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Summary

- The vulture population estimation in Gujarat was conducted on 28th and 29th May, 2016, in which four species of Globally Threatened vultures (as per IUCN Red List of Threatened Species) were included for population estimation. They were; White-rumped Vulture *Gyps bengalensis* (Critically Endangered), Long-billed Vulture *G. indicus* (Critically Endangered), Red-headed Vulture *Sarcogyps calvus* (Critically Endangered) and Egyptian Vulture *Neophron percnopterus* (Endangered).
- A total of 999 vultures of four species were recorded during May 2016 estimation. Of these, 843 individuals were *Gyps* vultures (458 White-rumped Vultures and 385 Long-billed Vultures), 24 Red-headed Vultures and 132 Egyptian Vultures. While during the previous statewide estimation in May 2012, a total of 1,037 vultures were recorded which included 938 *Gyps* vultures (577 White-rumped Vultures & 361 Long-billed Vultures), 8 Red-headed Vultures and 97 Egyptian Vultures.
- Of the four species of vultures covered under current population estimation, three species viz. Red-headed Vulture, Egyptian Vulture and Long-billed Vulture, have shown population increase by 300%, 36.1% and 6.65%, respectively as compared with the population estimation of 2012.
- Among various regions of the State, Saurashtra region supported the highest population of the four species of vultures (n= 458, i.e., 45.84% of total population) followed by North Gujarat (n=203, i.e., 20.32 % of total population). Central Gujarat and South Gujarat supported 157(15.71% of total population) and 109 vultures (10.91% of total population) respectively, whereas Kachchh region recorded the lowest population of vultures (n=72) during the 2016 estimation.
- Saurashtra region has also supported the highest population of *Gyps* vultures (n=430; 67.11% of the total population) population is concerned.
- To remove the effect of differences in areas of various regions (e.g., Kachchh-45652 sq km & S.Gujarat-14,676 sq. km) on region-wise vulture population, region-wise crude density was also determined, which is summarized in the table below:

Sr. No.	Region (Area in sq. km)	Population of vultures		Crude Density (number/sq.km) of four species	Crude Density (number/sq.km) of *Gyps* vulture
		No. of Four Species of Vultures	No. of *Gyps* Vulture		
1.	North Gujarat (30,424)	203	118	0.0067	0.0039
2.	Central Gujarat (40,027)	157	116	0.0039	0.0029
3.	South Gujarat (14,655)	109	109	0.0074	0.0074
4.	Saurashtra (65,266)	458	430	0.0070	0.0066
5.	Kachchh (45,652)	72	70	0.0016	0.0015
	Gujarat State (1,96,024)	999	843	0.0051	0.0043

- The highest crude density for all the four vultures and *Gyps* vultures was recorded for South Gujarat region, though their population was not the highest in the region. The table also shows that Saurashtra region recorded second highest crude density of four species of vultures considered collectively (0.0070 individuals/sq.km) as also that of *Gyps* vultures (0.0066 individuals/sq. km).
- Red-headed Vulture population was found to be concentrated only in Saurashtra region (18 individuals in Junagadh, 3 in Amreli, 2 in Gir Somnath and 1 in Surendranagar districts). Egyptian Vulture population was found to be occurring mainly in Banaskantha district of North Gujarat region (n=72, i.e. 54.5% of total EV population) and to certain extent in Ahmedabad district of Central Gujarat region (n=32, i.e. 24.24% of total EV population).
- Total population decline: Population comparison between 2012 (the year of previous statewide vulture population estimation) and 2016(the year of latest/current statewide vulture population estimation) estimations indicate a population reduction of 3.38% (0.93% annually) in total population of four species of vultures and reduction of 10.12% (0.03% annually) in *Gyps* vulture population. Among all the four vulture species, the steepest decline (20.58% & 5.61% annually) was recorded for White-rumped Vulture. However, the population comparison for all the four species of vultures for decade-long period cannot be made as during 2005, 2007 and 2010 vulture estimations, only *Gyps* vultures were covered. The population decline in total vulture population of the State during the 2012-2016 time-frame was only due to White-rumped Vulture population decline (mentioned above). The population has actually increased in case of Long-billed Vulture (from 361 individuals in 2012 to 385 individuals in 2016; 6.65% increase), Red-headed Vulture (from 8 individuals to 24 individuals; 300% increase) and Egyptian Vultures (from 97 individuals to 132 individuals; 36% increase).
- In approximately a decade's time-frame, i.e., between 2007 (1,431 *Gyps* vultures) and 2016 (843 *Gyps* vultures), there has been 41.1% decline in *Gyps* vulture population at the rate of 5.65% annually. Between 2012 (i.e., year of previous vulture estimation) and 2016 (i.e., year of the current/latest estimation), *Gyps* vulture population had declined by 10.12% (i.e., from 938 individuals to 843 individuals) with annual decline of 2.63%. The *Gyps* population decline between 2007 & 2010 estimations and that between 2010 & 2012 estimations had been 25.57% (annually 9.28%) and 11.92% (annually 6.15%) respectively. Thus, it may be concluded that annual rate of population decline for *Gyps* vultures have become slower between 2012-2016 (2.63%) as compared to that between 2007-2010 (9.28%), 2010-2012 (6.15%) and 2007-2016 (5.65%).
- Among all the four species of vultures, the steepest population decline was recorded for White-rumped Vultures between the previous population estimation of 2012 and the latest-one of 2016 and during the long-term (decade long) period of 2007 and 2016.
- For approximately a decade-long period of 2007-2016, it is understood for WRV that between 2007 (1,147 WRVs) and 2016 (458 WRVs), WRV population has declined by 60.1% with annual decline

rate of 9.61%. In comparison to WRVs, Long-billed Vultures (LBVs) are certainly having better population trend. Thus, for the short-term period between the two latest population estimations, i.e., between 2012 and 2016, the LBV population has increased by 6.65% with an annual increase rate of 1.62%. The population increase for LBV is even more prominent for the long-term time-frame of 2007-2016. Thus, if the comparison is made between Long-billed Vulture population of 2007 estimation (n= 217) with that of 2016 population estimation (n=385), it is revealed that there has been increase by 77.2% population with an annual increase rate of 6.51%.

- The region-wise comparison of *Gyps* vulture population change between 2007 and 2016 reveals that the highest decline (i.e., 84%) has occurred in Kachchh, followed by Central Gujarat (66.2%) and South Gujarat (54%) in that order. Contrary to the Kachchh, C. Gujarat and S. Gujarat, Saurashtra and N. Gujarat have experienced *Gyps* population rise in a decade's time-frame of 2007-2016. Thus, Saurashtra has experienced significant population rise of 54.67% (i.e., from 278 individuals in 2007 to 430 individuals in 2016) and North Gujarat has experienced modest population rise of 6.31% for *Gyps* vultures (i.e., from 111 individuals in 2007 to 118 individuals in 2016) in that order.
- The region-wise comparison of White-rumped Vultures' population change between 2007 and 2016 has revealed that the highest decline(i.e., 85.96%) has occurred in Kachchh region (i.e., from 456 individuals in 2007 to 64 individuals in 2016), followed by South Gujarat (85.92%; from 135 individuals in 2007 to 19 individuals in 2016), Central Gujarat (65.73%, i.e. from 286 individuals in 2007 to 98 individuals in 2016) and North Gujarat (30%, from 80 individuals in 2007 to 56 individuals in 2016) in that order. Contrary to these regions, Saurashtra has experienced population rise in WRV population from 190 vultures in 2007 to 221 vultures in 2016 (16.31% increase). Huge population decline in WRV population in districts like Ahmedabad (C. Gujarat) may not be solely due to vulture mortality. Rather, it may also be due to inter-district migration of population (e.g., Ahmedabd-to-Anand district).
- The region-wise comparison of Long-billed Vultures' population between 2007 and 2016 has revealed that Saurashtra region has experienced considerable population rise from 53 individuals in 2007 to 209 individuals in 2016. North Gujarat region has also experienced some population rise from 31 individuals in 2007 to 62 individuals in 2016, whereas Kachchh region has experienced stability of LBV population i.e., 6 individuals in 2007 and 2016. Only Central Gujarat and South Gujarat regions have experienced some population decline for LBV. The likely reason for less population decline in two regions or population rise in three other regions for LBV is that nesting of this species, unlike that of White-rumped Vultures, takes place in hills/rocky cliffs, that too often in forested areas away from human disturbance. Thus, LBVs' nesting locations, usually being away from human-dominated areas might be resulting into lesser/no disturbance during nesting and in turn, greater nesting success and increased population. Their less dependence on trees (and more dependence on crags in the hills) as a nesting place may also be a possible reason of higher nesting success leading to population increase (Pandey *et al.*, 2010).

1 Introduction

1.1 Biology and Ecology of Vultures

Vultures, especially the 'Old-world vultures', are known to be the flesh-eating scavenging birds. They belong to the family Accipitridae that also includes raptors or birds of prey like kites, eagles, harriers, hawks and buzzards. Unique adaptations of necrophagous behavior, soaring flight, keen eyesight and extremely low pH levels in their stomach (Balmford, 2013) make them most successful scavengers in many terrestrial ecosystems. Equipped with capability to fly, vultures can cover greater area in search of carrions/carcasses than land scavengers. They provide multiple ecological, economic and cultural services. They occupy significant position in food chains because they feed primarily on carrion or the flesh of dead animals. Quick disposing of carcasses by the vultures reduces the risk of contamination by pathogens and prevents the carcass rotting leading to elimination of the spread of diseases such as anthrax and rabies (Anon, 2015-16).

Worldwide a total of 23 species of vulture exist and they are primarily grouped into New World vultures (from the continents of North and South America) belonging to Cathartidae family and Old World vultures (from Europe, Africa, and Asia) belonging to family Accipitridae (MoEF, 2006; Thakur *et al.*, 2012). The group i.e., vultures, is a great example of convergent evolution as they are believed to have evolved separately from different ancestors (Johnson *et. al.,* 2006). New World vultures include 7 species of 5 genera while Old World vultures include 16 species of 9 genera. These two groups share some similarities such as naked head with some exceptions which actually facilitate to pull out the meat from inside carcasses and it is easier to keep a bald head clean. Another similarity is the large wingspan that enables them to fly at high altitudes and soar on thermals in order to find food. On the contrary, difference among them is in their ability to search and detect food. Old World vultures locate their food by sighting as they have very good eyesight while New World vultures rely heavily on smell to locate their meals.

Nine species of vultures have been recorded in the Indian subcontinent, of which five belong to the genus *Gyps* (Prakash *et al.*, 2003). All these nine species are old world vultures. All these species of vultures are widely distributed across the country.

The species found in India are:

1. White-rumped Vulture *Gyps bengalensis*
2. Long-billed Vulture *Gyps indicus*
3. Eurasian Griffon *Gyps fulvus*
4. Egyptian Vulture *Neophron percnopterus*
5. Red-headed Vulture *Sarcogyps calvus*

6. Cinereous Vulture *Aegypius monachus*
7. Himalayan Griffon *Gyps himalayensis*
8. Lammergier Vulture *Gypaetus barbatus*
9. Slender-billed Vulture *Gyps tenurostris*

Of the nine species of vultures recorded in India, seven species (at sr. no. 1 to 7 above) are recorded from Gujarat. Of these seven species, four species (at sr. no. 1 to 4) are regularly sighted in Gujarat. The details of those four species are given in forthcoming section in this chapter.

As vultures chiefly feed on carrions, their feeding behavior itself may invite chances of competition for feeding and lead to exclusion of some species. But long courses of evolution have provided the opportunities for survival of all vulture species. Darwin states that interspecific or intraspecific competition is a potent force in organic evolution as those species compete for the same limiting resources. A principle on competition between closely related species was given by Gause's called '*Competitive Exclusion Principle*' which states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually. Species composition of vultures is the best example of convergent evolution; however, they are also example of co-existence to rule out the occurrence of interspecific feeding competition in nature. They are evolved to avoid competition by choosing different times for feeding as well as different foraging patterns (Grubh 1974; Stewart 1978; Houston 1985; Prakash 1988). A study on feeding ecology of *Gyps* vulture species was carried out in captivity by Lahkar et al., (2010). Similar kinds of observations of feeding ecology of vultures were mentioned by Chander (2015). Both the studies showed how different species of vultures on carcass were able to avoid competition and co-exist due to behavioural differences in their foraging activities.

All the vulture species, even in India, show different mode of feeding as they have different morphology and physiology. Their

Do You Know!

- ***Vultures, especially the 'Old-world vultures', are known to be the flesh-eating scavenging birds***
- ***Unique adaptations of necrophagous behavior***
- ***Worldwide a total of 23 species of vulture exist and they are primarily grouped into New World vultures (from the continents of North and South America) belonging to Cathartidae family and Old World vultures (from the continents of Europe, Africa, and Asia) belonging to family Accipitridae***
- ***Nine species of vultures have been recorded in the Indian subcontinent, of which five belong to the genus Gyps All these species belong to old world vultures.***
- ***They are example of convergent evolution***
- ***New World vultures include 7 species of 5 genera while Old World vultures include 16 species of 9 genera.***
- ***Difference among them is in their ability to search and detect food. Old World vultures locate their food by sighting as they have very good eyesight while New World vultures rely heavily on smell to locate their meals.***

digestive efficiency characterizes them as scavengers as they can digest almost all parts of the carcass (Lahkar *et al.*, 2010; Chander, 2015). All species of vulture have different role in disposing a carcass. Firstly, large body-sized vultures having powerful bill start their role while spotting any carcass. Such species includes mainly Red-headed Vulture and Cinereous Vulture (Anon, 1991; Chander, 2015). Due to their crucial role on carcass, other vulture species has to wait. Functional role of both species is same, but their occurrence together is uncertain as both vulture species have different preference of habitats. Red-headed Vulture prefers forest area with hillocks while Cinereous Vulture, which is migratory for the state, prefers to be in open country near human habitation (Ali and Ripley, 1987, Chander, 2015). They largely prefer the skin and tough body parts and their powerful bill support to tear the upper layer of carcass (Chander, 2015). Once the tough skin is removed, opened carcass become favorable for other vulture species, especially *Gyps* and immediately their significant role starts (Chander, 2015). *Gyps* vulture species are adapted to feed on soft flesh of visceral organs (Kruuk 1967), facilitated by their heavy bill and long necks, devoid of feathers, which helps to thrust food deep from the dead body (Anon., 2015-16). Their numbers are also in proportion, hence, hundreds of *Gyps* on a carcass (Chander, 2015). Within *Gyps* species also each plays a different role (Lahkar et al., 2010; Chander, 2015). The White-rumped vultures having short neck prefer muscles just near the skin. The long-billed and slender-billed vultures are specialized to penetrate very deep into the carcass (Chander, 2015). Lahkar et al., (2010) also mentioned the difference in feeding habit in captive condition. According to observation White-rumped Vulture generally feed on fresh meat. On the contrary, Long-billed vulture and Slender-billed prefer putrefied meat. The longer neck of both the species than the White-backed vulture assists to take food from deeper (Lahkar et al., 2010). Finally, Egyptian Vultures, the smallest vulture, steps to clean the carcass. They prefer to feed on tendons, ligaments, their food also includes eggs, scats, maggots etc. However, they pick out first the dropping of the scavenging mammalian species near the carcasses. Similarly, their numbers are also in proportion. Consecutively, Lammergeier cleans up the remaining of the carcass by consuming bones (Newton, 1979).

In addition to feeding ecology, vultures do not carry prey back to their chicks instead they gorge at a carcass and regurgitate food from their crop to feed their young ones. A vulture can eat over 10% of their body weight i.e., up to 1 kilogram then can remain without food for 15-20 days (Anon, 2015-16). Vultures have very interesting relationship of commensalism with Lion on prey (Anon, 2015-16).

Vultures show unique behavior often called urohidrosis means they urinate on their legs and feet which help them to provide cool effects on hot days. It is also worth as antibacterial and anti-parasitic as they expose to such pathogens when walk through carcasses (Anon, 2015-16).

Vultures can live to be 70 years old and the male and female are monogamous and gregarious species. They breed colonially in cliffs or ridges of rocks as well as on trees depending of species (Mundy *et al.*, 1992). The nests may be built by a pair of

bird; they are usually large, durable and used year after year; most of the nests are built by branches, twigs and sticks of local plants. The males assist the females in incubating the eggs and caring for the chicks. Vultures mostly lay one egg every year (Anon, 2015-16).

The community composition of carcass scavengers has greatly changed due to vulture population decline. It has rapidly increased the canine population and related diseases like Anthrax, Tuberculosis etc. Carcasses disposal and the consequent rotting carcasses which are potential disease transmitters through the mammalian carcass scavengers, are being causing serious problems because of population decline.

1.1.1. *Gyps* vultures

Out of total 23 vulture species all across the world, India has nine species in the wild (MoEF, 2006; Thakur *et al.*, 2012). Out of these nine species which Indian subcontinent has, five belong to the genus *Gyps* (Ali and Ripley, 1987; Prakash *et al.*, 2003). Of the total five species, four species occurs in Gujarat and two of them are under the threat of rapid population decline.

(I) White-rumped Vulture *Gyps bengalensis* (Gmelin, 1788)

This species measures about 75-85 cm in length (Ferguson-Less and Christie,

Do You Know!

- *They are example of co-existence to rule out the occurrence of interspecific feeding competition in nature by choosing different times for feeding as well as different foraging patterns.*
- *Firstly, large body-sized vultures having powerful bill e.g. Red-headed Vulture and Cinereous Vulture tear the upper layer of carcass.*
- *Once the tough skin is removed, opened carcass become favorable for other vulture species, especially Gyps.*
- *Gyps vulture species feed on soft flesh of visceral organs, facilitated by their heavy bill and long necks, devoid of feathers*
- *Finally, Egyptian Vultures, the smallest vulture, steps to clean the carcass. They prefer to feed on tendons, ligaments, their food also includes eggs, scats, maggots etc.*
- *Consecutively, Lammergeier cleans up the remaining of the carcass by consuming bones*
- *In addition to feeding ecology, vultures do not carry prey back to their chicks instead they gorge at a carcass and regurgitate food from their crop to feed their young ones.*
- *A vulture can eat over 10% of their body weight i.e., up to 1 kilogram then can remain without food for 15-20 days.*
- *Vultures show unique behavior often called urohidrosis means they urinate on their legs and feet which help them to provide cool effects on hot days. It is also worth as antibacterial and anti-parasitic as they expose to such pathogens when walk through carcasses. Vultures can live to be 70 years old and the male and female are monogamous and gregarious species.*

2001). The neck and head is devoid of feathers with very broad wings and short tails. It gets its name due to the white rump and also has white neck ruff. It has short, heavy and mostly silver bill. Juveniles are largely dark brown. The species prefers wide range of habitats from evergreen forests to dry-deciduous to semi-arid areas also favours open country and cultivated areas. Worldwide, upto 1985 the species was described as the most abundant large bird of prey in the world, though, major stronghold to south Asian countries (Houston 1985). The species breeds between March to October. They are colonial nesters. Generally, they build their nest on large trees and lay one egg. They also nest sometimes on the cliffs of mountains (Dharmakumarsinhji, 1955).

The species is listed as Critically Endangered because it has suffered an extremely rapid population decline primarily as a result of feeding on carcasses of animals treated with the veterinary drug diclofenac.

(ii) Long-billed Vulture *Gyps indicus* (Scopoli, 1786)

The species is also known as Indian Vulture and Indian Long-billed Vulture. The species is resident to the state and once it was common across the state. The species is with bald head with broad wings and short tails. It is distinguished from other species by its buff body and wing coverts. The adults have pale-yellowish bill while juvenile have dark bill with pale culmen. It can be differentiated from Slender-billed Vulture through robust build, clean plumage, pale bill (in adults) and downy head and neck (juveniles).It shares similar habitat with that of White-rumped vulture. It nests chiefly on the cliffs and high mountains. It breeds between October to June, principally in December and January (Pandey *et. al.*, 2007). The species is also listed as Critically Endangered because it has suffered an extremely rapid population decline primarily as a result of feeding on carcasses of animals treated with the veterinary drug diclofenac.

1.1.2. "non-*Gyps*" vultures

Of the total seven species, three species are "non-*Gyps*" viz., Red-headed Vulture, Egyptian Vulture and Cinereous Vulture which occur in Gujarat state.

(iii) Red-headed Vulture *Sarcogyps calvus* (Scopoli, 1786)

The species, also called Indian Black Vulture and Pondicherry Vulture, is identified by its red colored head, neck and legs and remaining body parts are black colored. In flight, the white patches on sides of the neck base and on the upper things are prominent. The male birds have yellowish eyes and the female bird has dark reddish eyes (Ali and Ripley, 1987). It inhabits open country usually away from human habitation, well-wooded hills and dry deciduous forest with rivers. Generally, it occurs at lower density than *Gyps* vultures owing to its predominantly territorial behavior (Naoroji, 2006).

Nowadays, it is uncommon in many countries like Pakistan, Nepal, Bhutan, Myanmar (Hla *et al.*, 2011) and Singapore (Ferguson-Lees and Christie, 2001). In India, the species is sporadically distributed in some area like Gujarat and north-eastern states. However, it is considered fairly common in the west Himalayan foothills. In Gujarat, the species is frequently reported from Gir, Surendranagar and Kachchh region (Pandey et al., 2005, 2007, 2010).

The species was considered as Least Concern upto 2000 by the IUCN. By another assessment, the species was listed as Near Threatened in 2004 and directly shifted as Critically Endangered (IUCN) in 2007 due to massive population decline of vultures in India owing to mortality because of non-steroidal anti-inflammatory drug (NSAID) diclofenac.

(iv) Egyptian Vulture *Neophron percnopterus* (Linnaeus, 1758)

The species is also referred as Egyptian Eagle having feathered neck unlike other *Gyps* vulture. This is a small vulture. The adult is distinguished mainly by white body with yellowish face devoid of feathers and black flight feathers. The juveniles are blackish-brown with bare grey face with maturity, tail, body and wing converts white and face become yellow. It is common in semi-arid zones and drier areas and prefers open country Worldwide distribution of species is mainly in south and east Asia, Ethiopian and some of the part of Palearctic region (BirdLife International 2016). Alike *Gyps indicus*, they build nests on ledges or in caves on cliffs (Sarà and Di Vittorio 2003). However, the species was reported to be nest on large trees, buildings and electricity pylons (Naoroji, 2006). They are usually solitary, but will congregate at feeding sites (Ceballos & Donázar 1990).

Alike other vulture species of India, the species is facing the threats of diclofenac, non-steroidal anti-inflammatory drug. From 1988 to 2004 species was considered as Least Concern by IUCN but from 2007 onwards the species has been categorized as Endangered (EN).

1.2 Socio-cultural Values of Vultures

Many references of the Hindu, Egyptians, Zoroastrian Parsi community, *Vajrayana Buddhism* adhered Tibetan and Mongols religions have mentioned spiritual esteems and cultural association of vulture in their socio-culture (Anon, 2015-16).

An important Hindu scripture, the Ramayana, have referred significance of the vulture *Jatayu* who fought against evil Ravana to protect Sita. Further, it also explains how the *Jatayu* informed Rama in which direction Sita was being taken. Another reference of vulture is in story of courage and self-sacrifice of Jatayu and his brother Sampati when they used to compete over who could fly higher. Presently placing Griddharaj Parvat, located in the Ramnagar tehsil of Satna district in Madhya Pradesh, is believed to be the birthplace of Sampati, brother of Jatayu, mentioned in Ramayana. Griddharaj Parvat meaning Vulture Peak, is a unique

habitat for vultures together with number of other wildlife. Mainly *Gyps indicus* and *Gyps bengalensis* were seen in large numbers at the place (Anon, 2015-16). In addition, the bird is also depicted as the vehicle of Ketu, considered as the planet controlling deeds of a person (www. ecoheritage.cpreec.org) (Anon, 2015-16).

Vultures also play an important cultural role in southern Asia i.e., parts of India, Nepal and Tibet as they consume human cadavers which are left in the open during ritual of sky-burials.

Vultures are seen as heavenly birds, both literally and spiritually in Mongolia. According to *Vajrayana Buddhism*, which is adhered by majority of Tibetan and many Mongols, the body after death does not need to be preserved considering abandon parts. It may be eaten or naturally decomposed through Sky Burial which is a funeral practice of a human dead body placing on open ground to decompose. The body is exposed to the elements or to be eaten by scavenging animals, especially carrion birds. Mongolians believe that there are three types of animals that could eat a body. One is animals of the sky, or birds of prey, vultures. The next level is dogs and wolves, animals of the earth. The lowest level is maggots. Being eaten by vultures, and quickly, offers the best chance at a good reincarnation.

Culturally, vultures are also associated with country's Parsis (Zoroastrians) community. According to their religion, the elements of earth and fire should never be contaminated by the impurities of human flesh, and as a result, burial and cremation are unacceptable. The Parsis, therefore, "bury" their dead body in the sky. In practice, this means leaving the body on a high building, a Tower of Silence, to be devoured by vultures and other birds of prey. The concept of such ritual has deep sense of ecological basis. Parsis also believe that the vultures help release the spirit or soul of the dead.

Vultures are also painted in artwork and legends of the past of many other cultures.

1.3 Population Crisis in India and Gujarat

During 1987, one of the *Gyps* vulture species, White-rumped vulture was documented to be disappeared in Sigure region of the Nilgiri highlands in southern India (Davidar and Davidar, 2002; Risebrough, 2004). The number of vultures, during 1990s, visiting the Towers has significantly declined and was no longer sufficient to dispose of the available food (Risebrough, 2004). A sharp decline in number of vulture was first time recorded at Keoladeo National Park (Prakash, 1999). However, exact cause of decline was not known. Similar rapid decline of White-rumped Vulture and other *Gyps* vulture was also recorded in other parts of Indian subcontinent since the mid-1990s (Prakash 1999, Gilbert *et al.* 2006, Prakash *et al.* 2007, Chaudhary *et al.* 2012). Bombay Natural History Society conducted repeated survey (1992 -2007) across the country. Decline of 99.9% of white-rumped vulture and more than 95% of other *Gyps* vultures was inferred based on surveys (Prakash *et al.*, 2007; Venkitachalam et al., 2013). Population drop of White-rumped vulture was almost 99.9 % in India (Prakash, 1999; Prakash *et al.* 2007; Pain et al., 2008), thus, population estimated to be <5% of the original (Virani et al., 2001; Gilbert *et al.* 2002; Prakash *et al.* 2003; The Peregrine Fund 2004; Chhangani and

Mohnot, 2004; Gilbert et al., 2006; Umapathy *et al.*, 2009).

Similar fatality of vultures was recorded in Punjab province of Pakistan. Post mortem examination indicated the presence of uric acid deposition in their kidneys. The cause of deposition was found to be anti-inflammatory drug called "Diclofenac" (Oaks *et al.,* 2004). The drug is widely used as a painkiller for treatment of livestock. During postmortem examination, the similar symptoms were noticed in Indian *Gyps* vultures also (Green *et al.*, 2004). Similar symptoms and cause were also reported from India, Nepal and Bangladesh through postmortem examination of dead bird tissues (Mishra *et al.* 2002; Shultz *et al.* 2004; Swan *et al.* 2006; Khan, 2013). The drug which remains after death of cattle enters into vulture body and cause visceral gout and kidney failure. The vulture species facing the threat of decline due to diclofenac are now listed as critically endangered (BirdLife International 2016; IUCN, 2004; Venkitachalam *et al.*, 2013; Khan, 2013).

The population estimations conducted by GEER Foundation since 2005, recorded considerable population decline in the Gujarat State (Pandey *et al.,* 2007). During the first state level population estimation in 2005, 2,135 White-rumped Vultures (*Gyps bengalensis*) and 376 Long-billed Vultures (*Gyps indicus*) were recorded. According to the second estimation in 2007, a decline of 46.3% and 42.3% was recorded in the populations of White-rumped Vultures and Long-billed Vulture, respectively over a period of two years. Collectively, there was 46% decline in *Gyps* vulture population between 2005 and 2007. Furthermore, as per estimation of 2010, decline of 62.9% and 29.5% in the population of White-rumped Vulture and the Long-billed Vulture, respectively was recorded between 2005 and 2010 (Pandey *et al.,* 2010; Tatu *et al.,* 2012).

Do You Know!

- ***Vultures are mentioned in an important Hindu scripture, the Ramayana, as Jatayu who fought against evil Ravana to protect Sita.***
- ***Another reference of vulture is in story of courage and self-sacrifice of Jatayu and his brother Sampati***
- ***Presently placing Griddharaj Parvat, located in the Ramnagar tehsil of Satna district in Madhya Pradesh, is believed to be the birthplace of Sampati. The place is ideal habitat for vultures***
- ***Vultures are seen as heavenly birds, both literally and spiritually in Mongolia. According to them being eaten by vultures, and quickly, offers the best chance at a good reincarnation.***
- ***Parsi community of the country (Zoroastrians) "bury" their dead in the sky. In practice, this means leaving the body on a high building, a Tower of Silence, to be devoured by vultures and other birds of prey.***
- ***Parsi community also believe that the vultures help release the spirit or soul of the dead.***

1.4 Vulture Conservation in India and Gujarat

The population crash was noticed from about 1987 and evidently in 1999 and actual major causes of vulture decline was announced on 18th – 23rd May, 2003 (Prakash, 1999; Davidar & Davidar, 2002; Risebrough, 2004; Oaks *et al.,* 2004). Conservation efforts were initiated during late 1990s, many research, awareness programmes and captive breeding programs were conducted (Prakash *et al.* 2003, MoEF 2006; Umapathy *et al.*, 2009).

November 1998: Dr. Rahamani issued a "Vulture Alert" and anecdotal reports of local disappearances of vulture began to circulate throughout India (Risebrough, 2004).

6th August 1999: Dr. Asad Rahmani, Director of the Bombay Natural History Society (BNHS), convened a Vulture Conservation Strategy Planning Meeting in Mumbai, India to address the population declines of White-backed and Long-billed Vulture (Risebrough, 2004).

2000: The detailed research for causes of the decline was initiated in South Asia

2003: The surveys across the country pointed declined by more than 90% in comparison to populations in the early 1990s though abundant availability of carcasses and breeding habitat.

February 2003: The Bombay Natural History Society and the Haryana State Government, with financial support from the Darwin Initiative, UK, established a vulture care center in Pinjore, Haryana (Pandey *et al.*, 2007).

05 – 08 February 2004: International workshop at Kathmandu to work out an implementable action plan for phasing out the use of Diclofenac and simultaneous substitution with viable and effective alternates (Anon, 2015-16).

2004: A National Workshop was organized by MoEF at New Delhi to prepare a National Action Plan for conservation of the three species of vultures.

11th June, 2004: Secretary, Govt. of India issued letter to Chief Secretary of all states for formulating a comprehensive withdrawal of veterinary drug "Diclofenac".

2004: Asia's first Vulture Conservation Breeding Centre was set up at Pinjore, Haryana, India (Anon, 2015-16).

17th March 2005: During second meeting of the National Board for Wildlife (NBWL) under the Chairmanship of Hon'ble Prime Minister it was decided that MoEF would explore the possibility of placing a ban on veterinary drug Diclofenac in consultation with the Department of Animal Husbandry and Ministry of Health so that the drug may be phased out within 6 months. The meeting also endorsed the preparation of an Action Plan for conservation of vulture by the Government of India and the States.

31st January 2006: International Conference on vulture Conservation at New Delhi intended for exchange of information on the status of the vulture population in the range countries of the region, initiatives being taken by various organizations for its conservation, as well as identification of a regional action plan for vulture conservation, building on the respective national Action Plans. The recommendations of the Conference were as follows:

- The Governments of the respective countries may take immediate steps to

completely phase out veterinary drug Diclofenac. This would have to be complemented by aggressive awareness campaigns about the adverse ecological effects of the drug.

- To urgently establish vulture conservation centers, especially for the three endangered species.
- To conduct a reliable population estimate at State, country and regional levels.
- To strengthen education and awareness campaigns.
- To strengthen sharing of information amongst the stakeholders.
- Setting up of a Task Force for the region to collaborate in vulture conservation programmes in the regions.

11th May 2006: The drug controller general (India), Director of health services issued direction on 11th may 2006 to drug controller of all the state to phase out the production and marketing of veterinary formulations of Diclofenac within a period of three months.

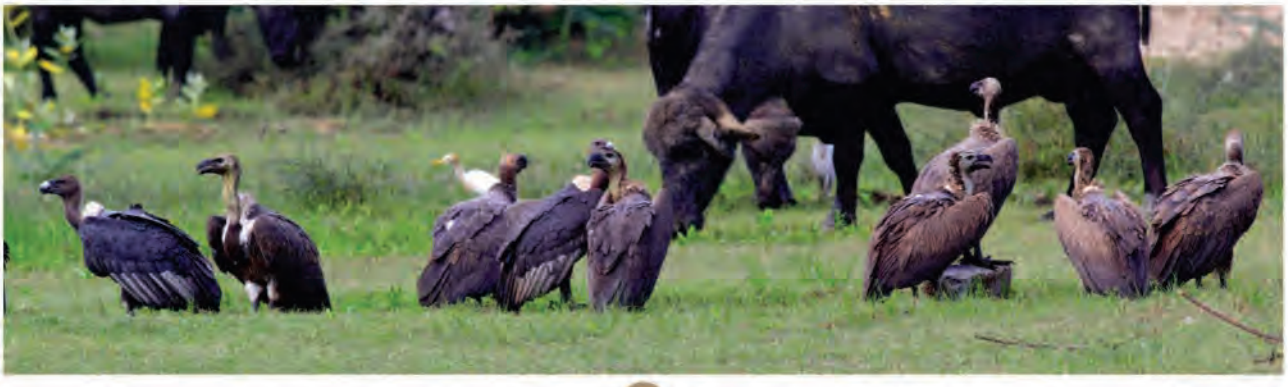
2006: Safety testing on African and Asian vultures demonstrated that an alternative veterinary drug, Meloxicam, is safe for vultures and other scavenging birds as well as effective for treating livestock (Anon, 2015-16).

2008: Under the Vulture Conservation Breeding programme, two White-backed Vultures first time bred at Breeding Centers. Breeding activity commenced at Breeding Centers in Assam and West Bengal (Anon, 2015-16).

2010:

- Successful fledging of three captive bred Long-billed vultures along with three more Slender-billed and four Oriental White backed vultures successfully demonstrated that all three species can be successfully bred at the Centres (Anon, 2015-16)
- The Bombay Natural History Society agreed to establish Vulture Safe Zones in India with the help of local partners and the Royal Society for Protection of Birds (RSPB).
- The UK Government's Darwin Initiative provided generous support to both *in situ* (Vulture Safe Zone) and *ex situ* (Vulture Conservation Breeding Centres) conservation action in India and Nepal through the RSPB.

2011: SAVE (Saving Asia's Vultures from Extinction) is constituted to bridge international boundaries, coordinate conservation action and enhance promotion and support for our cause.



2012:

- A symposium to develop a regional response to vulture conservation brought the Governments of Bangladesh, India, Nepal and Pakistan together and declared that they will work together to prevent the extinction of the three most threatened vultures in South Asia.
- Active involvement of IUCN, Central Zoo Authority (India) and Wildlife Institute of India

2013

- A meeting of Steering Committee constituted for South Asia's Vulture Conservation was held at New Delhi.
- With joint effort from Himalayan Nature and Ramdhuni Community Forest an artificial vulture restaurant was established at Ramdhuni Community Forest, Mahendranagar, Sunsari.

17th July 2015: Ministry of Health and Family Welfare issued notification that Diclofenac injection for human use shall be in single unit dose pack only, i.e. 3 ml.

State level conservation initiatives

25th June, 2004: Gujarat Forest Department wrote to all the veterinary doctors and veterinary drug dealer of Gujarat state for not using and selling veterinary drug 'Diclofenac'. Subsequently, the Gujarat Forest Department also issued an appeal in newspaper for the same.

21st July, 2004: Department of Forests and Environment, Government of Gujarat wrote to the Principal Chief Conservator of Forests, for sending necessary proposal for vulture care centers in the state.

8th August, 2004: A 30-minute radio programme on vulture conservation prepared by GEER Foundation was aired by All India Radio stations in Gujarat (covering the entire state).

31st August, 2004: The Director, Animal Husbandry, Government of Gujarat, issued a circular, advising veterinary doctors not to use 'Diclofenac'.

19th September, 2004: Bird conservation Society of Gujarat, an NGO organized a workshop on the vulture issues at Anand.

March, 2005: First statewide *Gyps* vulture nests estimation was conducted in Gujarat by GEER Foundation jointly with Gujarat Forest Department, NGOs and bird watcher.

26th and 27th May, 2005: First Statewide *Gyps* vulture population estimation was conducted in Gujarat by GEER Foundation jointly with Gujarat Forest Department, NGOs and bird watchers.

31st July, 2005: A report "Status of Vulture in Gujarat State" was released by GEER Foundation which contained a comprehensive statewide vulture estimation data and a detailed account of conservation efforts.

December, 2006: As provided for in the National vulture conservation action plan, GEER Foundation submitted a proposal for monitoring the *Gyps* vulture populations in Gujarat.

January to March 2007: Second statewide *Gyps* vulture nests survey was conducted in Gujarat by GEER Foundation jointly with Gujarat Forest Department, NGOs and bird watchers.

26th and 27th May, 2007: Second statewide *Gyps* vulture population estimation was conducted in Gujarat by GEER Foundation

jointly with Gujarat Forest Department, NGOs and bird watchers.

29th and 30th May, 2010: Third statewide *Gyps* vulture population estimation was conducted in Gujarat by GEER Foundation jointly with Gujarat Forest Department, NGOs and bird watchers.

1.5 Previous State-wide Vulture Population Estimations (2005-2012)

From historical time Gujarat has been an important state from the view-point of vultures. The importance of the state as a stronghold of vultures has been linked with the state's important role in dairy industry and livestock rearing. A large population of cattle and other livestock supporting the dairy industry naturally resulted in higher availability of carcasses that serve as food for various vulture species (Pandey *et al.*, 2007). The crisis of vulture population decline in the country came to lime-light in early 1990s (Pandey *et al.*, 2007). Even after that, Gujarat was a state with good vulture diversity.

The population estimations of vultures organized by GEER Foundation in 2005 and 2007 had indicated considerable population decline (Pandey *et al.,* 2007). The estimation conducted in 2005 was the first-ever vulture estimation in the state that showed the existence of 2,135 White-rumped Vultures /White-backed Vultures (*Gyps bengalensis*) and 376 Long-billed Vultures (*Gyps indicus*). Considering 134 unidentified *Gyps* vultures, it was determined that 2,647 *Gyps* vultures existed in the state during 2005 (Pandey *et al.,* 2007*)*. This estimation was a bench-mark population estimation for the state and it helped in determining changes in vulture population in the state when the second vulture population estimation was conducted in May 2007 (i.e., after 2 years' time-gap). The comparison of population figures of the *Gyps* vultures showed that the population of White-rumped Vultures (WRV) i.e. *Gyps bengalensis* had reduced from 2,135 in 2005 to 1,147 in 2007 (46.3 % population decline). Moreover, the population of Long-billed Vulture (LBV) i.e. *Gyps indicus* declined from 376 in 2005 to 217 in 2007 (indicating 42.3% population decline. Thus, population of *Gyps* vultures declined from 2,647 individuals in 2005 to 1,431 individuals in 2007 indicating 46% population decline. After the estimation in 2010, the White-rumped Vulture was observed to be declined by 62.9% from 2005 to 2010 and the Long-billed Vulture by 29.5% for the same period, their populations in Gujarat was 793 and 265 respectively, as per the 2010 census. The findings of 2010 estimation also revealed that the decline was less sharp from 2007 to 2010 than from 2005 to 2010, and in fact, there had been a slight increase in population of the Long-billed Vulture from 2007 to 2010. Consecutive estimation was conducted in 2012 by GEER Foundation. After 2012 vulture estimation, no other vulture estimation could be organized in the state for four years.