig. 4.5. Box plot showing Distance to the nearest house (in m) in the two sites

This plot is also similar to the previous graph (Fig. 5.3.). As, the houses are close near tar roads, the distance of nest from the house is almost similar.

4.2.3. Other Habitat Characteristics of OWBV

Across the Indian Sub-continent, the Konkan coast has most of the nesting sites in the coconut planted areas (Ali and Ripley, 1978). Within the coconut plantation, vultures have been observed preferring the coconut trees which were close to houses or well for nesting.

Importance Value Index (IVI) for trees present in the nesting sites

To get general idea about the vegetation, Importance Value Index (IVI) was done.

The formula to calculate IVI is as follows.

$$IVI = \text{Relative Density} + \text{Relative Frequency} + \text{Relative Dominance}$$

Following are the IVI values for the vegetation.

104.37	Coconut
46.53	Areca nut
15.47	Banana
7.270745	Jackfruit

Table 4.7. IVI Index of Nesting Site Vegetation Plots (Anjarle Site)

121.58	Coconut
39.65	Areca nut
19.70	Banana
5.15	Jackfruit

Table 4.8. IVI index for non nesting site vegetation plots (Anjarle Site)

Results clearly show that vegetation was dominated by coconut followed by Areca nut and banana in both nesting and non nesting sites. Same results were found in Deobag site. So, they are not shown in the table.

Normally vulture nests are found in colonies at traditionally used sites, usually in tree-tops 2–18 m high, often near villages, roads or canals (Ali and Ripley 1968–1998, Sarker 1987, Grimmett *et al.* 1998). Colonial nesting is the norm, with up to 15 nests in a tree, and up to 100 in a 250 m diameter circle (Hume and Oates 1889–1890). Colonies in the Sundarbans, Bangladesh, covered a large area: 2–6 km², whilst those in Pakistan numbered over 80 pairs (Roberts 1991–1992) and in fact one site has been found to hold over 1,000 nests; colony size is generally larger in the plains than in the hills in India (Baker 1932–1935). Colonies may be used for at least 50 years consecutively (Hume and Oates 1889–1890). Large trees are generally favoured as nest and roost sites (Baker 1932–1935), including: *Shorea robusta*, *Ficus religiosa* (peepal), *Siris*, and *Pterygota alata* in the Doon valley, Uttar Pradesh (Singh 2000); *Mangifera indica*, *Tamarindus indica*, *F. religiosa*, *Azadirachata indica*, and *Dalbergia sissoo*, often in the

centre of villages, in Lucknow, Uttar Pradesh (Jesse 1909); usually *D. sissoo* (shisham), also *T. indica* (tamarind) and *Ficus Religiosa* in Agra, Rajasthan (Satheesan 1995); *Prosopis cinerea* in the Thar desert, Rajasthan (Rahmani 1996b); *Cocos nucifera* (coconut), *Terminalia indica*, and *Ficus* in Gir forest, Gujarat (Grubh 1978); *Dalbergia paniculata* and *F. religiosa* at Ramjeetola, Madhya Pradesh (Kanoje 1996a); *Mangifera indica* (mango) and *Bombax malabaricum* (silk cotton) in south Konkan district, Maharashtra (Hume and Oates 1889–1890); Casuarina, *M. indica*, *Ficus religiosa*, *Ficus bengalensis*, *Terminalia indica*, and palm trees in Calcutta district (Munn 1899); *Terminalia arjuna* in northern Tamil Nadu (SS). In the Punjab valley of Pakistan, *Dalbergia sissoo* (shisham) trees are critically important to the still considerable populations of this vulture (M. A. Virani *in litt.* 2001). Rarely, nests are found on buildings when suitable trees are absent, especially in desert and semi-desert areas (Satheesan 1995), and nests on cliffs are also known (Jerdon 1862–1864). For example, 605 in Jodhpur, the commonest nesting sites were 10–15 m high on cliffs, and the second commonest sites were 7–10 m high in *Ficus bengalensis*, although in arid areas nests were as low as 4 m because of the lower stature of the trees; less often *Azadirachata indica*, *Eugenia jambolina* (jaman) and *Tamarindus indica* were used (Sharma 1970).

Local people in the Konkan coast have also informed that in fed decades before oriental white backed vultures use to prefer *Ficus bengalensis*, *Ficus religiosa* and mango trees for nesting but these trees have been removed from this region and planted with coconut, casuarinas and areca nut. Since there is no option for breeding vulture to choose nesting trees in the coconut dominated landscape they prefer the coconut trees for nesting, which resulted conflict between farmers and vulture in the Konkan coast.

4.3. Breeding success and breeding behaviour of OWBV

4.3.1. Breeding Success

Colonial nesting is the norm; with up to 15 nests in a tree, and up to 100 nests in a 250 m diameter circle (Hume and Oates 1889–1890), therefore, it is prudent to conclude that there was no colonial nesting observed during 2011 in the Konkan coast as maximum number of active

nests observed were four in Anjarle. This is in fact very shocking as the Konkan belt was well known for several colonial nesting sites of Oriental white backed vulture (Hume and Oates 1889–1890).

During the study period, 7 active nests were found. Of these, four nests were at Anjarle, 2 were at Murud and 1 at Deobag site. Active nest means a pair continuously sitting at the nest and doing their nesting activities including egg lay. Of the seven nests, three nests were successful and fledglings from these nests could leave successfully at the middle of April, 2011. The other three nests were abandoned at midway and one nest was with dead adult vulture but with an egg on 18th February, 2011 in Anjarle Site. In overall, 43% of nesting success was observed in the Konkan coasts during 2011 although the sample size was very low (N=7).

Mayfield's estimation of nest survival was done for all nests in all of the sites i.e. Anjarle, Murud and Deobag. Following Table 4.8. shows the results for this estimate (Mayfield, 1961).

Nest mortality rate during incubation	0.01 nest/ day
Nest survival during incubation	0.63 nest/ incubation period
Nest Survival during nestling period	1 nest/ Nestling period
Nest Survival from incubation to fledgeling stage	0.63 nest/ The Fledgling Period
Nestling Survival	1 Hatchling/ Nestling Period
Egg Survival During Incubation	1 egg / Incubation period

Table 4.9. Mayfield's estimation of nest survival in the study area during 2011

The estimate runs the calculation to give the figure which shows that the survival or mortality rate per day. The result shows that the nest survival during nestling period was 1. It means after hatching of the egg, there was no mortality in any nest. Though here sample size is low, but still this estimate is significant enough to prove a point that even in such unfavourable

conditions, the remaining population of OWBV in the Konkan Coast is managing quite well and reproducing also. But, the use of diclofenac has not yet completely stopped from the study area. This information was gathered from various local people who own cattle.

The Anjarle site was having a vulture restaurant, but it never started working during the study period due to non-availability of carcasses. Therefore, vultures were on their own to find food for the hatchlings. Still they could manage to rear their young ones largely feeding fish resources available on the sea shore as per local people's observation.

Therefore, there is a hope that vulture in the Konkan coasts can be recovered provided the complete banning and phasing out of diclofenac drug, opening up of more vulture restaurant to supply diclofenac free meat and better compensation for farmers.

4.3.2. Breeding Behaviour

The nests of OWBV were monitored for nearly two and half month in Anjarle. Based on the observation on nesting behaviour from February, 2011 till Mid April, 2011, I have categorized all data into two groups for time budget analysis and estimated the frequency of activities.

Behavioural Activities of Chick:

Following activities were recorded during the study period.

Resting in nest, Preening, Scanning, Flapping wings, Defecation, Resting with head down, Resting on Perch, Feeding, Basking, Removing leaf sheath, Requesting food, Calling.

Behavioral Activities of Adult:

Following activities were recorded during the study period.

Basking, Resting, Preening, looking around, Provisioning, Nest guarding, Absent, Resting with head down, Defecation.

Activities like basking, resting, nest guarding look similar, but they are not. Nest guarding activity has observations when adult was sitting on other tree near the nesting tree and not on the nest tree. Resting activity is recorded only at the nest and nowhere else. In nest guarding, it may have rested there. But my main focus was on the activities which were performed at the nest.

4.3.2.1.A. Time Budget Analysis of Adult's nesting behaviour

Following table shows the percentage values for each activity across 7 weeks

Activity	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week
Basking	1.94	0	0	0	0	0	0
Resting	22	28.76	23.45	18.53	18.42	21.38	18.88
Preening	9.33	8.65	4.88	5.71	7.26	4.16	4.72
Scanning	0	0	0	0	0	2.65	1.38
Provisioning	0.61	0.79	0.39	0.43	0.78	1.26	0.69
Nest Guarding	22.66	15.47	21.98	18.41	32.91	34.68	12.08
Absent	43.44	45.63	49.28	56.86	34.49	35.83	62.22
Resting with head down	0	0.67	0	0	6.06	0	0
Defecated	0	0	0	0.03	0.04	0	0

Table 4.10. Percent time spent on each activity by adult OWBV across 7 weeks

1. Basking:

This activity was generally seen during the morning observation sessions that to only in the first session which starts at 6:00 a.m. and ends at 9:00 a.m. In this activity the adult bird used to perch on the branch of the nesting tree with its back towards the opposite direction to the sun. After sometime, the bird would change its position and face its back towards the sun and stay motionless for nearly an hour or more than that.

Most of the times, adult was leaving the nest tree and was going to other neighbouring tree for basking. That's why there were observations of this activity only for the first week.

2. Resting:

Resting refers to the stage where the bird is standing or perching still without much of a movement. The graph below has activities which were only observed at the nesting tree. The graph shows that resting activity near the nest was higher in the early period of breeding season when the chick was too young to defend itself from predators. But as weeks gone by, the resting activity was started to decrease significantly than earlier weeks.

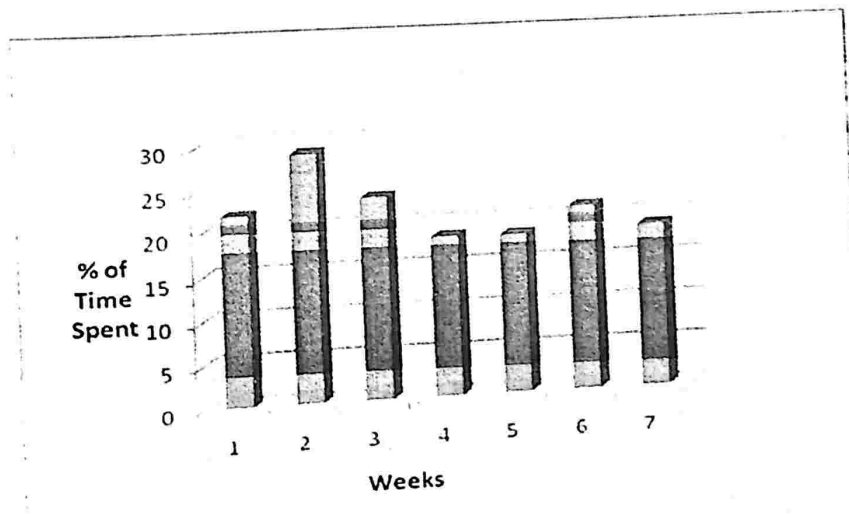


Fig. 4.6. Percent time spent on resting by adult OWBV in the nest across 7 weeks

3. Preening:

Preening was the most common behaviour shown by many birds. It generally used to clean the feathers from ectoparasites, soil or dust particles. There are many ways by which birds do preening. They preen their different body parts one at a time. The graph below has different preening phases added together to make one category. It has included following activities.

- i. Preening of wings
- ii. Preening of neck
- iii. Preening of belly
- iv. Preening of tail feathers
- v. Preening on perch
- vi. Preening in nest

The graph (Fig 4.7.) showed gradual decrease in the preening activity till the end of breeding season.

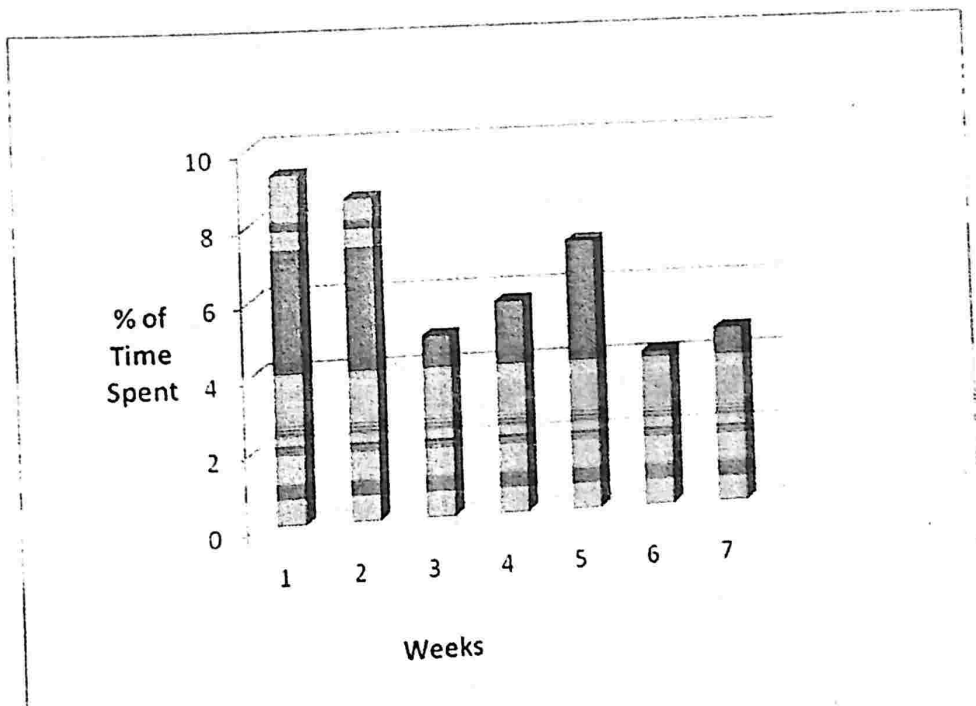


Fig. 4.7. Percent time spent on preening by adult vulture in the nest across 7 weeks

4. Scanning:

This activity includes the vigilance of the adult towards its nest to protect it from the predators. Here also, looking around from perch, nest, from other branch were added together to make one category. This has only those observations which were made when adult was sitting on the nesting tree. Otherwise scanning was also observed when adult was perching on the other tree. But the birds were observed only when they were present at the nest only and not anywhere else.

5. Provisioning:

This activity refers to the adult where it gives food to the chick at any point of time. There was a particular time interval between two successive food deliveries. The recording of the activity started when adult starts giving the food to the chick and ended when it stops giving the food to chick.

The graph of provisioning shows more or less similar trend except the sixth week observation showed more percentage of time spent in this activity.

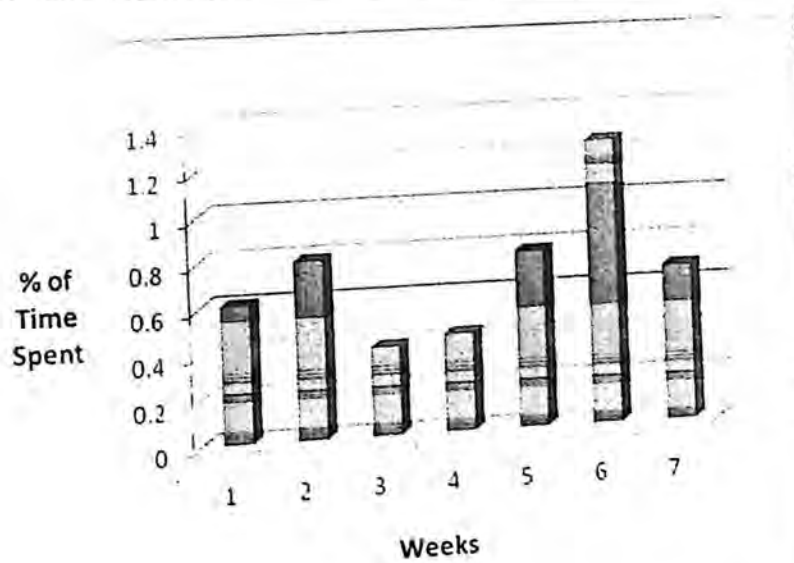


Fig. 4.8. Percent time spent on provisioning by adult OWBV in the nest across 7 weeks

6. Nest Guarding:

This behaviour includes adult sitting on other tree and keeping an eye on nest from there. This behaviour was observed for many times during the study period. The graph showed slight increase in nest guarding activity. There is no specific explanation for this activity.

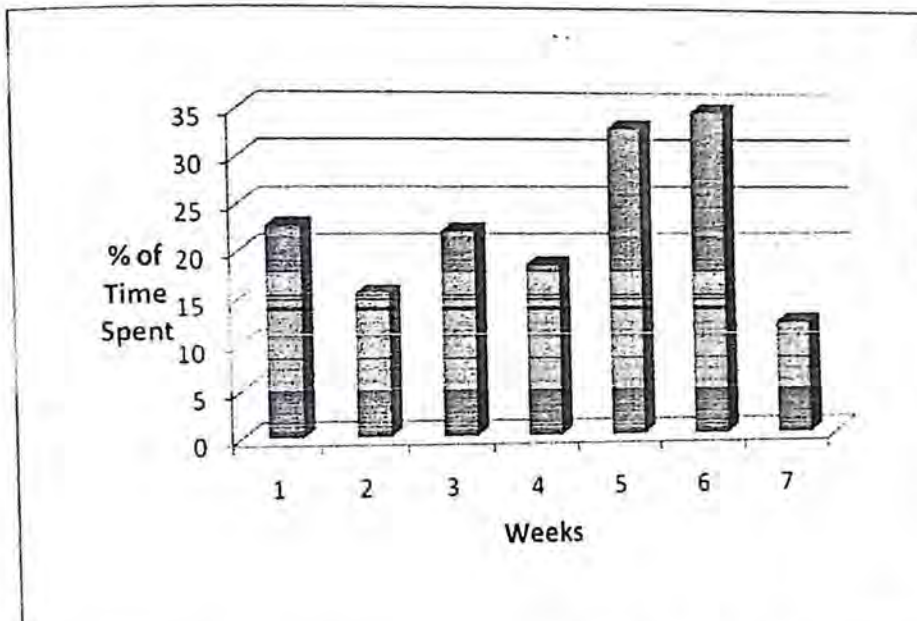


Fig. 4.9. Percent time spent on nest guarding by adult OWBV across 7 weeks

7. Absent from the nest:

Most of the time, the adult birds were went outside the nest site and came late in the afternoon. Since this activity may be related to food availability, for example, if the food is available at close proximity the adults are expected to return back the nest quickly otherwise it will take more time for adult to look for food. Therefore, this activity was observed carefully to have some understanding about the food availability in the region. This study observed that most of the time especially when chicks grown older, adults took a lot of time to return back to the nest may be inferred that the food availability in the region was scarce. But this activity remained more or less similar throughout the study time period.

8. Resting With Head Down:

This is the typical behaviour which has been in a debate for a longer period of time. It is also called as neck drooping behaviour. It generally tells about a state of unhealthy bird which eventually dies. But some say that it's just a thermoregulatory mechanism of the body to cope up with hot weather. This behaviour was seen but it was a rare event and mostly seen during the moist afternoons of the Konkan Coast during the month of March in which temperatures in the afternoon rises pretty high.

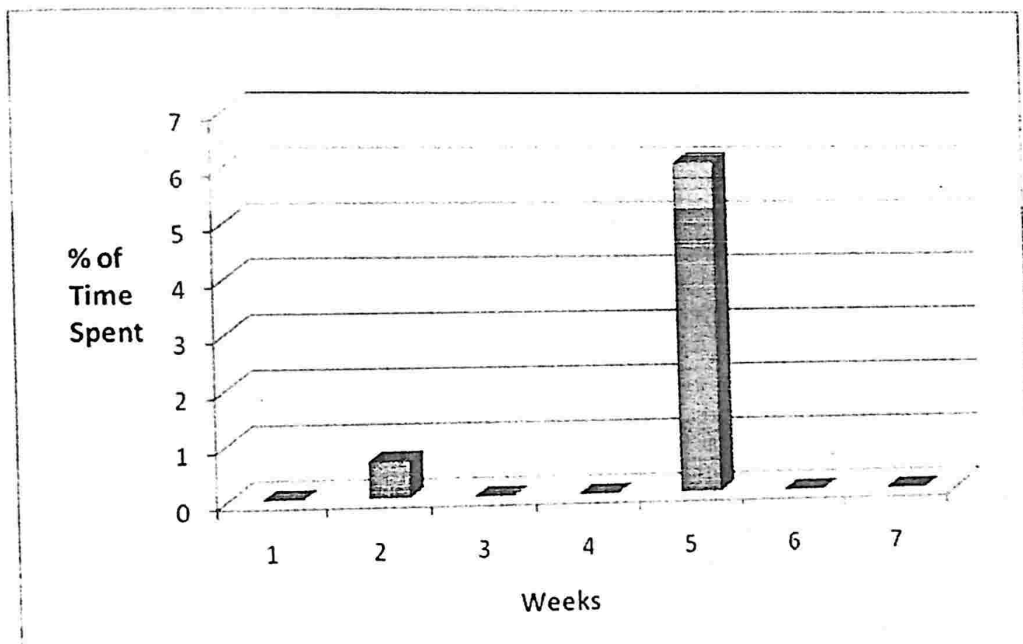


Fig. 4.10. Percent time spent on resting with head down by adult OWBV in the nest across 7 weeks

9. Defecation:

This activity was seen rarely as the adult bird used to defecate elsewhere other than the nest tree. The ground below was full of white colored, highly odorous smell of its excreta. But mostly it was of the chick which in the nest during the whole time.

Only 4th and 5th week has got this behavior. Otherwise, it is rare to see this activity near the nest tree. The reason behind this is unknown.

4.3.2.1.B. Time Budget Analysis for Chick

Following table shows percent time spent for each activity across 7 weeks of observations

Activity	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week
Resting in nest	70.46	71.46	60.47	41.3	31.7	28.05	19.3
Preening	29.02	27.3	33.13	35.31	27.81	27.26	30.55
looking around	0	0	0	0	7.46	24.4	29.16
Flapping wings	0	0	1.78	6.74	9.04	5.11	3.88
Defecated	0	0	0.03	0.15	0.11	0.27	0.55
Resting with head down	0	0	0	0.31	4.08	2.89	2.77
Resting on perch	0	0	4.16	15.19	18.8	10.39	12.77
Provisioning	0.46	0.79	0.39	0.79	0.71	1.26	0.69
Basking	0	0	0	0	0	0	0
Removing Leaf Sheath	0	0	0	0.15	0.23	0.11	0
Begging	0.04	0.43	0	0	0	0.03	0
Calling	0	0	0	0	0	0.15	0.27

Table 4.11. Percent time spent on each activity by chick of OWBV across 7 weeks

1. Resting in nest:

This behavior was mainly seen during the early breeding season when chick was too small to come out of the nest. The graph shows steady decrease in the time spent in this activity. As chick grew older, it started to spend less time on this activity.

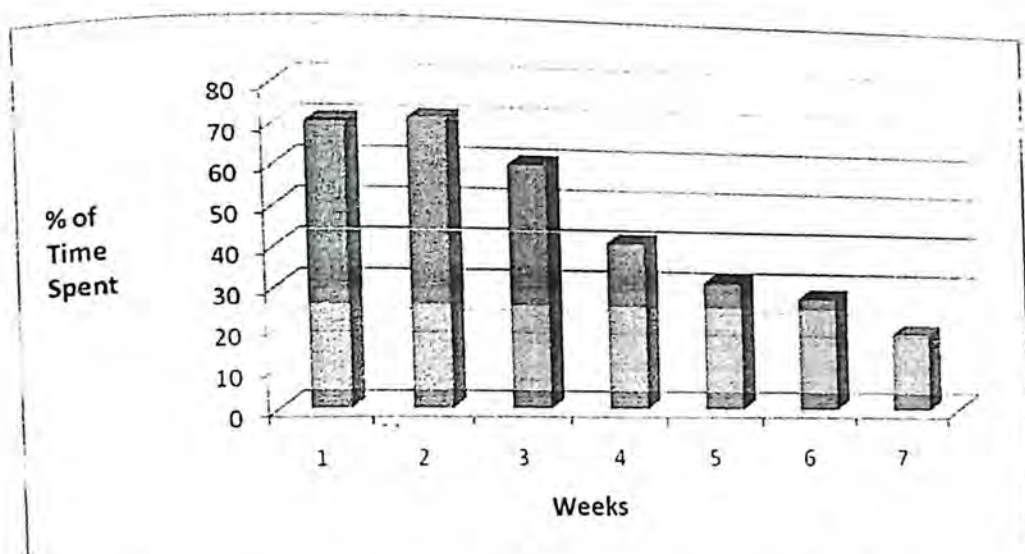


Fig. 4.11. Percent time spent on resting in nest by chick OWBV across 7 weeks

2. Preening:

This activity was similar to the adult's activities of preening. The chick showed more or less similar pattern of spent time on this activity.

3. Scanning:

It is the similar behavior to that of the adult bird. As time progressed, the chick became more curious about the surrounding environment and the activity went on increasing till the end of the breeding season.

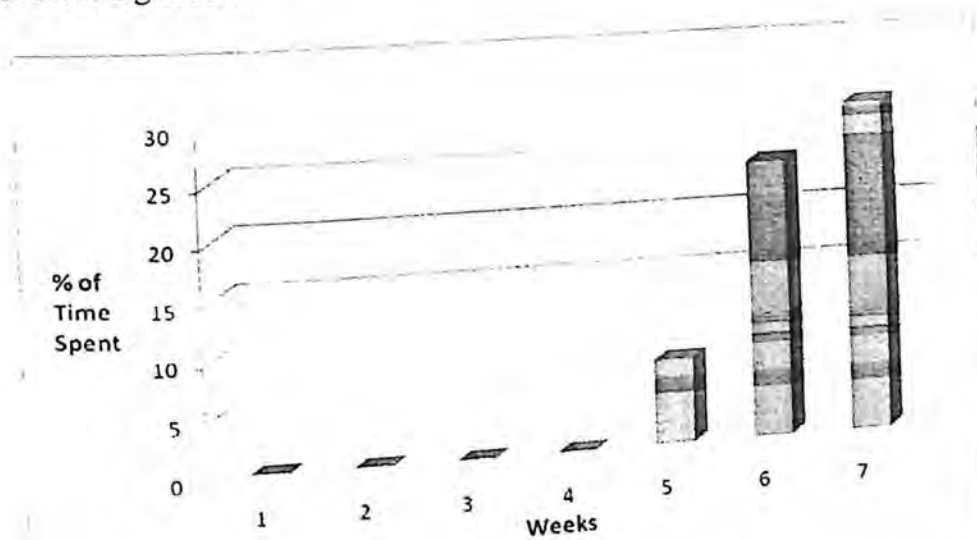


Fig. 4.12. Percent time spent on scanning by chick OWBV in the nest across 7 weeks

4. Flapping Wings:

This activity was started during the third week of hatchling. The chick used to flap its wings to practicing flying technique and strengthening the flight muscles.

This activity also went on a steady increase and then gradually decreased as chick got mature and capable of abandoning the nest by itself.

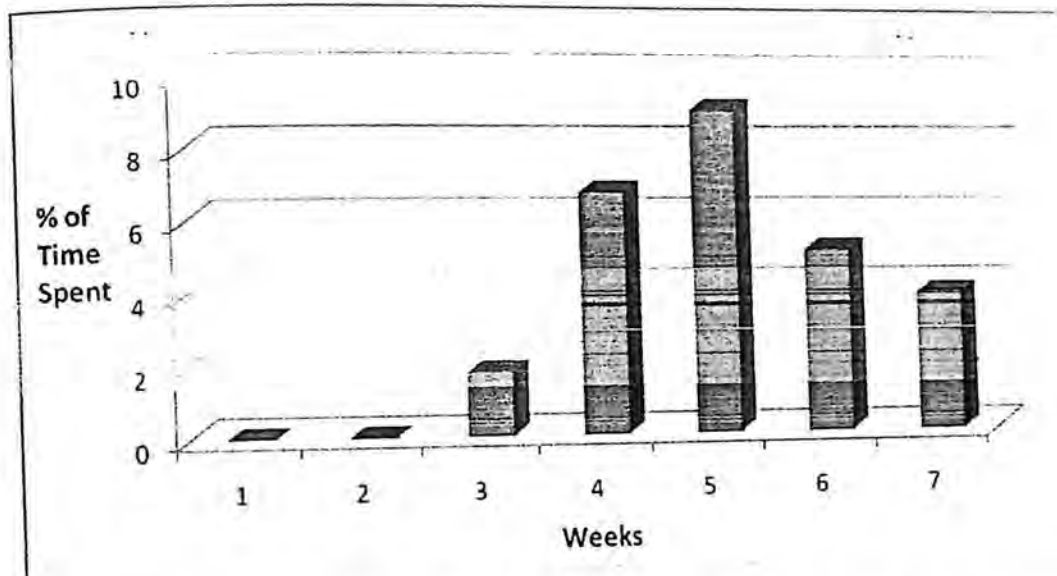


Fig. 4.13. Percent time spent on flapping wings by chick OWBV in the nest across 7 weeks

5. Defecation:

It is similar activity as like the adult bird. The chick used to defecate inside the nest, which caused huge bad odour around the nest. While, the ground below was full of white droppings. Local people say that nothing can grow in such soil because its dropping is highly acidic.

So, time spent in this activity also goes on increasing till the end of breeding season. This is because; in earlier observations it was difficult to see this activity, as chick was inside the nest. So, when it started to come out of the nest, this activity became more visible day by day. That's why the graph showing such pattern. There is no other reason for such kind of pattern of the graph.

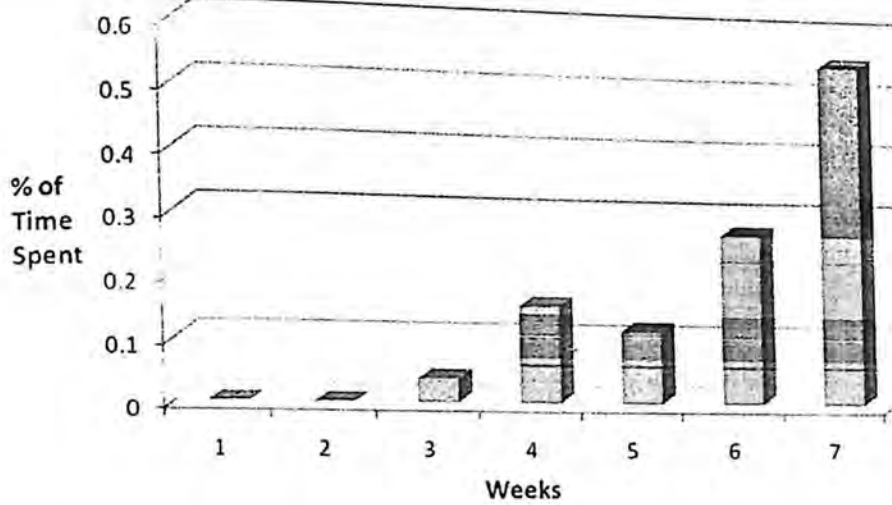


Fig. 4.14 Percent time spent on defecation by chick OWBV across 7 weeks

6. Resting with head down:

It is the similar behaviour to that of adult.

Chick showed this behaviour at the later stage of its development, when it started to perch outside the nest. Also this behaviour was mostly seen during afternoon sessions.

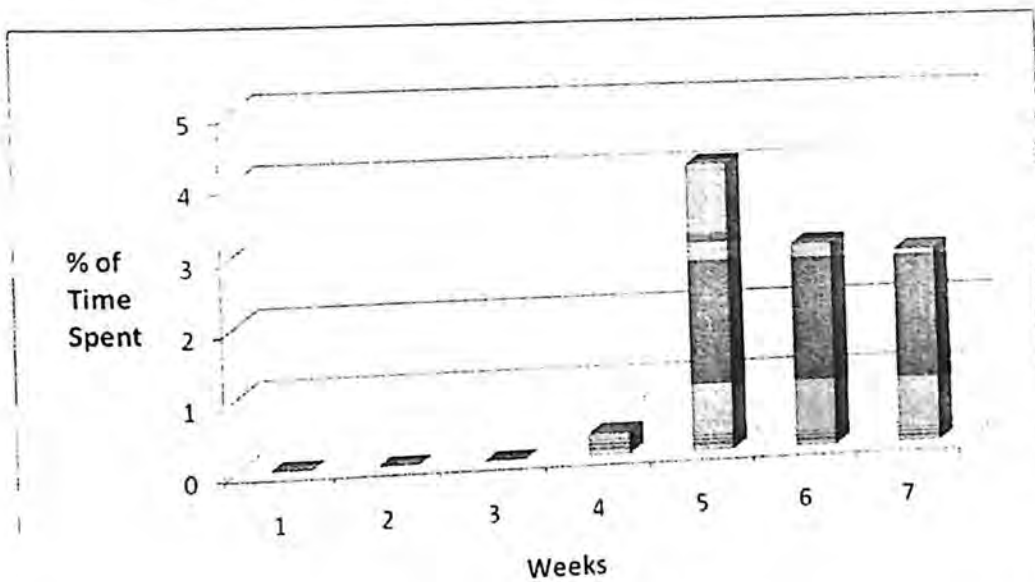


Fig. 4.15 Percent time spent on resting with head down by chick OWBV across 7 weeks

7. Resting on perch:

It is the similar activity like resting in nest, but thought to be an important point during the development of the chick, so kept it separately.

This activity also shows similar trends. It goes on increasing till the end of the breeding season.

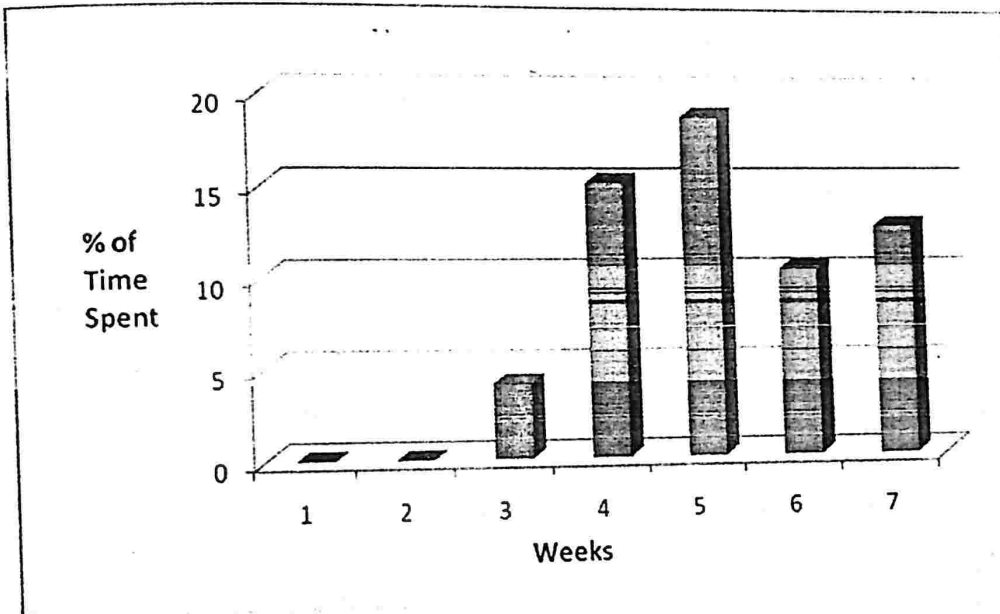


Fig. 4.16. Percent time spent on resting on perch by chick OWBV across 7 weeks

8. Feeding:

It was the opposite to observation on the adult's provisioning activities. It was the main activity of all as it affects directly to the survival of the bird.

The graph showed fairly similar pattern of feeding. Slight increase in the time spent for feeding as food requirements got increased at the end.

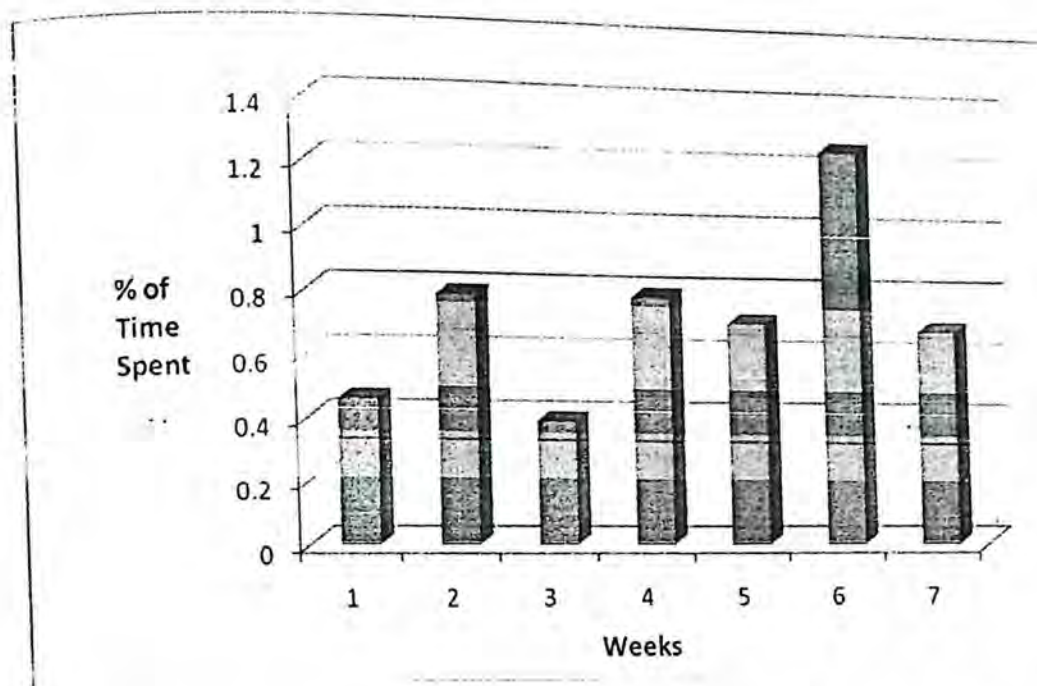


Fig. 4.17 Percent time spent on feeding by chick OWBV in the nest across 7 weeks

9. Basking:

This activity was not observed in the chick as it was combined with resting in nest and resting on perch during morning hours. So, graph is not showing any projections for this particular activity.

10. Removing leaf sheath:

This was a unique behaviour observed during the late months of the breeding season. The chick used to remove the leaf sheath of the coconut tree from its base. It was ultimately leading to leaf loss for the coconut tree. The reason behind this activity is unknown.

11. Requesting Food:

This activity was generally followed by adult giving food to the chick. This activity was used to draw the attention of the adult bird to invoke them to give food.

This activity was seen during the early breeding season, later it got disappeared totally. Because, this activity is prominently seen during the early stage of development. In later stage, the chick didn't do request for food.

12. Calling:

Sometimes the chick used to make croaking calls like crows. This activity was seen in the late March. And seen only when there was no adult bird around.

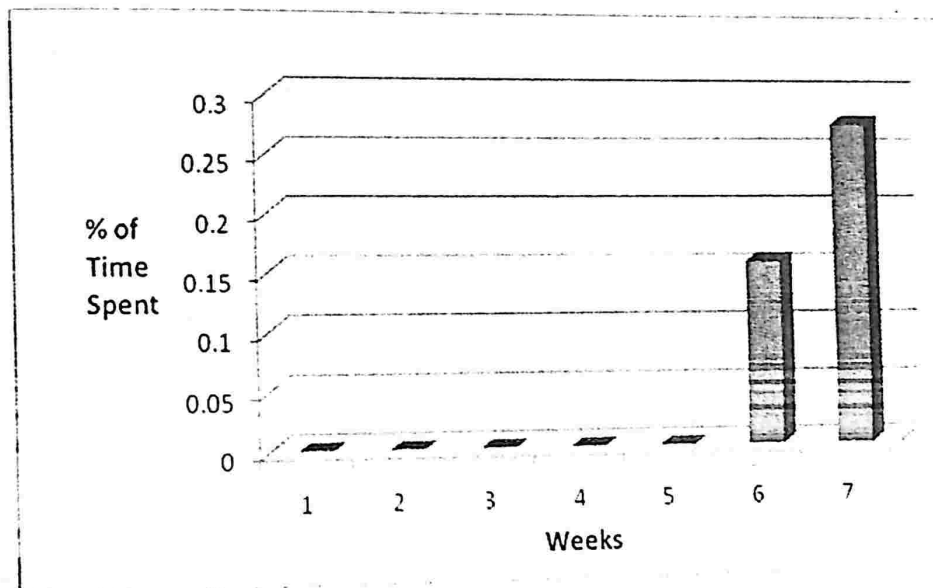


Fig. 4.18. Percent time spent on calling by chick OWBV in the nest across 7 weeks

4.3.2.2. Frequency of activities

Time budget is important to understand about the major behavioral activities but some of the activities which are done rarely in term of time but are done more frequently, that can be analyzed by doing the frequency analysis. Here the activities are counted for their repeat in an observation period.

4.3.2.2.A. Adult Frequency Graph

Following Fig.4.19. shows the frequency graph for adult during the entire breeding season.

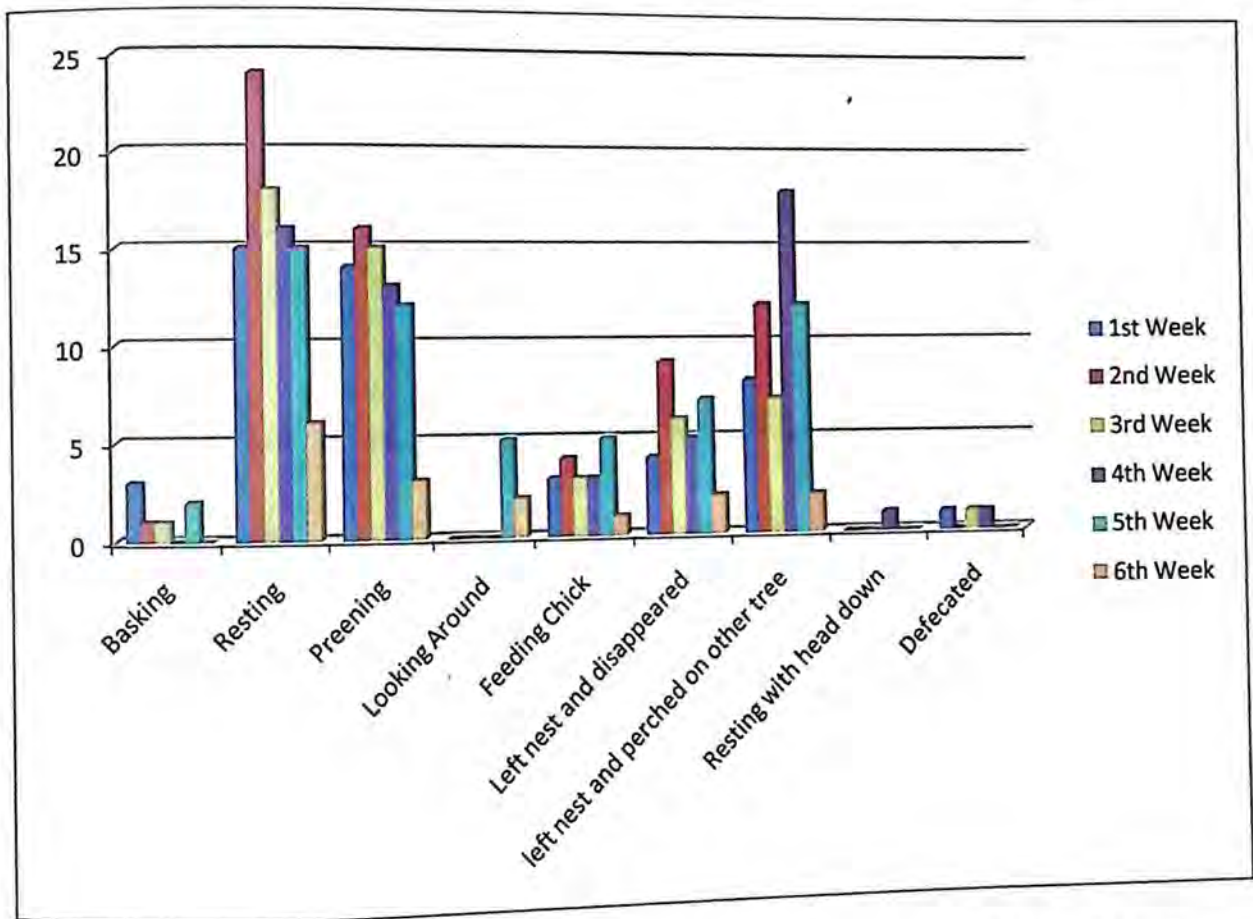


Fig.4.19. Frequency of various activities by adult OWBV across the weeks in the study area

The graph shows, most frequently done activity was 'resting' in the early time period (February to March). But later this activity was shifted to 'Left and perched on other tree' which was the behaviour of nest guarding.

4.3.2.2.B. Chick Frequency graph

The vulture chick was mostly alone in the nest during the study period. Also it started to come out of the nest in Mid March, 2011.

Following Fig.4.20 shows the frequency graph for the chick.

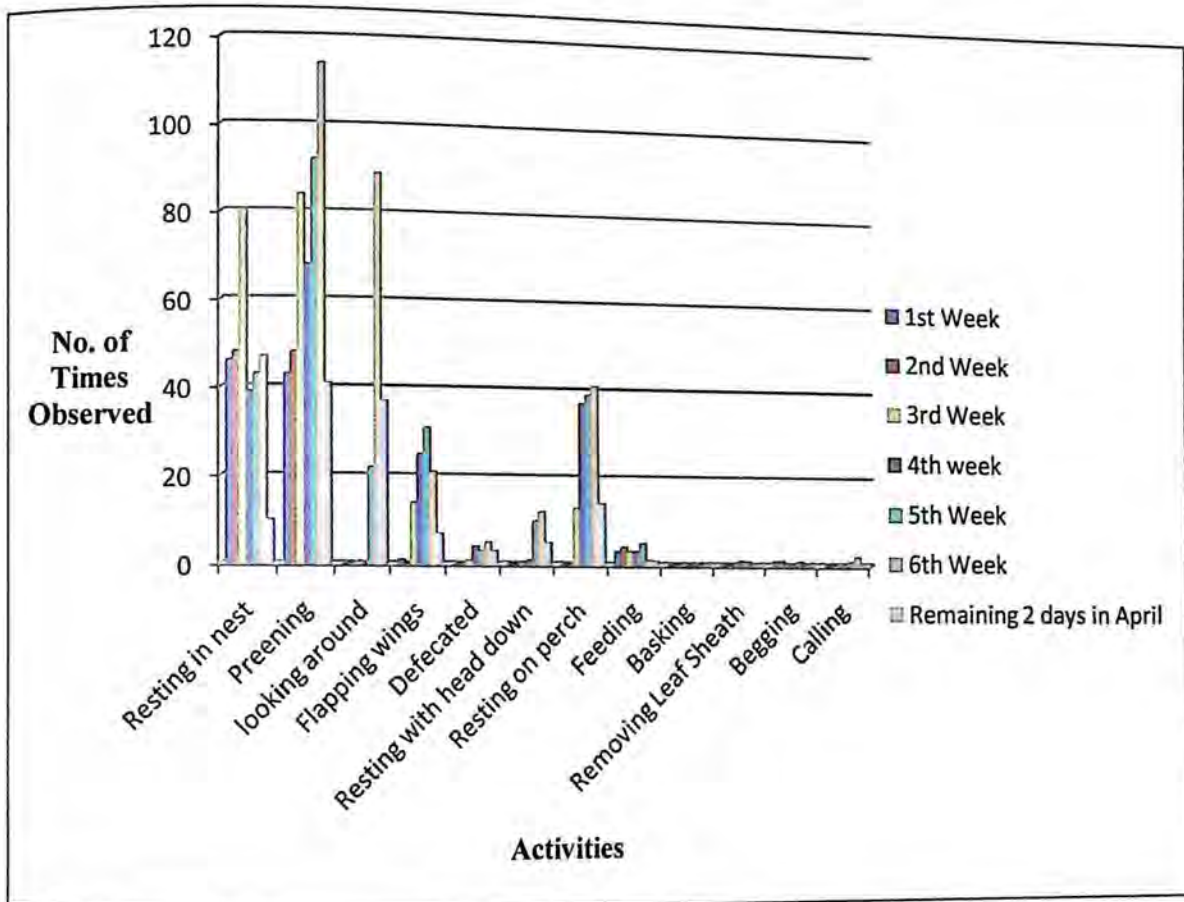


Fig.4.20. Frequency of various activities by chick OWBV across the weeks in the study area

4.3.2.3. Failed nesting behaviour

On 16th February 2011, four pairs of OWBV came to the Anjarle site and they have started to stay there for two weeks. They were probably visited this site earlier that was because when they arrived they were all landed on old nesting trees. Old nests in these trees have been removed by the farmers to prevent the vulture to nest further in these palms.

when they arrived they were all landed on old nesting trees. Old nests in these trees have been removed by the farmers to prevent the vulture to nest further in these palms.

There was a high hope of breeding of these pairs in Anjarle as they have started preparing for nesting as soon as they landed. But, unfortunately, after spending two weeks they have left the nesting colony. This failed nesting behavior might be due to nest destruction by farmers. Birds might have successful breed here if the old nests were retained.

5. Discussion

5.1. Status and distribution of Oriental white-backed vulture in the study area

Results clearly show that the status and distribution of OWBV is very low in the study area. After looking at the results, following points should be considered important for the status and distribution.

5.1.1. Threats

Major threats were observed for the nesting population of vultures in the Konkan coasts include the nest destruction by coconut farmers due to inadequate or lack of compensation. People in the region have started burying or burning cattle carcass to keep their villages clean which had resulted diminishing food sources for vultures. Fishermen were also observed throwing their cattle carcasses in the sea. Vultures may not be comfortable feeding the floating carcasses that too in sea. However, this may also be argued in other way that the people have started burying the cattle carcass because there were no vultures to feed on them. Whatever it may be the shortage of cattle carcasses seems to be one of the major threats to nesting population of vultures in the Konkan coasts.

5.1.2. Conservation perspectives

Initially this study was proposed to study the success of vulture restaurant in the region, however, that failed because of non-availability of cattle carcasses for the vulture restaurant during the study period. Vulture restaurant collect the cattle carcasses from nearby villages and keep it for 72 hours assuming that the diclofenac present in the carcass will disintegrate fully within 48 hours time. After preserving the carcasses for 72 hours they keep the diclofenac free carcasses on the ground near nesting colony for vultures to feed. Since there was a shortage of cattle carcasses for vultures in the region, it would be prudent to open vulture restaurants near nesting colonies such as Anjarle, Murud and Deobag.

Coconut farmers strongly believe that their crop yield drastically comes down when vultures start using their tree for nesting. Therefore, they started destroying the nest at the

beginning itself. In this connection, it would be better to adequately compensate the farmers which would enhance the nesting success of this critically endangered vulture. A scheme to provide compensation to the Coconut tree owners on whose tree the vulture builds a nest has been launched by the Govt. of Maharashtra recently (Subhash Puranik pers. Comm.,2011), but it is yet to get implemented properly.

5.2. Nest site selection and habitat characteristics of nesting colonies of OWBV

Study found that there was no significant difference in the habitats of both active and old nesting colonies in the Konkan coast which indicates that the decline of nesting population of vultures in the region may not be exclusively due to habitat destruction. Several similarities among all nesting colonies which include presence in the coconut plantation areas, proximity to sea shore, flat terrain, proximity to fresh water, forests, human habitation and also to carcasses dumping ground.

There was no significant difference in the tree heights of between nesting and non-nesting areas. Oriental white-backed vultures largely preferred an area with tree heights between 12 m to 30 m with an average height of 16 m. Most of nesting trees were either close to road, well or houses. This might be to avoid predation of nests or easy to approach the nest from foraging or for better vigilance by parents.

There was a shift in the nest site selection of OWBV due to non-availability of large sized natural nesting trees such as *Ficus bengalensis*, *Ficus religiosa* and mango in this region. Since there is no option for breeding vulture to choose nesting trees in the coconut dominated landscape they prefer the coconut trees for nesting, which resulted conflict between farmers and vulture in the Konkan coast (Konkan Survey Result).

5.3. Breeding success and breeding behaviour of OWBV

Colonial nesting is the norm, with up to 15 nests in a tree, and up to 100 nests in a 250 m diameter circle (Hume and Oates 1889-1890), therefore, it is prudent to conclude that there was

no colonial nesting observed during 2011 in the Konkan coast as maximum number of active nests observed in a single site was four in Anjarle. Earlier, breeding peak of vulture was observed in October–January in south Konkan district, Maharashtra (Hume and Oates 1889–1890) but this study could observe the breeding peak during January and March. Continuous observation on breeding peaks of vultures covering several years of observations in Konkan coast is required to check whether there is a shift in the breeding peak or not.

As weeks progressed, the adult birds started to leave the nest for a longer period of time that might be due to non-availability of food nearby or diminishing fear of chick predation as chick had grown bigger. Major activity of the chick was resting in the nest but it gradually changed as time progressed. Preening was the second major activity that was mostly observed followed by looking around, resting on perch, etc. Chicks were observed with tranquil and resting during the first 3-4 weeks and then later they came out of the nest and started to perch on the leaf of the coconut.

Since birds were not tagged, differences in the activities of parents and interactions between two nesting adults etc could not be observed which needs to be studied to understand the cost and benefits of parental care.

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OWBV chick in Murud Site (Preening)

a



Oriental White-backed Vulture (*Gyps bengalensis*) fledgling: After abandoning the nest

b

Plate 1



a

Adult bird sitting on the nesting tree (Coconut leaves are damaged)



b

Adult bird basking near the nesting tree

Plate 2



a

Adult bird with chick at Deobag Nesting Site, Sindhudurg District



b

Adult bird sitting on the chick (Both pictures were taken at same nest at same day and after an interval of 10 minutes with the same adult individual)

Plate 3



a

Burundi – One of the village covered in the Konkan Survey, A Typical Habitat dominated by coconut plantations



b

Large area of Coconut plantations used for toddy extraction making unsuitable habitat for Vulture Nesting

Plate 4



**Dead Vulture found in the nest A12 at Anjarle Site on 18 February,
2011**