3 Results & Discussion

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. 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.

3.1 Total Vulture Population in 2016 and its comparison with Previous Population estimations in Gujarat

3.1.1 Total Vulture Population in 2016

Table 3.1 shows population of four species of vultures viz., White-rumped Vulture *Gyps bengalensis,* Long-billed Vulture *Gyps indicus,* Red-headed Vulture *Sarcogyps calvus* and Egyptian Vulture *Neophron percnopterus*. It not only summarizes total state-wide vulture population in 2016 (including population of *Gyps* vultures), but also gives region-wise and district-wise population of each of the four vulture species covered under this population estimation. It also gives *Gyps* vulture population for entire State, regions and districts.

Table 3.1: Region wise and district wise details of population of different vulture species in Gujarat state-2016

Sr. No.	Districts	*Gyps* Vultures			Red-headed Vulture (RHV)	Egyptian Vulture (EV)	Total Vultures (Gyps+ 'Non-Gyps')	Remarks
		White-rumped Vulture (WRV)	Long-billed Vulture (LBV)	Total *Gyps*				
Region: North Gujarat								
1.	Arvalli	0	0	0	0	0	0	Newly constituted district after 2012 estimation.
2.	Banaskantha	0	0	0	0	72	72	
3.	Gandhinagar	0	0	0	0	5	5	
4.	Meh sana	56	0	56	0	06	62	
5.	Patan	0	0	0	0	2	2	
6.	Sabarkantha	0	62	62	0	0	62	
Sub-total		56	62	118	0	85	203	
Region: Central Gujarat								
7.	Ahmedabad	24	0	24	0	32	56	
8.	Anand	70	1	71	0	2	73	
9.	Bharuch	0	0	0	0	0	0	
10.	Chhota Udepur	0	0	0	0	0	0	Newly constituted district after 2012 estimation.
11.	Dahod	0	0	0	0	0	0	
12.	Kheda	0	0	0	0	2	2	
13.	Mahisagar	0	8	8	0	5	13	Newly constituted district after 2012 estimation.
14.	Narmada	0	0	0	0	0	0	
15.	Panchmahals	0	9	9	0	0	9	
16.	Vadodara	4	0	4	0	0	4	
Sub-total		98	18	116	0	41	157	

Sr. No.	Districts	*Gyps* Vultures			Red-headed Vulture (RHV)	Egyptian Vulture (EV)	Total Vultures (Gyps+ 'Non-Gyps')	Remarks
		White-rumped Vulture (WRV)	Long-billed Vulture (LBV)	Total *Gyps*				
					Region: South Gujarat			
17.	The Dangs	0	43	43	0	0	43	
18.	Navsari	0	0	0	0	0	0	
19.	Surat	0	0	0	0	0	0	
20.	Tapi	0	0	0	0	0	0	
21.	Valsad	19	47	66	0	0	66	
Sub- total		**19**	**90**	**109**	**0**	**0**	**109**	
					Region: Kachchh			
22.	Kachchh	64	6	70	0	02	72	
Sub- total		**64**	**06**	**70**	**0**	**02**	**72**	
					Region: Saurashtra			
23.	Amreli	54	33	87	03	0	90	
24.	Bhavnagar	83	03	86	0	0	86	
25.	Botad	0	0	0	0	0	0	Newly constituted district after 2012 estimation.
26.	Devbhoomi Dwarka	0	0	0	0	0	0	Newly constituted district after 2012 estimation.
27.	Gir Somnath	0	42*	42	02	0	44	Newly constituted district after 2012 estimation.
28.	Jamnagar	0	0	0	0	0	0	
29.	Junagadh	0	131	131	18	03	152	
30.	Morbi	0	0	0	0	0	0	Newly constituted district after 2012 estimation.
31.	Porbandar	0	0	0	0	0	0	
32.	Rajkot	0	0	0	0	0	0	
33.	Surendranagar	84	0	84	01	1	86	
Sub-total		**221**	**209**	**430**	**24**	**04**	**458**	
Total State Population		**458**	**385**	**843**	**24**	**132**	**999**	

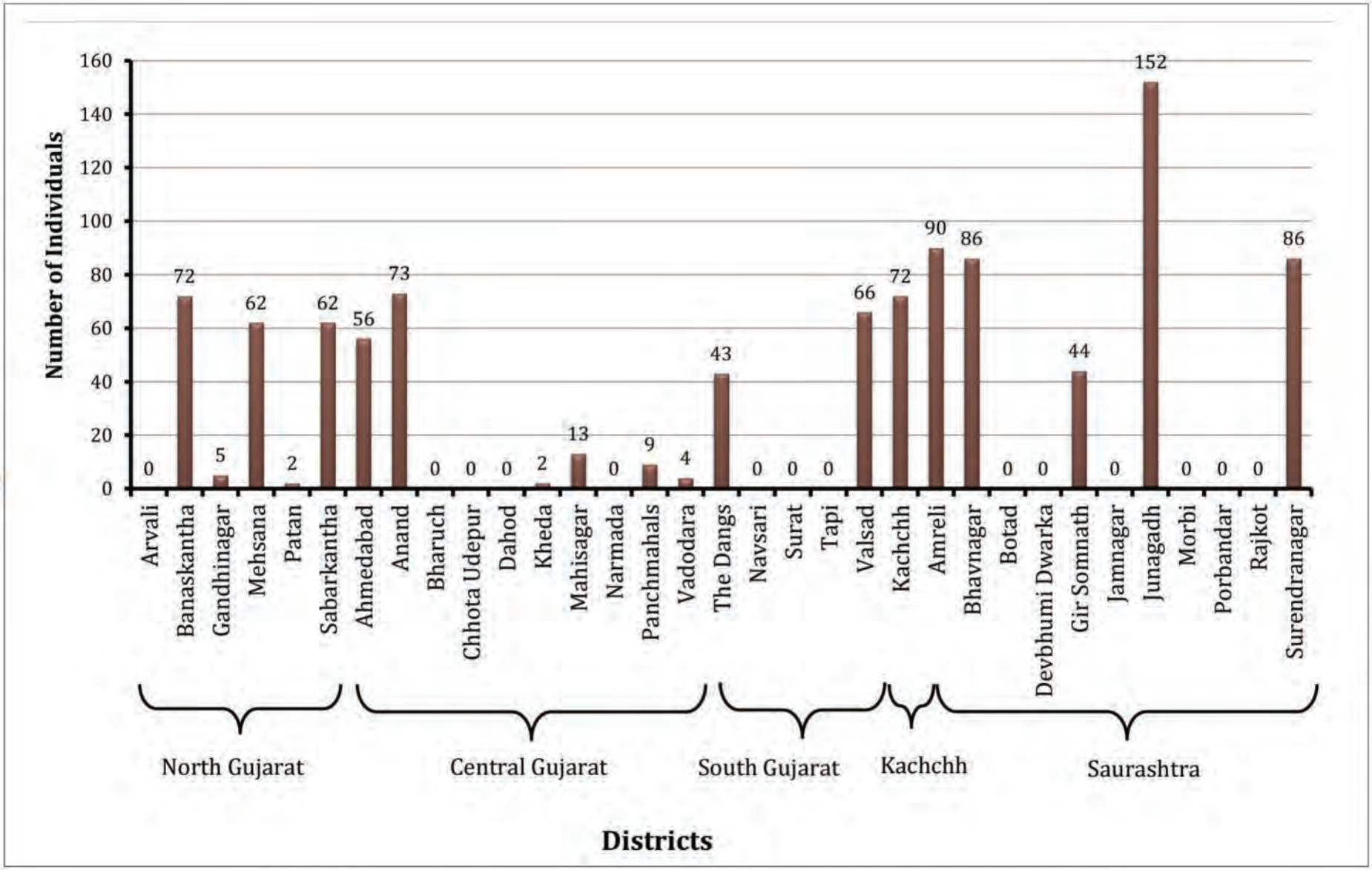


Fig. 3.1: Region wise and district wise population of vultures in Gujarat state-2016

Of the total 999 vultures recorded in the State, 843 (i.e., 84.4%) individuals were the *Gyps* vultures, i.e., individuals of White-rumped and Long-billed vultures collectively. Both the species are Critically Endangered at global level as per the Red List of Threatened Species of IUCN and they are also included in Schedule I of the Indian Wildlife (Protection) Act, 1972. Rest of the 156 vultures (i.e., 15.6%) were the individuals of Red-headed Vulture *Sarcogyps calvus* and Egyptian Vulture *Neophron percnopterus* (collectively) that do not belong to the *Gyps* genus (and can be considered as "non-*Gyps* vultures").

3.1.1.1 Region-wise and District-wise Distribution of All the Vultures Collectively in 2016

3.1.1.1 a) Region-wise Distribution

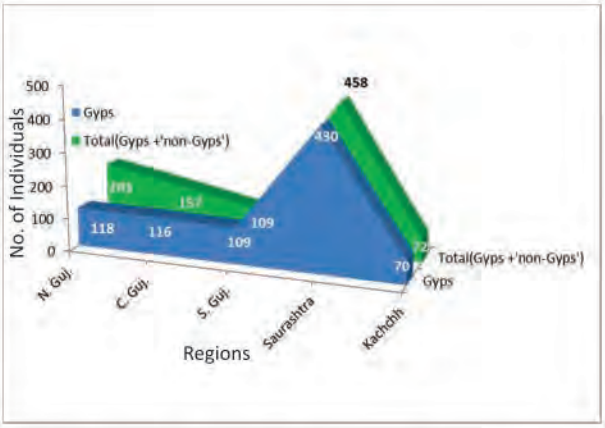
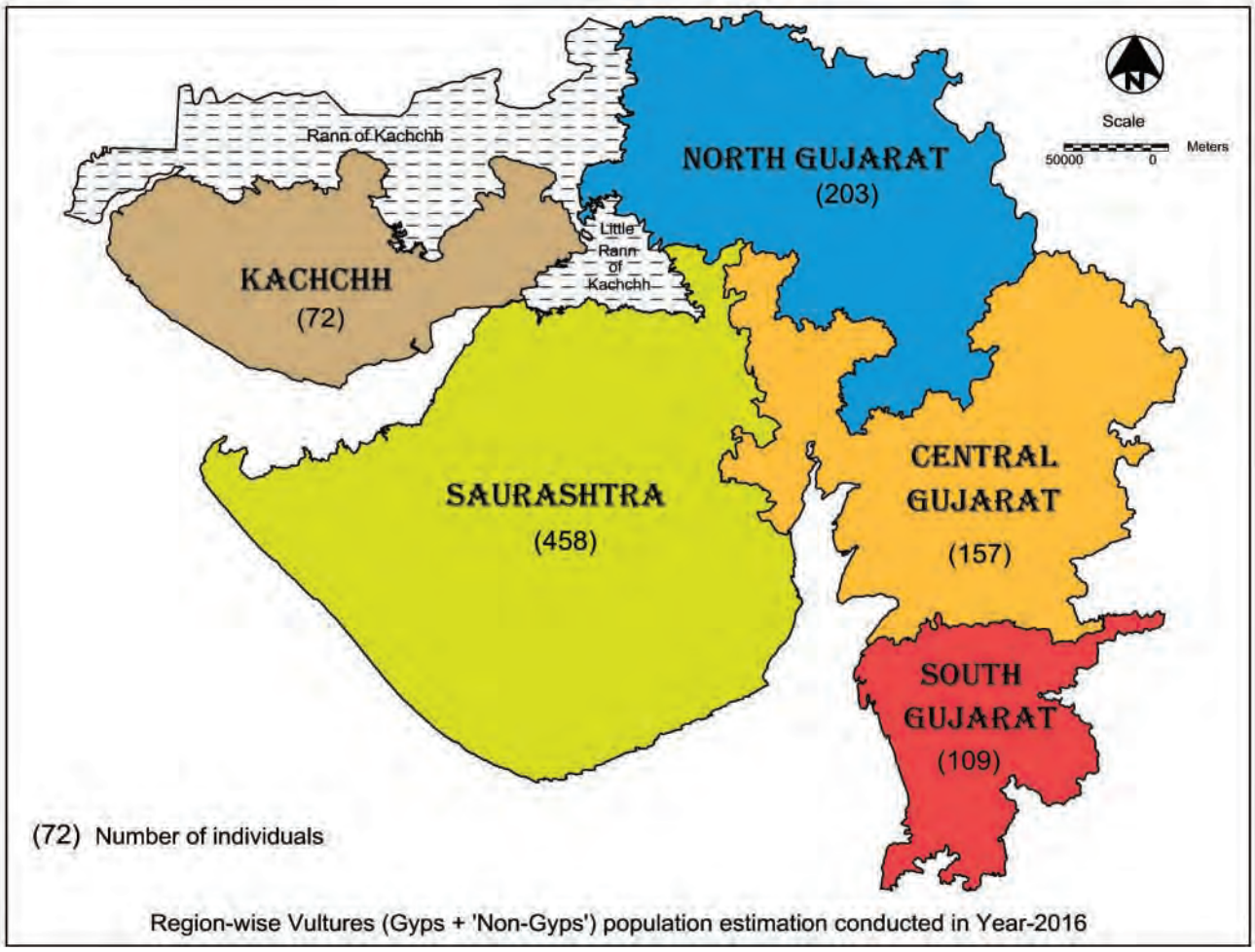
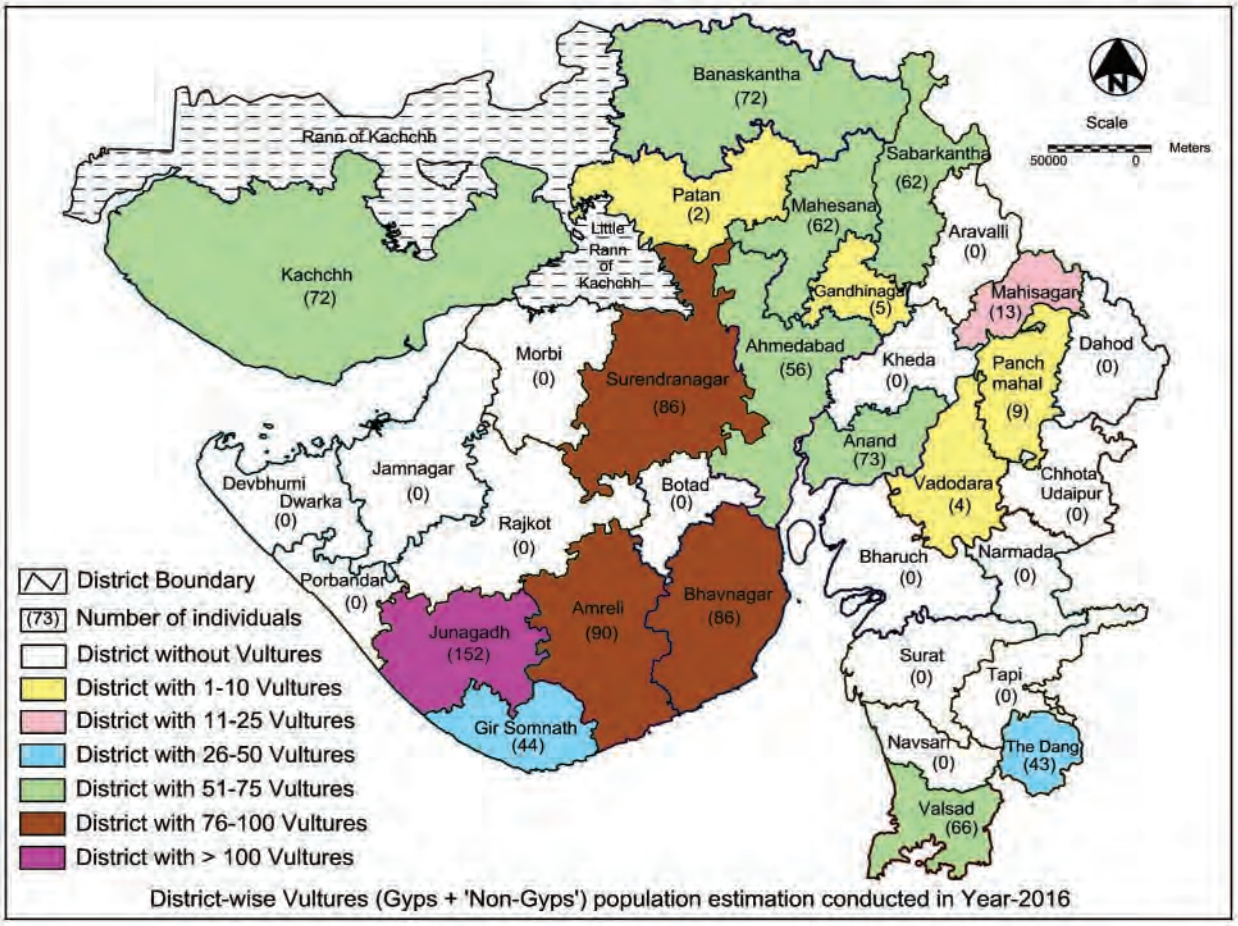


Fig. 3.2: Region-wise population of all the four species of vultures including Gyps vulture population-2016



Region-wise Vultures (Gyps + 'Non-Gyps') population estimation conducted in Year-2016



As per 2016 estimation, among various regions of the State, Saurashtra region had supported highest population of vultures (n= 458, i.e., 45.84% of total population) followed by North Gujarat (n=203, i.e., 20.32 % of total proportion). Central Gujarat and South Gujarat supported 157(i.e., 15.71% of total vultures in the State) and 109 vultures (10.91% of total vultures), respectively. Kachchh region had lowest population of vultures (n=72) during the 2016 estimation (Table 3.1, Fig. 3.1).

About *Gyps* vultures, it is revealed that Saurashtra region supported their highest population (n=430; 51% of total *Gyps* vultures in the State; Table 3.1). The lowest *Gyps* vulture population was recorded in Kachchh region (n=70; 0.08% of total *Gyps* vultures in the State). Rest of the regions supported moderate and somewhat similar *Gyps* vulture population i.e., North Gujarat region supported 118 *Gyps* vultures (13.99% of total *Gyps*), Central Gujarat region supported 116 *Gyps* vultures (13.76% of total *Gyps*) and South Gujarat region supported 109 *Gyps* vultures (12.93% of total *Gyps* vultures of Gujarat).

3.1.1.1b) District-wise Distribution

As per 2016 estimation, among various districts of the State, Junagadh district supported the highest number of vultures (n=152), i.e., 15.21% of total vulture population of the State. This district also supported the highest number of *Gyps* vultures (n=131) (Table 3.1). Thirteen districts namely, Aravalli, Bharuch, Chhota Udepur, Narmada, Navsari, Surat, Tapi, Botad, Devbhoomi Dwarka, Jamnagar, Morbi,

Rajkot and Jamnagar) were found to be devoid of vultures. Another four districts which supported just a few vultures belonged to Central Gujarat region, namely, Kheda (2 vultures), Vadodara (4 vultures), Panchmahals (9 vultures) and Mahisagar (13 vultures). Rest of the districts that belonged to all the five major regions of the State supported the vulture population ranging from over 40 to around 90 vultures (e.g., Dangs-43 Gir Somnath-44, Ahmedabad-56, Mehsana-62, Sabarkantha-62, Valsad-66, Banaskantha-72, Kachchh-72, Anand-73, Bhavnagar-86, Surendranagar-86 and Amreli-90)

With regards to the *Gyps* vulture population in various districts, it has been revealed that Junagadh district has supported the highest *Gyps* vulture population (n=131) followed by Amreli (n=87) and Bhavnagar districts (n=86). For rest of the districts, *Gyps* population scenario is almost similar to total vulture population scenario. Thus, except for some districts (especially those in North Gujarat like Banaskantha, Mehsana and Gandhinagar), in majority of districts of the State, *Gyps* vulture population itself has constituted total vulture population. The three exceptional districts in North Gujarat region where total vulture population differed from *Gyps* population were Banaskantha, Gandhinagar and Mehsana. In Banaskantha, total vulture population has been 72 individuals, but it was solely due to 72 Egyptian Vultures. In Gandhinagar district, total vulture population of 5 individuals was due to 5 Egyptian Vultures. Moreover, total vulture population of 62 individuals in Mehasana district was due to combined population of 56 *Gyps* vultures and 6 Egyptian Vultures.

3.1.2 Population Trend

3.1.2.1 Short-term Trend (2012-2016)

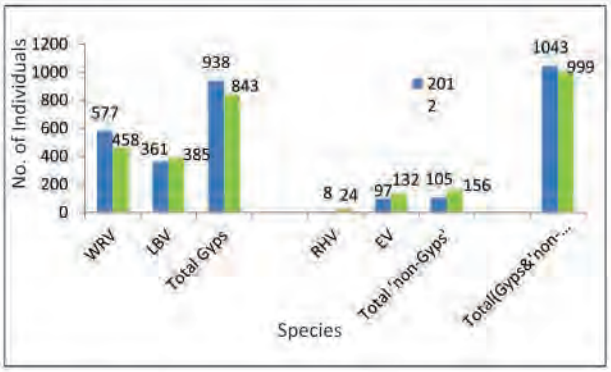


Fig. 3.3: Comparative account of populations of *Gyps* and 'non-*Gyps*' vultures in 2012 and 2016 in Gujarat State

During the last vulture estimation in the State, which was carried out in 2012, all the four species of vultures mentioned above were covered. Comparison of total vulture population in 2012 (n=1,037) with that of 2016 (n=999) has indicated that the vulture population has declined by 3.66%. It also indicates that vulture population has declined by an annual rate of 0.92%. For only *Gyps* vultures, population decline of 10.12% has been revealed by comparing 938 *Gyps* vultures recorded in 2012 and 843 *Gyps* vultures recorded in 2016. The population decline in *Gyps* vultures had occurred at an annual rate of 2.63 % between 2012 and 2016. The annual rate of decline of all four or only *Gyps* vultures for the short -term period of 2012-2016 is insignificant if one compares it with the annual rate of decline over the long-term period, i.e., between the years 2005(n=2,647) and 2016(n=999) as also between 2007(n=1,431) and 2016(n=999).

3.1.2.2 Long-term Trend (2005/2007-2016)

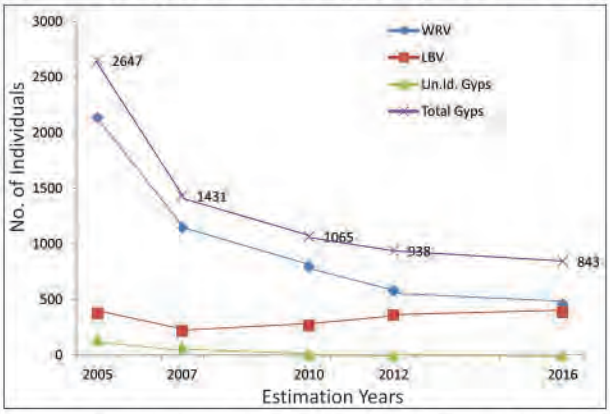


Fig. 3.4a: *Gyps* vulture population from 2005 to 2016 in Gujarat

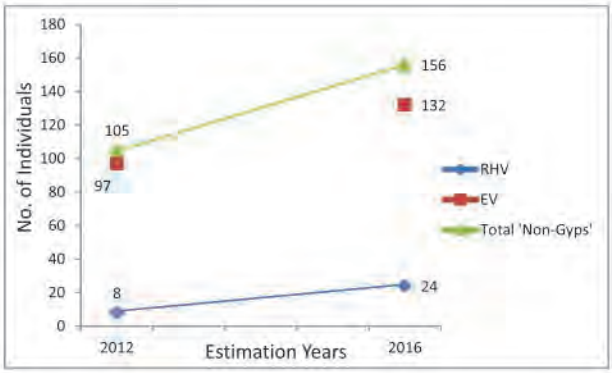


Fig. 3.4b: Population of non *Gyps* vultures from 2005 to 2016 in Gujarat State

The annual rate of population decline in total vulture population between 2005 and 2016 has been found to be 8.4% and that between 2007 and 2016 has been found to be 3.87%. Moreover, the annual rate of population decline in Gyps vultures for the long-term period of 2005-2016 and 2007-2016 has revealed that between 2005 (2,647 *Gyps* vultures) and 2016 (843 *Gyps* vultures), there has been an overall decline by 68.2% at an annual decline rate of 9.78% (Annexure III). Further, it is found that between 2007 (1,431 *Gyps* vultures) and 2016 (843 *Gyps* vultures), there has been an overall decline of 41.1% at annual decline rate of 5.65%.

3.2 Species-wise status of vultures

3.2.1 White-rumped Vulture (*Gyps bengalensis*)

3.2.1.1 Estimated population in 2016

A total of 458 White-rumped Vultures (WRVs) were recorded during the two days vulture population estimation in May, 2016 in Gujarat state (Table 3.1).

3.2.1.2 a) Region-wise Distribution

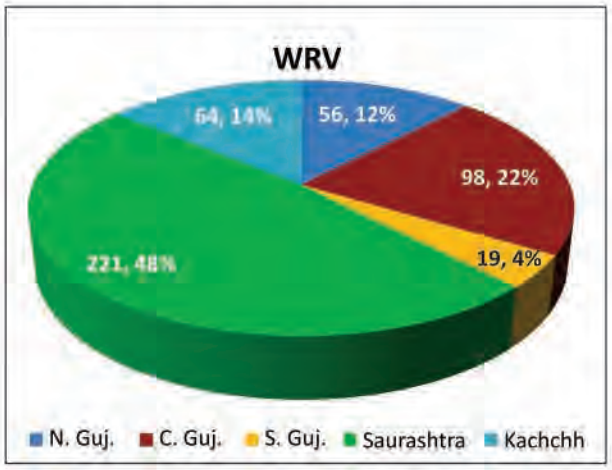


Fig. 3.5: Distribution of WRV across various regions of Gujarat State-2016

As per 2016 survey, among various regions of the State, Saurashtra region had supported highest population of White-rumped Vultures (n= 221, i.e., 48.25% of total WRV population) followed by Central Gujarat (n=98, i.e., 21.39% of total proportion). Though North Gujarat and Kachchh regions supported moderate numbers of White-rumped Vultures (i.e., 56 and 64 individuals, respectively), South Gujarat supported relatively very low numbers (i.e., 19) of White-rumped Vultures (Table 3.1)

3.2.1.2b) District-wise Distribution

As far as district-wise distribution of White-rumped Vultures in the State is concerned, it is revealed that Surendranagar district (n=84; 18.34% of total WRV population) and Bhavnagar district (n=83; 18.12% of total WRV population) have supported the highest populations of this species. Some other districts in which the WRVs were found to be widely distributed include Anand (n=70; 15.28% of total WRV population), Kachchh (n=64; 14% of total WRV population), Amreli (n=54; 11.8% of total WRV) and Mehsana (n=56; 12.22% of total WRV). Districts like Ahmedabad (n=24), Valsad (n=19) and Vadodara (n=4) have recorded relatively low population of WRVs, whereas many districts were found to be completely devoid of WRVs (e.g., all districts of Saurashtra region except Amreli, Bhavnagar and Surendranagar, all districts of South Gujarat except Valsad, all districts of Central Gujarat except Ahmedabad, Ananad and Vadodara and all districts of North Gujarat except Mehsana).

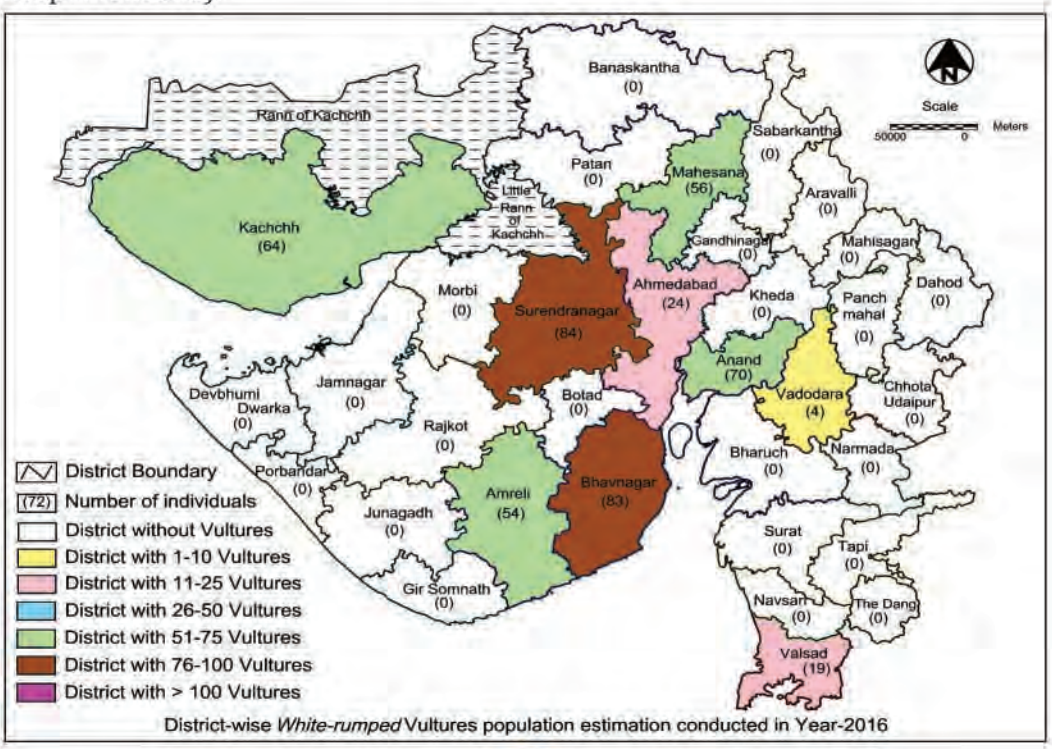
3.2.1.3 Population Trend of White-rumped Vulture

3.2.1.3a) Short-term Trend (2012-2016)

Considering WRV population as per the last/previous vulture survey in 2012 (i.e., 577 WRVs), it is revealed that within 4 years after that, i.e., by 2016, the population of WRV has declined by 20.62% with an annual decline rate of 5.61%.

3.2.1.3b) Long-term population trend (2005/2007-2016)

To determine long term population change for WRVs, their 2016 population has been compared with that of 2005 and 2007 population estimation surveys. It is revealed that between 2005 (2,135 WRVs) and 2016 (458 WRVs), population has declined by 78.55% with annual decline rate of 12.94%. It is also understood that between 2007 (1,147 WRVs) and 2016 (458 WRVs), WRV population has declined by 60.1% with annual decline rate of 9.61%.



District-wise *White-rumped* Vultures population estimation conducted in Year-2016

3.2.2 Long-billed Vulture (*Gyps indicus*)

3.2.2.1 Estimated population in 2016

A total of 385 Long-billed Vultures (LBVs) were recorded in Gujarat state during the two days vulture population estimation in May, 2016 (Table 3.1).

3.2.2.2a) Region-wise Distribution of LBV-2016

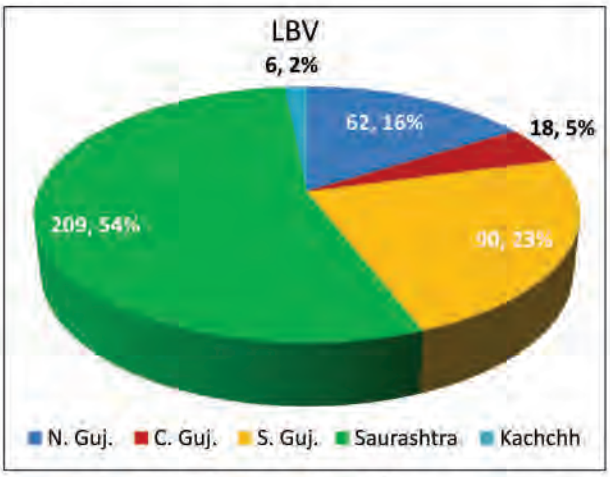


Fig. 3.6: Distribution of LBV across various regions of Gujarat State-2016

As per 2016 estimation, among various regions of the State, Saurashtra region has supported the highest population of Long-billed Vultures (n=209, i.e., 54.28% of total LBV population) followed by South Gujarat region (n=90, i.e., 23.37% of total LBV population). Though North Gujarat region supported moderately high LBV population (n=62, i.e., 16.10% of total LBV population), Central Gujarat supported low population of LBV (n=18) and Kachchh region supported very low numbers (n=6) of LBVs (Table 3.1, Fig.3.6).

3.2.2.2b) District-wise Distribution of LBV-2016

As far as district-wise distribution of Long-billed Vultures in the State is concerned, it is revealed that Junagadh district has supported exceptionally high population (n=131; 34.03% of total LBV population) in comparison with other districts. The other districts with higher LBV population has been Sabarkantha (n=62, 16.10% of the total LBV population). Valsad (n=47; 12.21% of total LBV population), Dangs (n=43; 11.16% of total LBV population), Gir Somnath (n=42; 11% of total LBV population) and Amreli (n=33; 8.57%) were found to be the districts with moderate-to-good LBV population, whereas Panchmahals(n=9), Kachchh (n=6) and Bhavnagar(n=3) had very low LBV population.

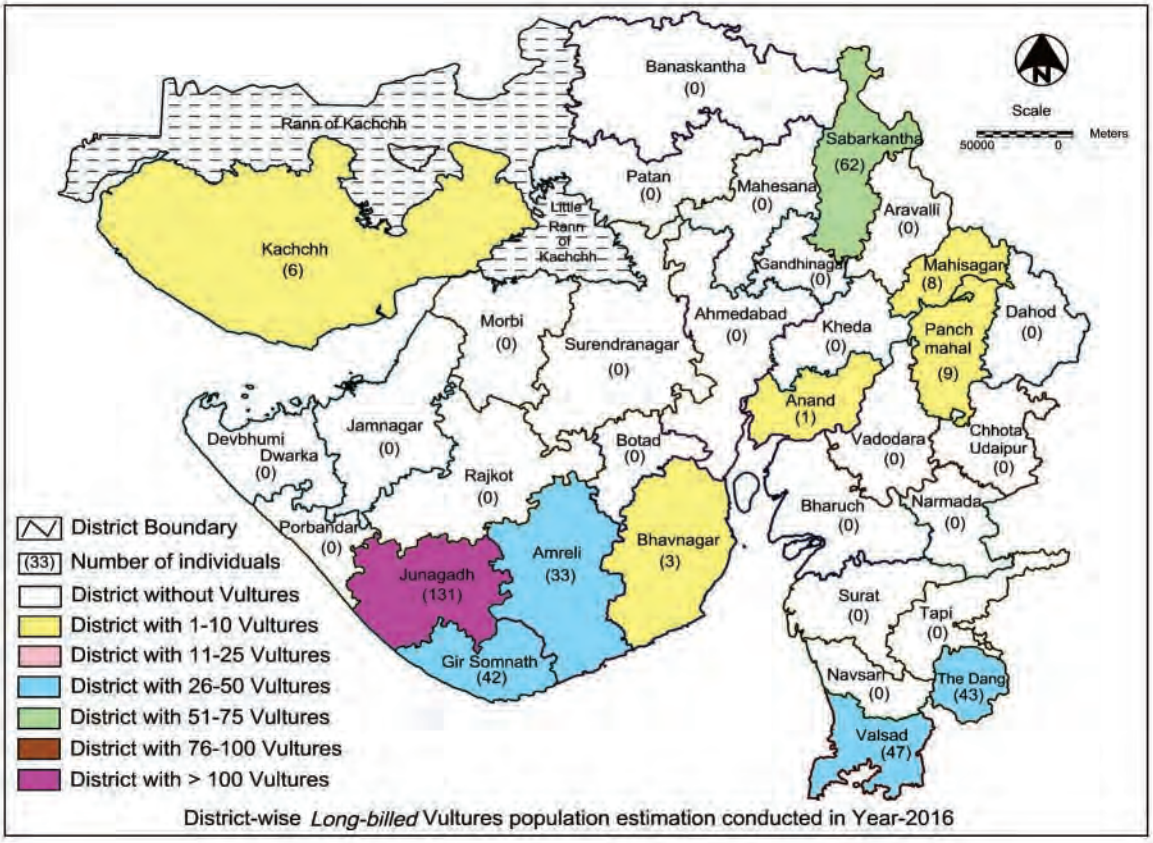
3.2.2.3 Population Trend of Long-billed Vulture

3.2.2.3a) Short-term Trend (2012-2016)

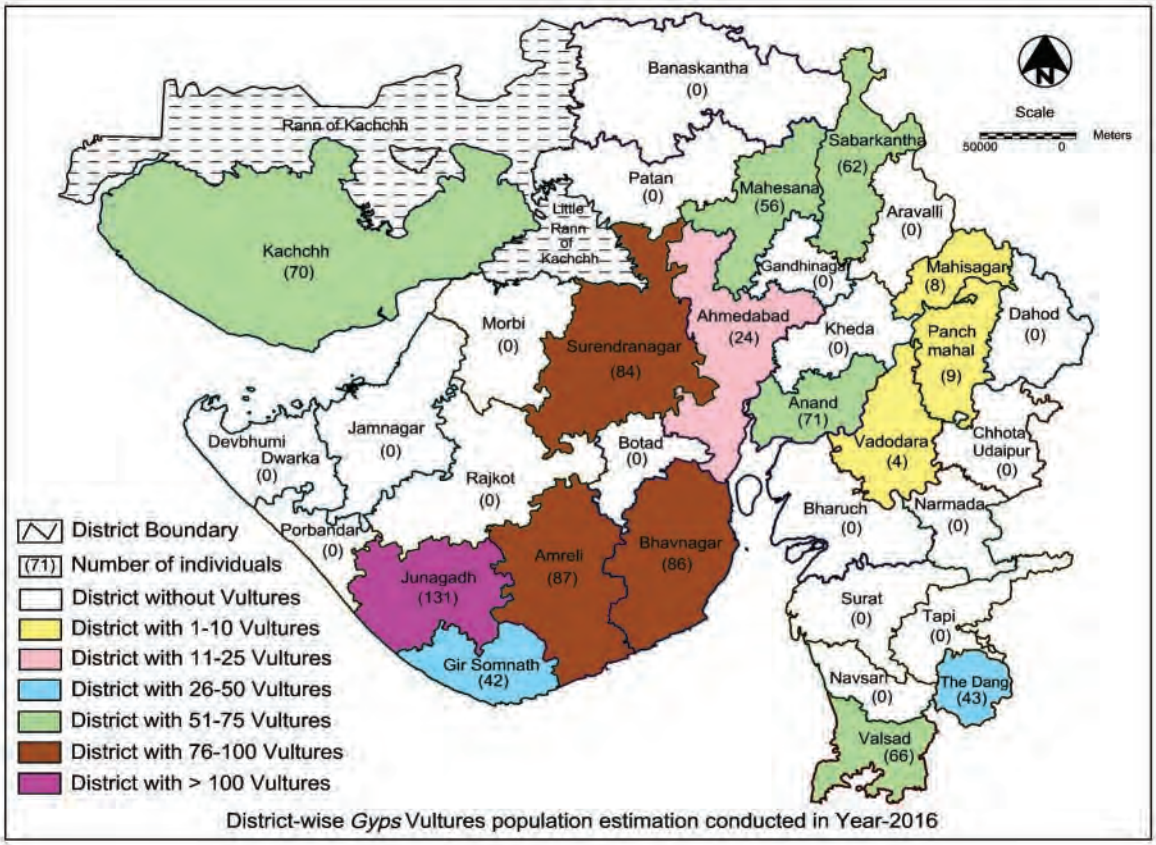
Comparison of Long-billed Vulture population estimated in the previous population survey of 2012 (n=361) with that of 2016 population (n=385), a modest increase in population by 6.65% with an annual increase rate of 1.62% is revealed.

3.2.2.3b) Long-term Trend (2005/2007-2016)

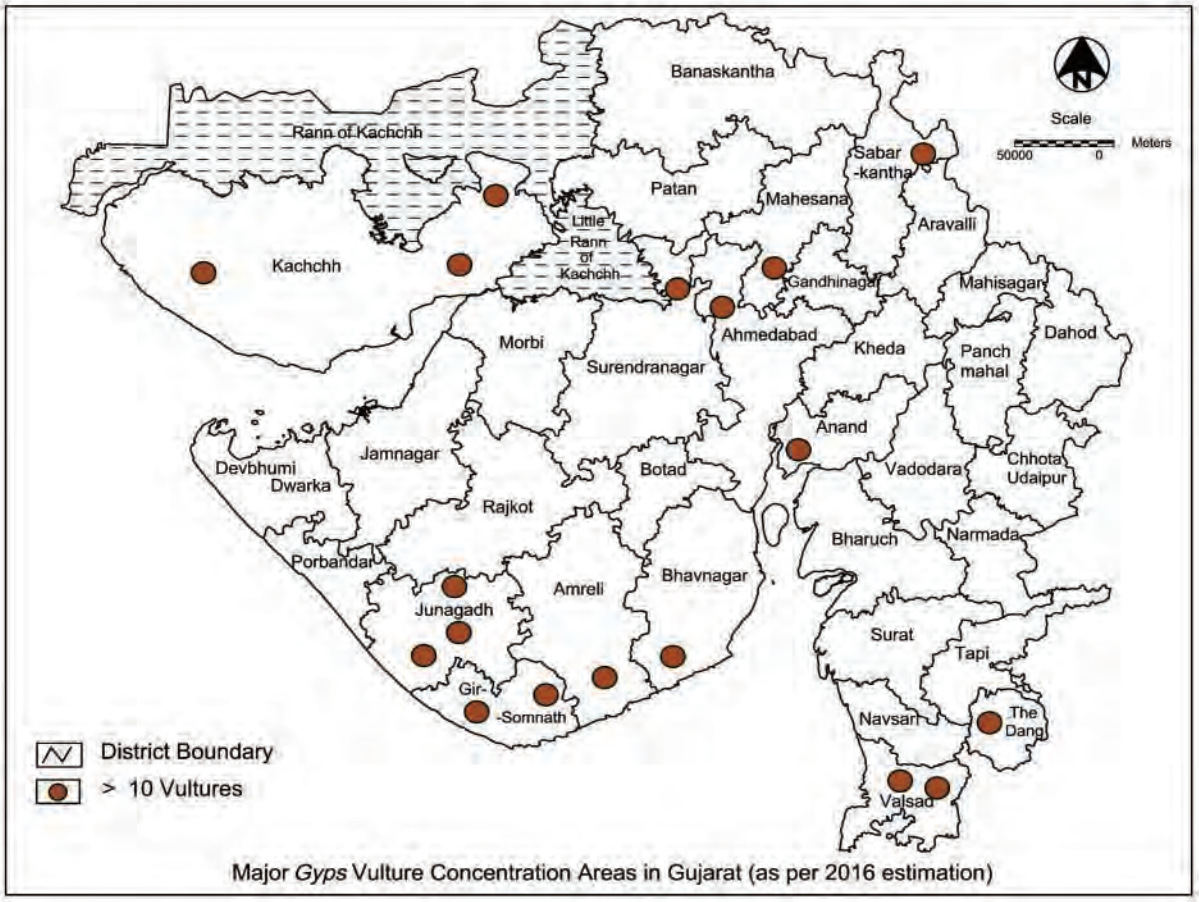
Unlike White-rumped Vulture's population, the population of Long-billed Vulture has never declined drastically since the first state-wide vulture survey conducted in 2005. On the contrary, the comparison of Long-billed Vulture population in 2005 (n=376) with that of the latest population estimation (of 2016; n=385) has indicated 2.39% population increase with an annual rate of 0.21%. The population increase for LBV is even more prominent between 2007 and 2016. Thus, if the comparison is made between Long-billed Vulture population of 2007 survey (n= 217) with that of 2016 population estimation (n=385), it is revealed that there has been increase by 77.2% in LBV population population with an annual increase rate of 6.51%.



District-wise *Long-billed* Vultures population estimation conducted in Year-2016



District-wise *Gyps* Vultures population estimation conducted in Year-2016



Major *Gyps* Vulture Concentration Areas in Gujarat (as per 2016 estimation)

3.2.3 Red-headed Vulture (*Sarcogyps calvus*)

3.2.3.1 Estimated population in 2016

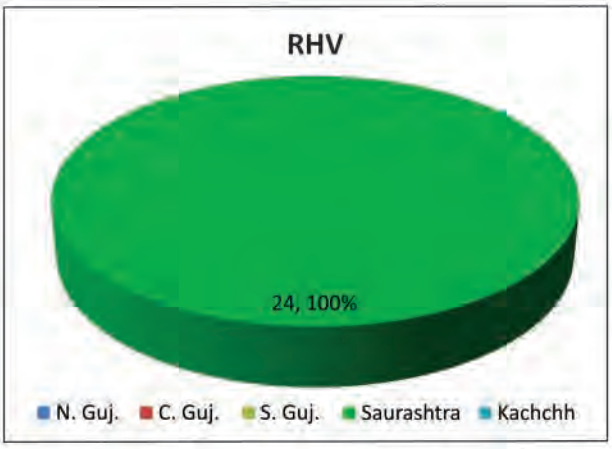
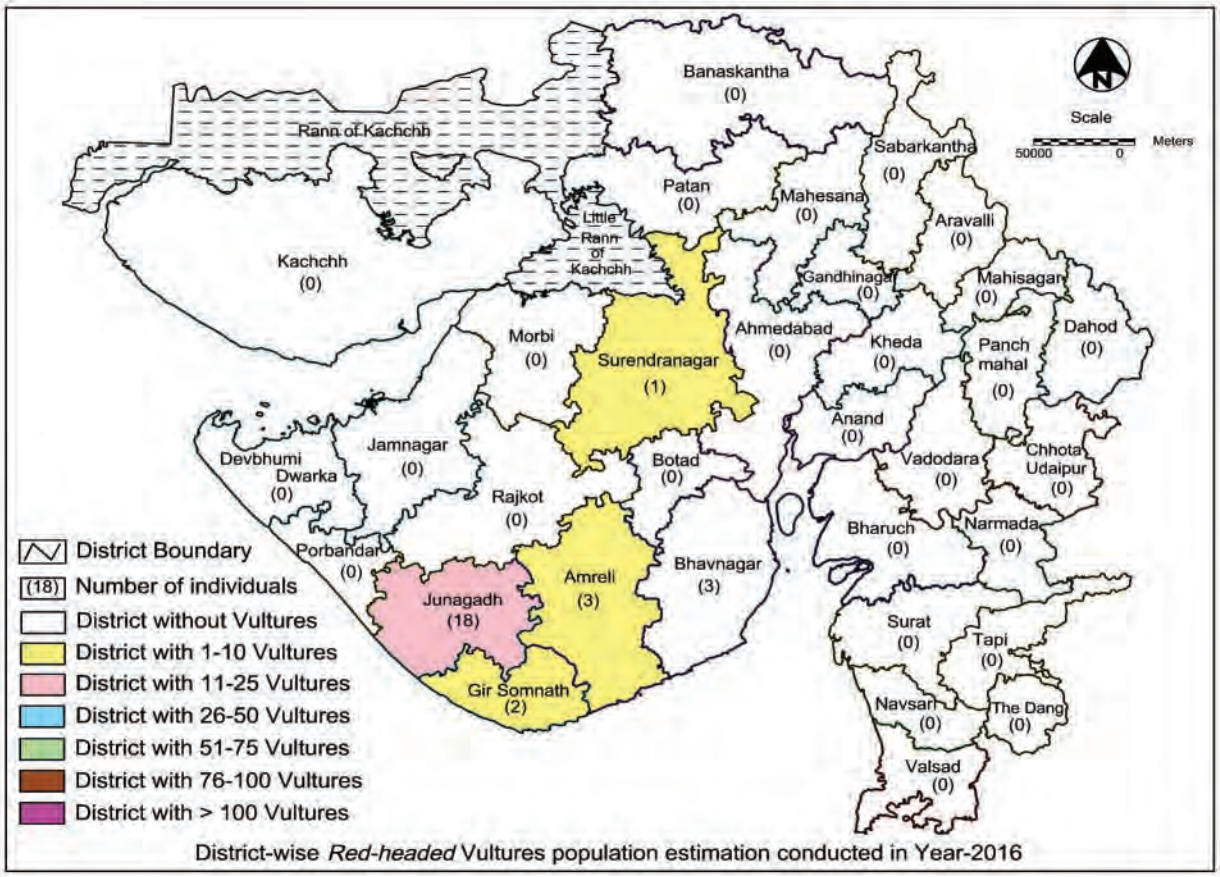


Fig 3.7: Distribution of RHV across various regions of Gujarat State-2016

Red-headed Vulture is a Critically Endangered species on global scale as per IUCN criteria. It is known to be uncommon in the State having patchy distribution. In the vulture estimations of the years from 2005 to 2010, Red-headed Vulture (as also Egyptian Vulture) was not included. Therefore, past distribution and long-term population trend for this species cannot be determined. However, Red-headed Vulture (as also Egyptian Vulture) was included in the last vulture estimation of 2012. In 2012 vulture estimation, a total of 8 Red-headed Vultures were recorded (with 5 in Junagadh and 3 in Amreli). In 2016 estimation, a total of 24 Red-headed Vultures were recorded and all of them occurred only in Saurashtra region (Table 3.1, Fig. 3.7) with 18 in Junagadh, 3 in Amreli, 2 in Gir Somnath and 1 in Surendranagar districts. Thus, a population increase of 300% has been recorded with an annual rate of 31.6%.



3.2.4 Egyptian Vulture (*Neophron percnopterus*)

3.2.4.1 Estimated population 2016

Egyptian Vulture is an endangered species on global scale as per IUCN criteria. In the vulture estimations of the years from 2005 to 2010, Egyptian Vulture (as also Red-headed Vulture) was not included. Therefore, past distribution and long-term population trend for this species cannot be determined. However, Egyptian Vulture (as also Red-headed Vulture) was included in the last vulture estimation of 2012.

In 2012 vulture estimation, a total of 97 Egyptian Vultures were recorded [with highest numbers concentrated in Ahmedabd and Banaskantha distrcts; i.e., 38 and 33, respectively]. In 2016 estimation, a total of 132 Egyptian Vultures were recorded (with their populations mainly concentrated in Banaskantha (n=72) and Ahmedabad (n=32) districts (Table 3.1, Fig.3.8). Thus, between 2012 and 2016, a population increase of 36.10% has been recorded with an annual rate of 8 %.

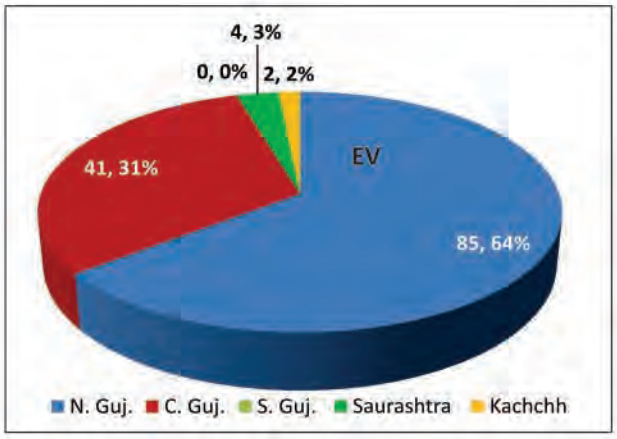
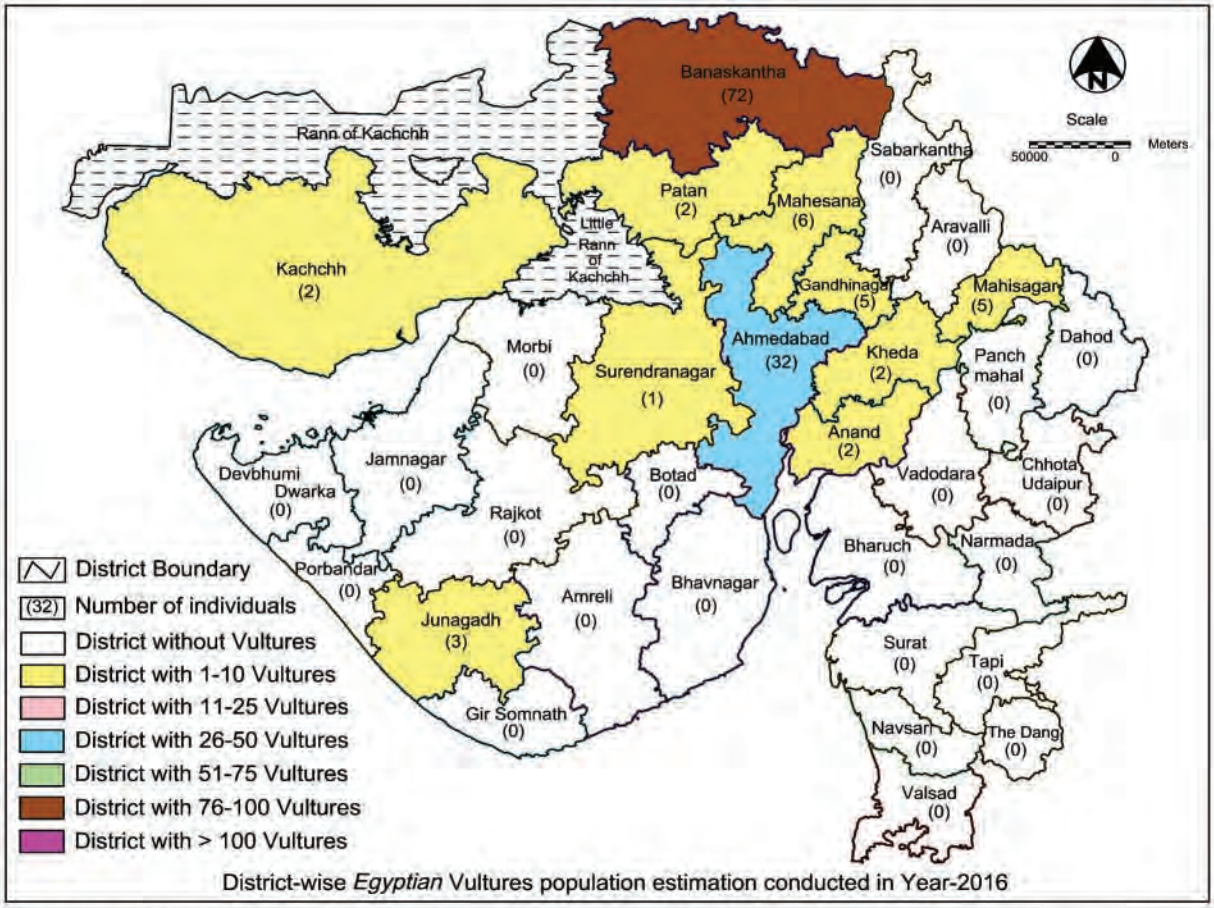


Fig.3.8: Distribution of EV across various regions of Gujarat State-2016



District-wise *Egyptian* Vultures population estimation conducted in Year-2016

3.3 Status of Various Regions and Some of Their Districts from View Point of Vultures

In Section 3.1, status of all the four species of vultures was comprehensively discussed from their distribution and population trend point of views. It gave comprehensive vulture-centric information. However, for effective conservation, it is also important to have comprehensive information on status of various regions and districts of the state from the view-point of occurrence of various species of vultures. Various sub-sections of the section 3.2 would be useful in having such information.

3.3.1 North Gujarat Region: In 2016, North Gujarat region has supported both species of *Gyps* vultures as also Egyptian Vulture. It did not record any Red-headed Vulture. Crude density of four, 2 non *Gyps* and 2 *Gyps* species in North Gujarat region was 0.0063 ind./sq.km and 0.0036 ind./sq.km respectively. As far as *Gyps* vulture population over last one decade (2007-2016) is concerned, it was found to have decreased from 111 in 2007 to 74 in 2010(33.33% decrease). However, the *Gyps* vulture population has increased from 74 in 2010 to 124 in 2012 (67.56% increase) and it remained more or less same (n=118) in 2016. In nutshell, *Gyps* vulture population has not much fluctuated in last one decade (2007-2016) as it was 111individuals in 2007 and 118 individuals in 2016.

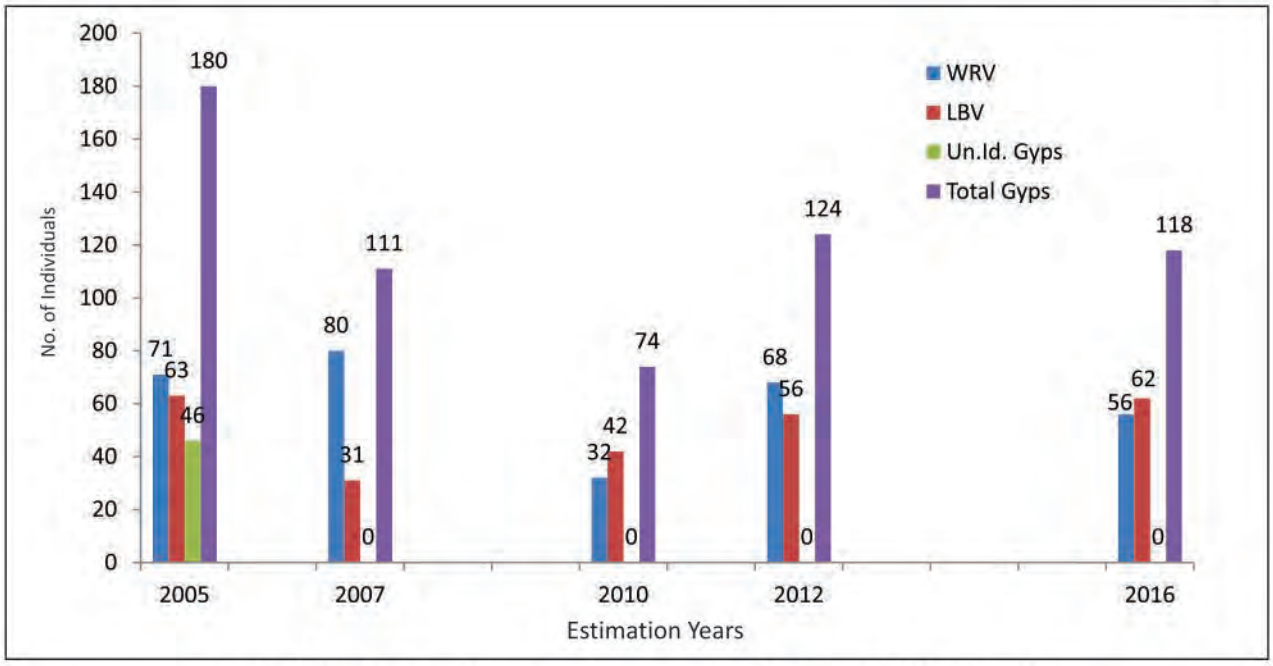


Fig. 3.9a: *Gyps* vulture population in North Gujarat (2005-2016)

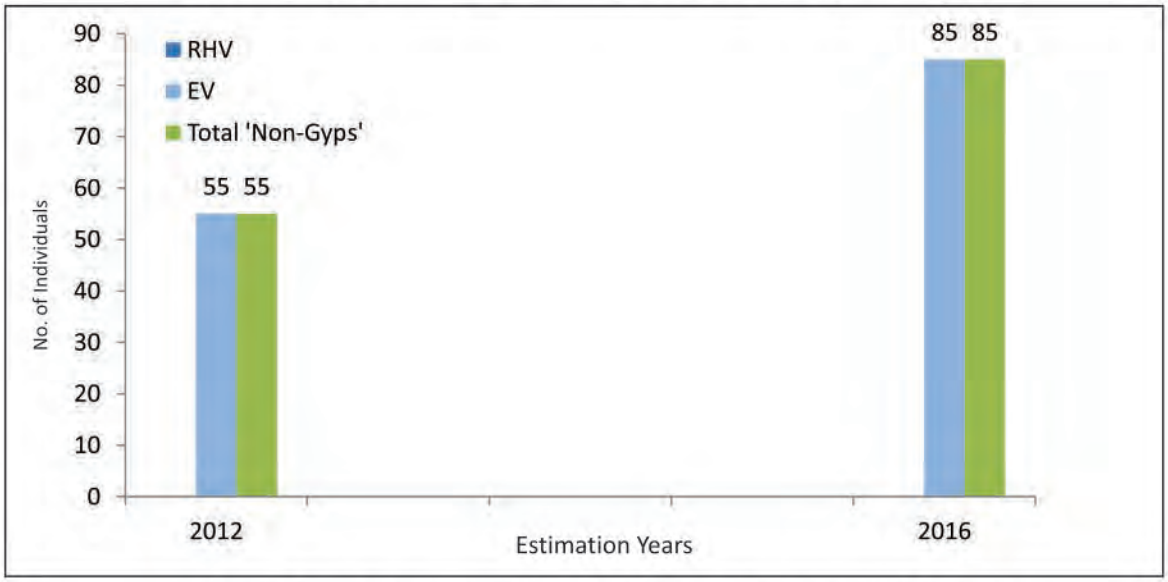


Fig. 3.9 b: Population of non *Gyps* in North Gujarat (2012-2016)

3.3.1.1 Some Important Districts of North Gujarat from View-Point of Vulture Population

a) Banaskantha District:

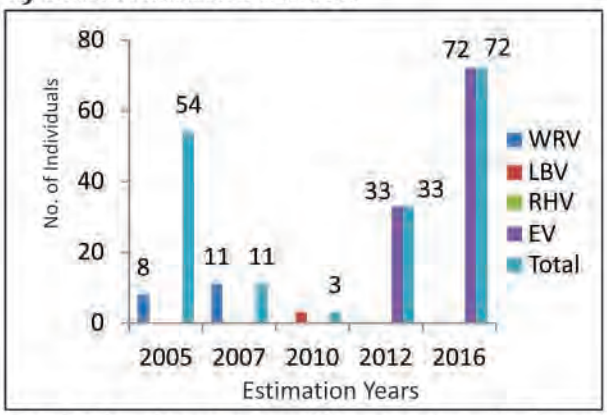


Fig. 3.10 a: Population of four species of vultures in Banaskantha district from 2005 to 2016

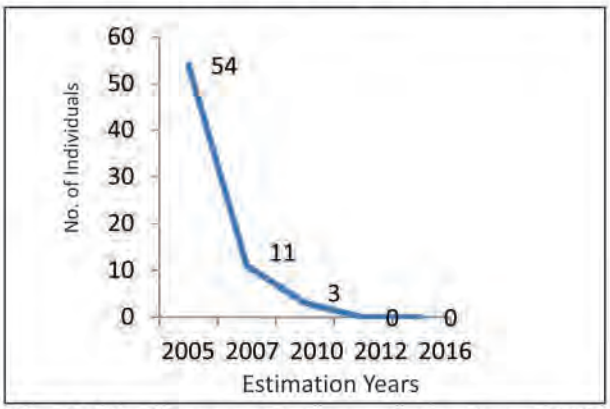


Fig. 3.10b: Gyps population variation from 2005 to 2016 in Banaskantha district

Fig.3.10a and 3.10b reveal following facts:

a) Since 2007(i.e., about a decade), Banaskantha district has been inhabited by White-rumped Vulture, Long-billed Vulture and Egyptian Vulture during the months of May/June. However, in the recent time, i.e., from 2012 onwards, the district has recorded only Egyptian Vultures

b) May 2016 vulture population was found to be 72 individuals, all of which happened to be the Egyptian Vultures. In fact, Banaskantha district has been the district with highest EV population among all the districts as per 2016 estimation.

c) Species-wise or even group-wise population comparison for 2007 and 2016 is not feasible as two different species have occurred during 2007 and 2016. As Banasknath has a geographical area of 10,757 sq.km, vulture crude density can be considered to be 0.006 ind./sq.km in 2016. Fig.3.10b indicates that Gyps vulture population has gone declining from 2007 (n=11) to 2010 (n=3) to 2012 & 2016 (n=0) in the district.

(b) Mehsana District:

Fig. 3.11a and 3.11b reveal following facts:

a) Since 2007(i.e., about a decade), Mehsana district has been inhabited mainly by White-rumped Vultures and to certain extent by Egyptian Vultures during the months of May/June;

b) May 2016 vulture population was found to be 62 individuals, of which 56 individuals (90.3%) were White-rumped Vultures and only 6 individuals(9.7%) were Egyptian Vultures

c) As 60 White-rumped Vultures (WRVs) were recorded in 2007, it can be said that its population has slightly decreased by 6.7% by May 2016(i.e., in a decade's time).

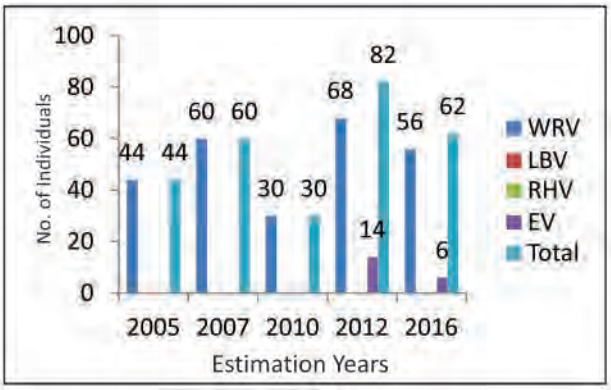


Fig. 3.11a: Population of four species of vultures in Mehsana district from 2005 to 2016

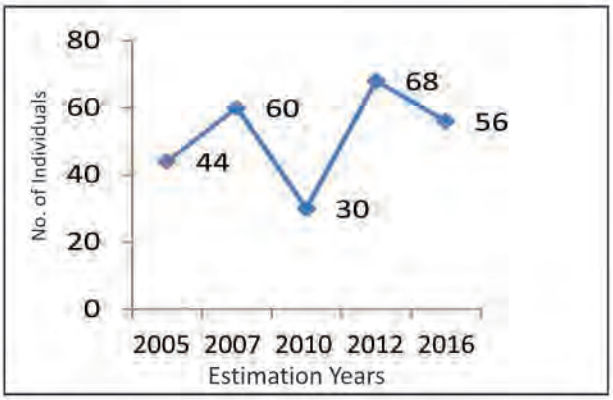


Fig. 3.11b: *Gyps* population variation from 2005 to 2016 in Mehsana district

As Mehsana has a geographical area of 4,386 sq.km, vulture crude density can be considered to be 0.014 ind./sq.km in 2016, of which WRV has crude density of 0.013 ind./sq.km. and Egyptian Vulture crude density has been negligible 0.001 ind./sq.km. Fig. 3.11b indicates Gyps population reduction by 6.7% between 2007and 2016 , where during the short-term period of 2012-2016, Gyps population has decreased more intensely, i.e., by 17.64%. It might be noted that Mehsana district has never recorded Long-billed Vulture and Red-headed Vulture during the month of May/June.

(c) Sabarkantha District:

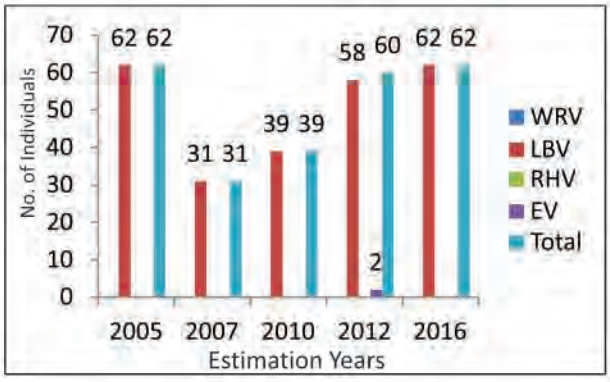


Fig. 3.12a: Population of four species of vultures in Sabarkantha district from 2005 to 2016

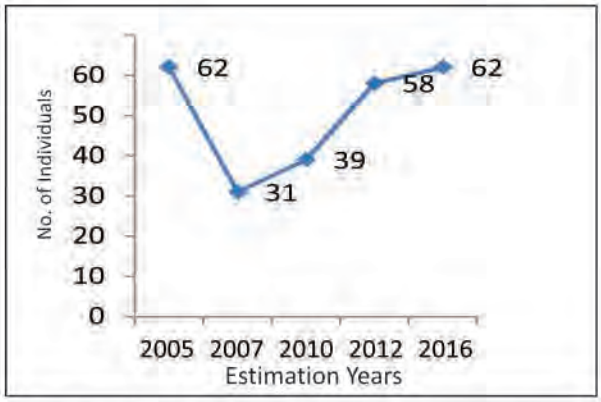


Fig. 3.12b: *Gyps* population variation in Sabarkantha district - 2005 to 2016

Fig. 3.12 a and 3.12 b reveal following facts:

a) Since 2007(i.e., about a decade), Sabarkantha district has been inhabited predominantly by Long-billed Vultures during the months of May/June;

b) May 2016 vulture population was found to be 62 individuals, all of which were Long-billed Vultures

c) As 31 Long-billed Vultures (LBVs) were recorded in 2007, it can be said that its population has doubled by May 2016 indicating 100% population increase in about a decade's time. As Sabarkantha district has a geographical area of 4,173 sq.km, its vulture crude density can be considered to be 0.015 ind./sq.km in 2016. As all the vultures recorded in May 2016 had been Long-billed Vultures, it can also be said that crude density of Long-billed Vultures in Sabarkantha district has been 0.015 ind./sq.km. Fig. 3.12b indicates *Gyps* population has doubled during a decade's period between 2007 and 2016. Between 2012 and 2016, the *Gyps* population has varied negligibly (i.e., by 6.8%). It might be noted that Sabarkantha district has never recorded White-rumped Vulture and Red-headed Vulture, though Egyptian Vultures were recorded in negligible numbers in 2012.

3.3.2 Central Gujarat Region: In 2016, Central Gujarat region has supported both species of *Gyps* vultures as also Egyptian Vulture. It did not record any Red-headed Vulture. Crude density of 2 non *Gyps* and 2 *Gyps* vultures in Central Gujarat region are 0.0037 individuals/sq.km and 0.0027 individuals/sq.km respectively. As far as *Gyps* vulture population over last one decade (2007-2016) is concerned, it was found to have decreased from 343 in 2007 to 261 in 2010(23.9% decrease). Unfortunately, the *Gyps* vulture population has also decreased further from 261 individuals in 2010 to 151 individuals in 2012 (42.14% increase) and then to 116 individuals in 2016 (23.17% decrese from 2012). In nutshell, *Gyps* vulture population has consistently declined over a decade's time (2007-2016) in Central Gujarat region by 66.18%(i.e., from 343 in 2007 to 116 in 2016)(Fig.3.13a). However, population of non-*Gyps* vultures has almost remained stable between 2012 and 2016(Fig. 3.13b).

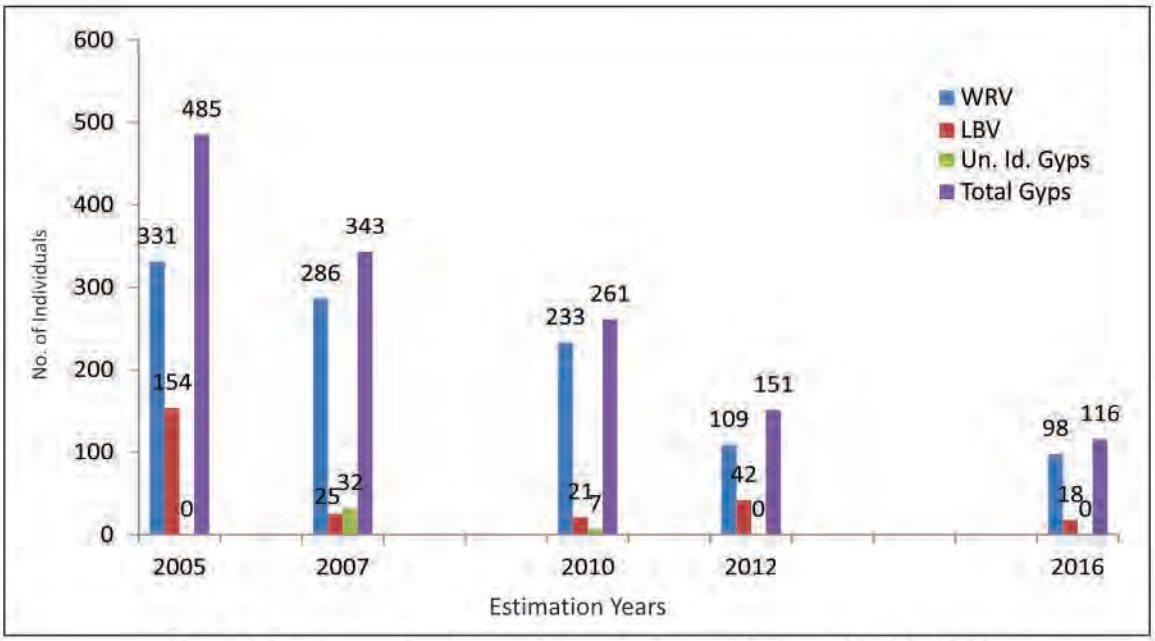


Fig. 3.13a: *Gyps* vulture population in Central Gujarat (2005-2016)

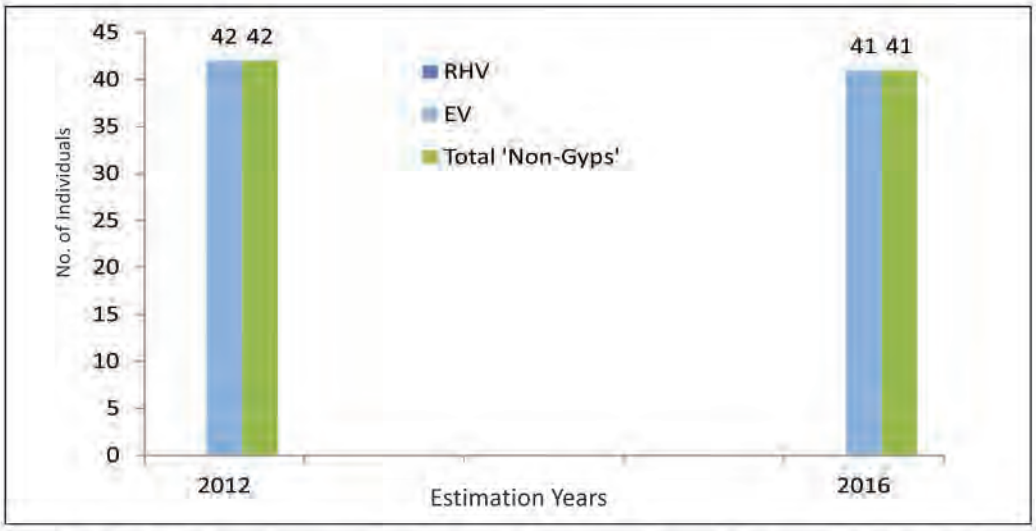


Fig. 3.13b: Population of non *Gyps* Vultures in Central Gujarat(2012-2016)

3.3.2.1 Some Important Districts of Central Gujarat from View-Point of Vulture Population

a) Ahmedabad District

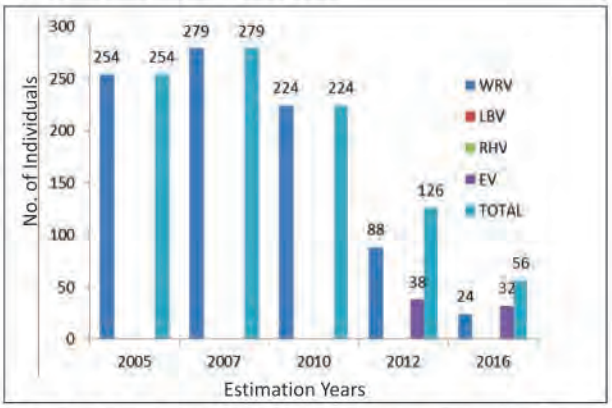


Fig. 3.14a: Population of four species of vulture in Ahmedabad district -2005 to 2016

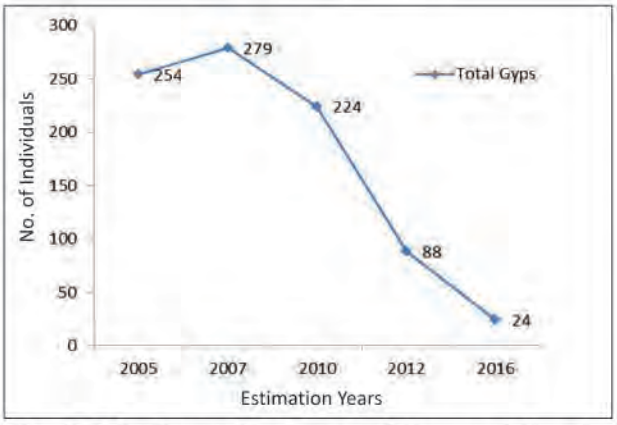


Fig. 3.14b: *Gyps* vultures population variation in Ahmedabad district from 2005 to 2016

Fig. 3.14a and 3.14b. reveal following facts:

a) Ahmedabad district has been inhabited by White-rumped Vulture and Egyptian Vulture during the months of May/June;
b) May 2016 vulture population was found to be 56 individuals, of which 24 individuals (42.85%) were White-rumped Vultures and 32 individuals (57.14%) were Egyptian Vultures

As 279 White-rumped Vultures (WRVs) were recorded in 2007, it can be said that its population has reduced by 91.4% by May 2016(i.e., in a decade's time). It does not necessarily indicate death of massive population of this species. Rather, in view of several experienced vulture enthusiasts of the State, currently reduced WRV population in Ahmedabad district might be due to shifting of major population of these vultures from Ahmedabad to other nearby districts like Anand and Surendranagar wherein their population was not high in the past, but was found to be high during current population estimation. Considering that vultures are long-distant fliers, such inter-district population shift cannot be ruled out and thus reduction by 72.2% is also recorded between 2012 WRV population and 2016 WRV population. As Ahmedabad has a geographical area of 7,170 sq.km, vulture crude density can be considered to be 0.0078 ind./sq.km in 2016, of which WRV has crude density of 0.0034 ind./sq.km. Fig. 3.14b indicates Gyps population reduction by 91.4% between 2007 (24% annual reduction over the time-san of 4 years) and 2016 and 72.7% (13.4% annual reduction over the time-san of 4 years) between 2012 and 2016. It might be noted that Ahmedabad district has never recorded Long-billed Vulture and Red-headed Vulture during the month of May/June when population surveys are usually carried out in the State.

b) Anand District

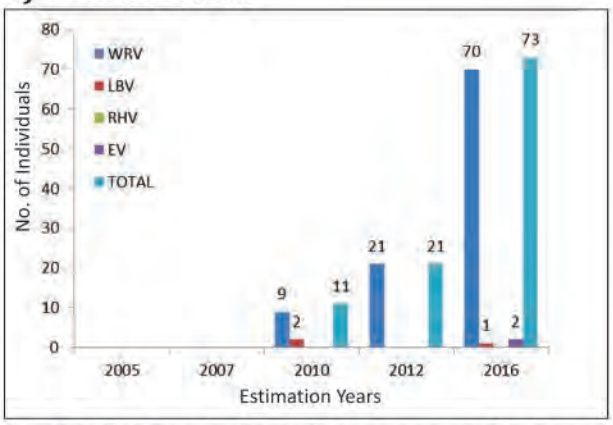


Fig. 3.15 a: Population of four species of vultures in Anand district from 2005 to 2016

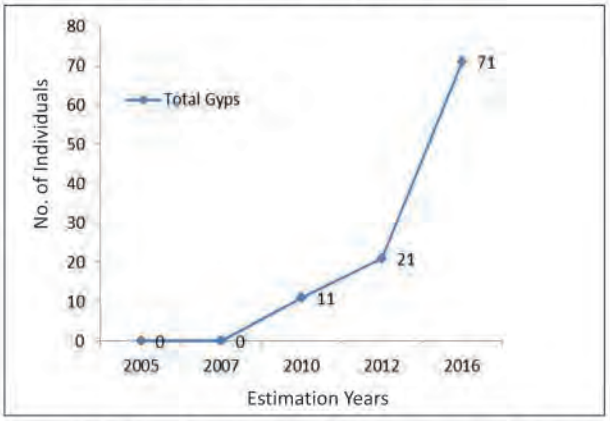


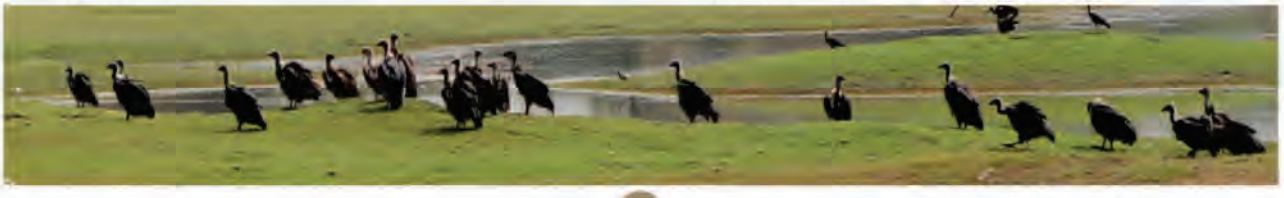
Fig. 3.15b: *Gyps* population variation in Anand district -2005 to 2016

Fig. 3.15a and 3.15b. reveal following facts:

a) Anand district has been mainly inhabited by White-rumped Vultures though negligible numbers of Long-billed Vultures and Egyptian Vultures have also been during the months of May/June;

b) In May 2016, vulture population was found to be 73 individuals, of which 70 individuals (95.8%) were White-rumped Vultures and 1 individual (1.36%) was Long-billed Vulture and 2 (2.74%) individuals were Egyptian Vultures.

A decade back, i.e., in 2007, only 9 individuals of White-rumped Vulture (WRVs) were recorded and therefore it can be said that its population has increased in a decade's time (2007-2016) by 677% as recorded in May 2016. It does not necessarily indicate massive breeding success of this species in Anand. Rather, in view of several experienced vulture enthusiasts of the State, the increased WRV population in Anand district might be due to shifting of major population of these vultures from other districts like Ahmedabad (or even Surat) wherein their population was high in the past, but was found to be drastically reduced during current population estimation. Considering that vultures are long-distant fliers, such inter-district population shift cannot be ruled out and thus increase by 233% is also recorded between 2012 WRV population (n=21) and 2016 WRV population (n=70). As Anand has a geographical area of 2,941 sq.km, vulture crude density can be considered to be 0.0248 ind./sq.km in 2016, of which WRV has occurred with crude density of 0.0149 ind./sq.km. Fig. 3.15b indicates *Gyps* population increase from zero population in 2007 to 71 individuals 2016 and 238% (13.4% annual reduction over the time-san of 4 years) between 2012 and 2016. It might be noted that Anand district has always recorded nill/negligible number of Long-billed Vultures and Egyptian Vulture and it has never recorded Red-headed Vulture during the month of May/June when population estimations are usually carried out in the State.



c) Panchmahals District

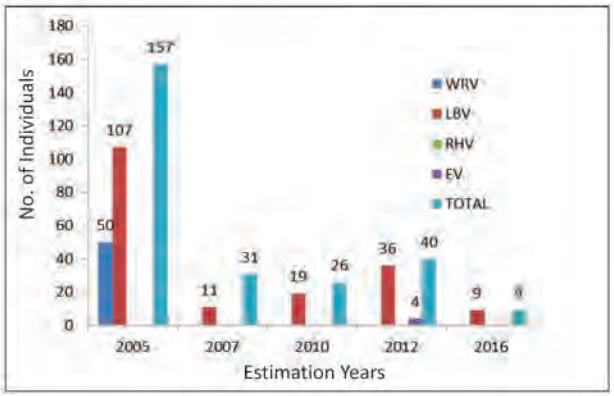


Fig. 3.16a: Population of four species of vultures in Panchmahals district from 2005-16

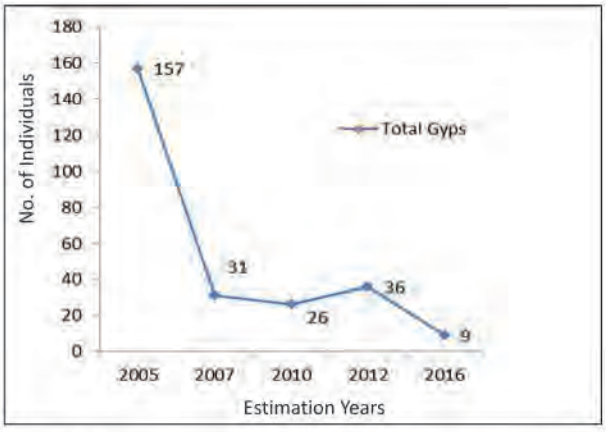


Fig. 3.16b: *Gyps* population variation from 2005 to 2016 in Panchmahals district

Fig. 3.16a and Fig. 3.16b reveal following facts:

a) From 2007 onwards, Panchmahals district has been mainly inhabited by Long-billed Vultures during the months of May/June though 50 WRVs were recorded in 2005. Very low numbers (n=4) of Egyptian Vultures had been recorded in 2012, but earlier surveys did not include enumeration of this species;

b) May 2016 vulture population was found to be only 9 individuals; all of which were Long-billed Vultures

c) A decade back, i.e., in 2007, only 11 individuals of LBVs were recorded on confirmed basis and therefore it can be said that its population has remained more or less stable till 2016 when 9 LBVs were recorded.

d) In 2007, 20 vultures were unidentified *Gyps* and 11 individuals were LBV resulting into total 31 Gyps vultures, thus there has been 71% reduction in *Gyps* vulture population between 2007 and 2016 as only LBVs were the *Gyps* vultures in 2016. Between 2012 and 2016, there has been 75% population reduction in *Gyps* vulture population (Fig. 3.16b). As Panchmahal has a geographical area of 3,272 sq.km, vulture crude density can be considered to be 0.0027 ind./sq.km in 2016. It might be noted that Anand district has always recorded nil/negligible number of Long-billed Vultures and Egyptian Vulture and it has never recorded Red-headed Vulture during the month of May/June when population surveys are usually carried out in the State.

d) Vadodara District

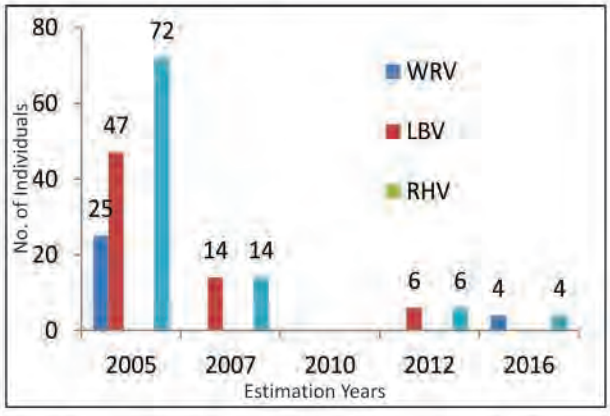


Fig. 3.17 a: Population of four species of vultures in Vadodara district -2005 to 2016

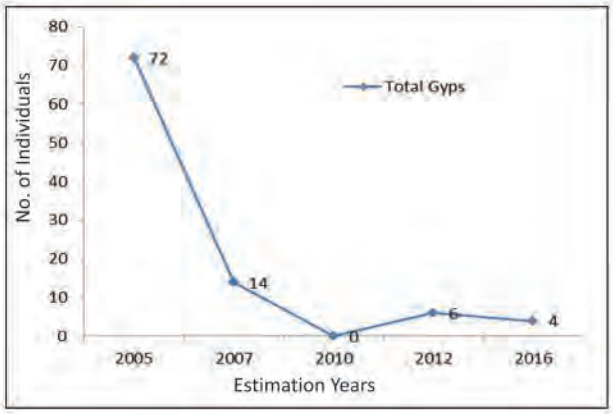


Fig. 3.17b: *Gyps* vultures population in Vadodara district from 2005 to 2016

Fig. 3.17a and Fig. 3.17b reveal following facts:

a) From 2007 onwards, Vadodara district has experienced noticeable variation in vulture species composition as in 2007 only LBV was recorded, in 2010 none of the vultures were recorded, in 2012 only LBVs were recorded whereas in 2016 only WRVs were recorded. Irrespective of the species, numbers of individuals have always remained low (14 individuals in 2007, 6 individuals in 2012 and 4 individuals in 2016). As Vadodara has a geographical area of 4,312 sq.km, vulture crude density can be considered to be 0.0009 ind./sq.km in 2016.

3.3.3 South Gujarat Region: In 2016, South Gujarat region has supported both species of *Gyps* vultures though Egyptian Vulture has not been recorded. It did not record any Red-headed Vulture too. Crude density of *Gyps* vultures in South Gujarat region was 0.0074 individuals/sq.km. As far as *Gyps* vulture population over last decade (2007-2016) is concerned, it was found to have remained stable at 237 individuals from 2007 to 2010. Unfortunately, the *Gyps* vulture population had decreased from 237 individuals in 2010 to 180 individuals in 2012 (24% decrease) and then to 109 individuals in 2016 (39.44% decrease from 2012). In nutshell, *Gyps* vulture population has declined over a decade's time(2007-2016) in South Gujarat region by 54%(i.e., from 237 in 2007 to 109 in 2016)(Fig.3.18).

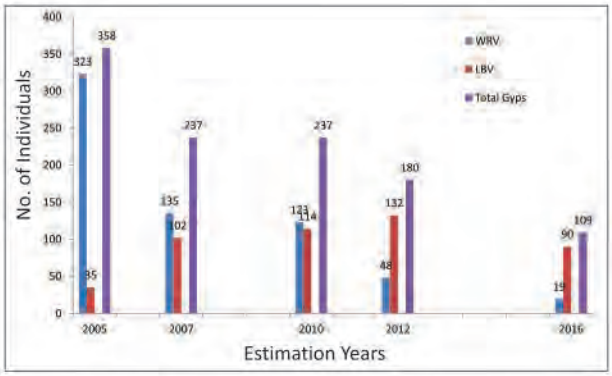


Fig. 3.18: *Gyps* vulture population in South Gujarat (2005-2016) (Note: There were no 'non-*Gyps*' vultures in South Gujarat)

3.3.3.1 Some Important Districts of South Gujarat from View-Point of Vulture Population

a) Dangs District

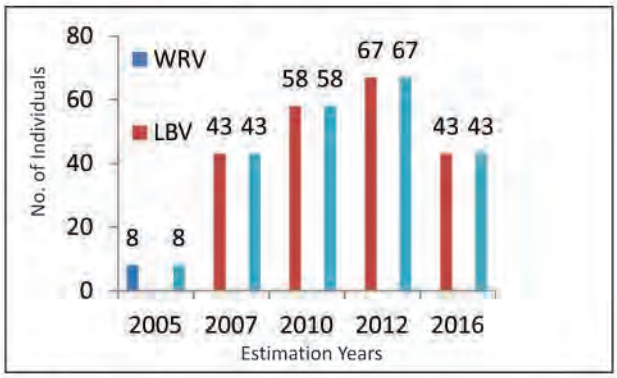


Fig. 3.19a: Population of four species of vulture in Dangs district-2005 to 2016

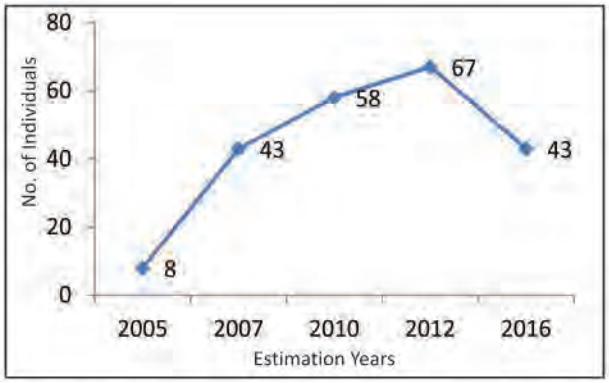


Fig. 3.19b: *Gyps* vultures population variation in Dangs district from 2005 to 2016

Fig. 3.19a and Fig. 3.19b reveal following facts:

a) From 2007 onwards, only Long-billed Vulture (LBV) has been recorded in the Dang district during the months of May/June though few WRVs were recorded in 2005. Thus, vulture population of this district is constituted of LBV only

b) LBV population in 2007 and 2016 has been same though during 2010 and 2012 higher populations of 58 individuals and 67 individuals were recorded respectively.

c) Fig. 3.17b indicates that though *Gyps* vulture population has remained stable on the long-term basis (from 2007 to 2016), it has reduced by 35.8% between the last estimation of 2012 and the current estimation of 2016. As Dangs has a geographical area of 1,764 sq.km, its vulture crude density can be considered to be 0.024 individuals /sq.km in 2016. It might be noted that Dangs district has always recorded nil/negligible number of White-rumped Vultures and though Red-headed Vulture and Egyptian Vulture have been included in the population surveys since 2012, they have not been recorded.

d) Shri Uday Vora noted local movements of around 30 vultures from Dang to Don areas of Maharashtra close to Gujarat border.

b) Valsad District

Fig. 3.20 a and Fig. 3.20 b reveal following facts:

a) In 2010 and 2016, both WRV and LBV have been recorded. But, in 2007 and 2012, only LBVs were recorded. This means that White-rumped Vultures (WRVs) might be floating, opportunistic population in the district, whereas LBVs are permanent residents;

b) A decade back, i.e., in 2007, 31 LBVs were recorded, but in the latest estimation of 2016, 47 LBVs have been recorded indicating 51.6% higher population in 2016 as compared to that in 2007;

c) In a decade's time (2007-2016), the Gyps vulture population has increased by 113% (from 31 individuals to 66 individuals). In the short-term period of 2012-2016, the Gyps vulture population has remained stable (i.e., around 66 individuals).

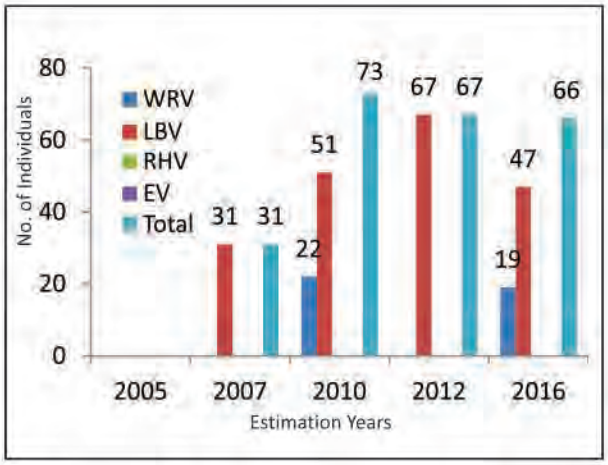


Fig. 3.20 a: Population of four species of vulture in Valsad district -2005 to 2016

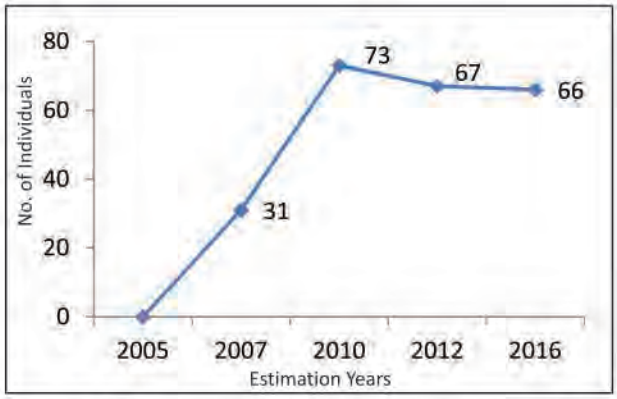


Fig. 3.20b: Gyps vultures population in Valsad district from 2005 to 2016

As Valsad district has a geographical area of 3,034 sq.km, its vulture crude density can be considered to be 0.022 ind./sq.km in 2016. It might be noted that though Red-headed Vulture and Egyptian Vulture have been included in the population surveys from 2012, they have not been recorded in the district.

c) Surat District

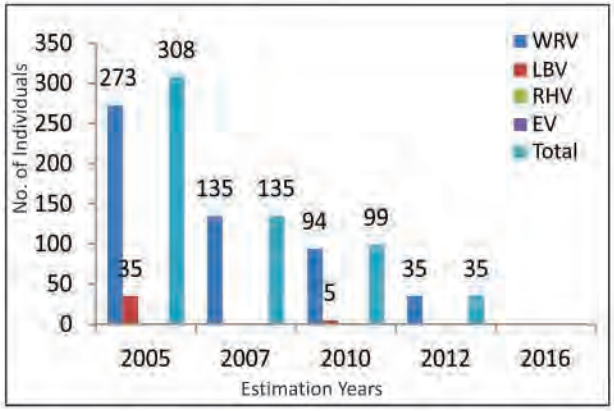


Fig. 3.21a: Population of four species of vulture in Surat district - 2005 to 2016

Fig. 3.21a and Fig. 3.21b reveal following facts:

a) Surat has been inhabited only by Gyps vultures since about a decade(i.e., from 2007 onwards) and White-rumped Vulture has been a predominant and regularly occurring Gyps species;

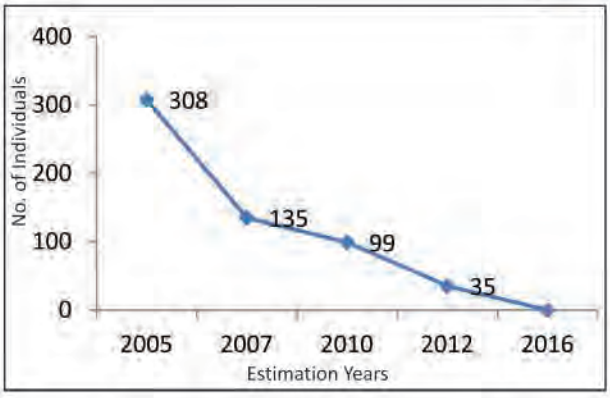


Fig. 3.21b: *Gyps* vultures population variation in Surat district from 2005 to 2016

b) Total vulture population (as also *Gyps* vulture population) has consistently reduced from 2007(n=135) to 2010 (n=99), 2010 to 2012 (n=12) and 2012 to 2016 (n=0).

c) A decade back, i.e., in 2007, 31 LBVs were recorded, but in the latest estimation of 2016, 47 LBVs have been recorded indicating 51.6% higher population in 2016 as compared to that in 2007;

d) In a decade's time (2007-2016), the total *Gyps* vulture population as also that of White-rumped Vulture has declined by 100%(from 135 individuals in 2007 to no individuals in 2016). In the short-term period of 2012-2016 also, the *Gyps* vulture population has declined by 100%. Surat has geographical area of 4,418 sq.km., but in May, 2016 not a single vulture has been recorded.

3.3.4 Saurashtra Region: In 2016, Saurashtra region has supported both species of *Gyps* vultures as also Egyptian Vulture and Red-headed Vultures. In fact, all the Red-headed Vulture population of the State was found to have been concentrated in Saurashtra. Crude density of all species and

Gyps vultures in Saurashtra region are 0.0071 ind./sq.km and 0.0066 ind./sq.km respectively. As far as *Gyps* vulture population over last one decade (2007-2016) is concerned, it was found to have decreased from 278 individuals in 2007 to 258 individuals in 2010(7.19% decrease). Interestingly, the *Gyps* vulture population has remained stable from 258 individuals in 2010 to 260 individuals in 2012. Further, it is very encouraging to see that Gyps vulture population has increased to 430 individuals in 2016 (43.33% increase from 300 individuals in 2012). *Gyps* vulture population has also increased declined over a decade's time (2007-2016) in Saurashtra region by 59.85% (i.e., from 269 individuals in 2007 to 430individuals in 2016) (Fig.3.22a). Population of vultures other than *Gyps* vultures (non-*Gyps* vultures) has increased between 2012 and 2016 (Red-headed Vulture increased from 8 individuals to 24 individuals and Egyptian Vulture population increased from zero to 132 individuals (Fig. 3.22b).

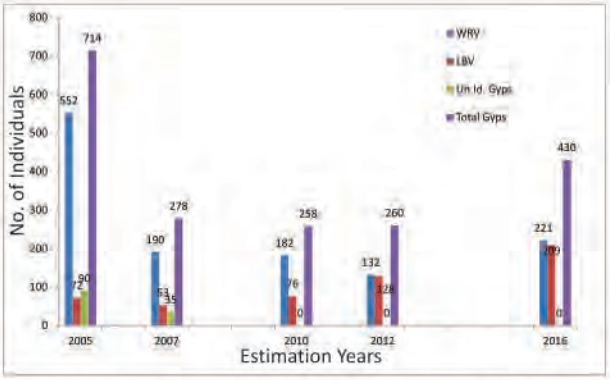


Fig. 3.22a: *Gyps* vulture population in Saurashtra region (2005-2016)

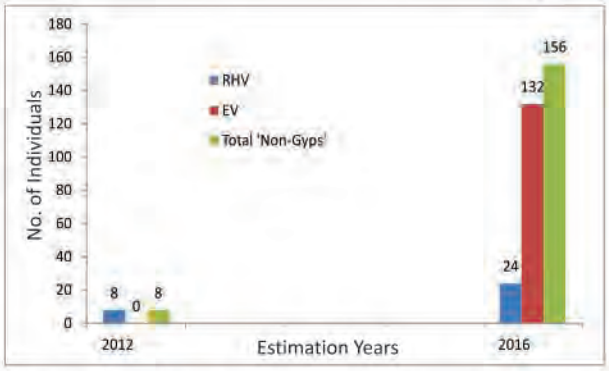


Fig. 3.22b: Population of non *Gyps* Vultures in Saurashtra region (2012-2016)

3.3.4.1 Some Important Districts of Saurshtra from View-Point of Vulture Population

a) Amreli District

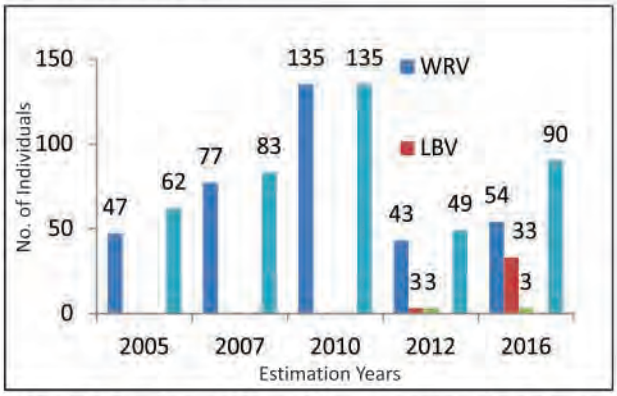


Fig. 3.23 a: Population of four species of vultures in Amreli district-2005 to 2016

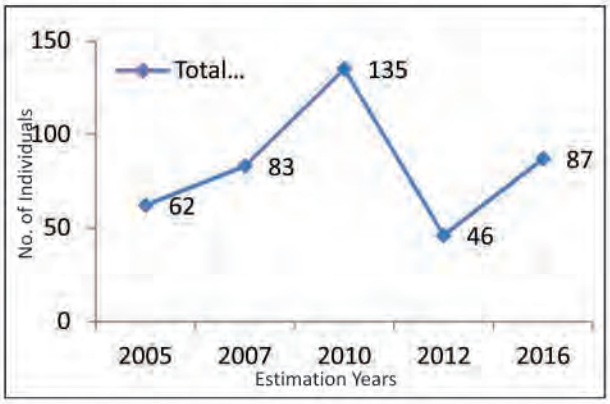


Fig. 3.23 b: *Gyps* vultures population in Amreli district - 2005 to 2016

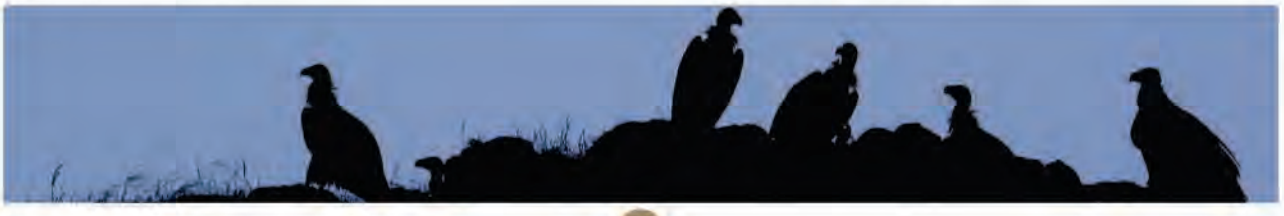


Fig. 3.23a and Fig. 3.23b reveal following facts:

a) Amreli district has been inhabited by the two species of Gyps vultures and Red-headed Vulture (RHV). Egyptian Vulture has not been recorded though it was included in the estimation of 2012 and 2016.

b) May 2016 vulture population was found to be 90 individuals, of which 54 individuals (60%) were White-rumped Vultures and 33 individuals (37%) were Long-billed Vultures and 3 individuals (3%) were Red-headed Vultures.

c) As 77 White-rumped Vultures (WRVs) were recorded in 2007, it can be said that its population has reduced by 29.8% by May 2016(i.e., in a decade's time).

d) On short-term basis, i.e., between 2012 and 2016, WRV population has in fact, increased by 25.6%.

e) Though Long-billed Vulture had not been recorded before 2012 vulture survey, between 2012 and 2016, LBV population has increased considerably.

f) Three individuals of RHV have been recorded during 2012 and 2016 vulture estimation.

g) Fig. 3.23b indicates that during a decade's time-span of 2007-2016, *Gyps* population has remained almost stable (i.e., 83 individuals in 2007 and 87 individuals in 2016). However, during the shorter time-span of four years (2012 to 2016), the *Gyps* vulture population has increased by 89% (from 46 individuals to 87 individuals).

As Amreli has geographical area of 6760 sq.km, the crude density of vultures in Amreli district can be considered to be 0.013 ind./sq.km. The crude density of White-rumped Vulture can be considered to be 0.008 ind./sq.km and that of Long-billed Vulture can be considered as 0.005 ind./sq.km.

b) Junagadh District

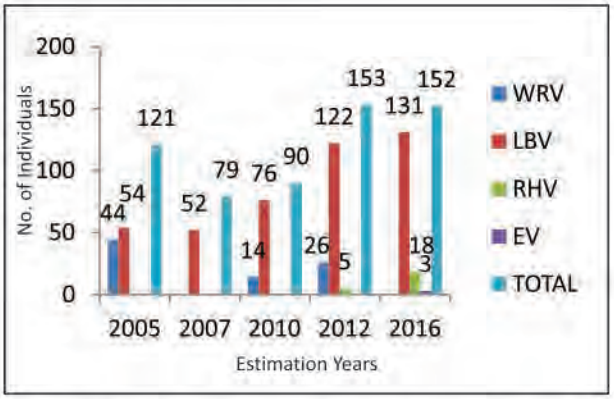


Fig. 3.24a: Population of four species of vultures in Junagadh district - 2005 to 2016

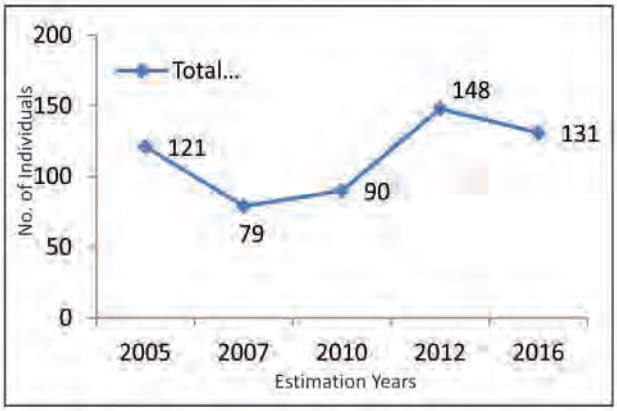


Fig. 3.24b: *Gyps* population variation in Junagadh district-2005 to 2016

Fig. 3.24 a and Fig. 3.24 b reveal following facts:

a) Junagadh district has been inhabited by the three vulture species as per the May 2016 vulture population survey. They include Long-billed Vultures (n=131), Red-headed Vultures (n=18) and Egyptian Vultures (n=3).

b) During May 2016 vulture population was found to be 152 individuals, of which 54 individuals (35.5%) were White-rumped Vultures and 33 individuals (37%) were Long-billed Vultures and 3 individuals (21.7%) were Red-headed Vultures.

c) As 52 Long-billed Vultures LBVs were recorded in 2007, it can be said that its population has reduced by 152% by May 2016(i.e., in a decade's time-frame). In fact, LBVs population has consistently increased, i.e., from 52 individuals to 76 individuals during 2007 to 2010, 76 individuals to 122 individuals during 2010 to 2012 and 122 individuals to 131 individuals during 2012 to 2016.

d) On short-term basis, i.e., between 2012 and 2016, LBV population has in fact, increased by 7.37%.

e) Five individuals of RHV have been recorded during 2012 and eighteen RHVs were recorded in 2016 vulture estimation.

f) Fig. 3.24b indicates that during a decade's time-span of 2007-2016, *Gyps* population has increased by 65.82% (i.e., 79 individuals in 2007 and 131 in 2016 individuals). However, during the shorter time-span of four years (2012 to 2016), the *Gyps* vulture population has decreased by 11.48% (from 148 individuals to 131 individuals).

As Junagadh has geographical area of 5,092 sq.km, the crude density of vultures in the district can be considered to be 0.03 ind./sq.km. The crude density of Long-billed Vulture can be considered to be 0.025 ind./sq.km and that of Red-headed Vulture can be considered as 0.0035 ind./sq.km.

c) Bhavnagar District

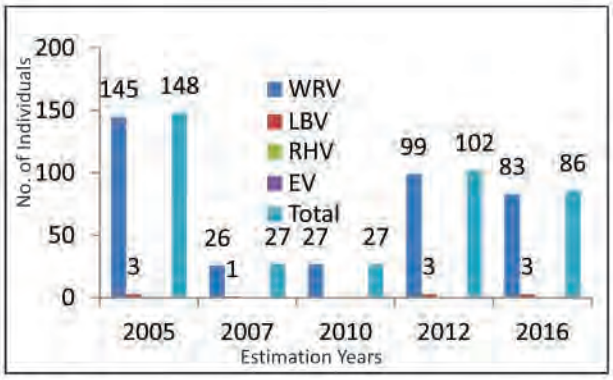


Fig. 3.25a: Population of four species of vulture in Bhavnagar district -2005 to 2016

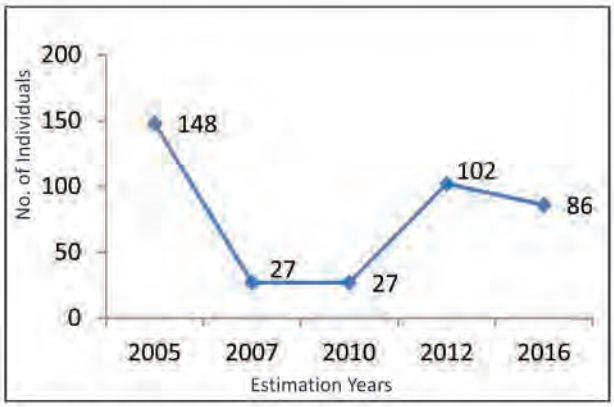


Fig. 3.25b: Gyps vultures population in Bhavnagar district - 2005 to 2016

Fig. 3.25a and Fig. 3.25b reveal following facts:

a) Bhavnagar district has been mainly inhabited by White-rumped Vulture (WRV) as per the May 2016 vulture population estimation. A total of 83 WRVs have been recorded in May 2016. Only 3 Long-billed Vultures have been recorded.

b) As 26 WRVs were recorded in 2007, it can be said that its population has increased by 219% by May 2016(i.e., in a decade's time-frame).

c) On short-term basis, i.e., between 2012(n=99) and 2016(n=83), WRV population has reduced by 16.2%

d) Fig. 3.25 b indicates that during a decade's time-span of 2007-2016, *Gyps* population has increased by 218.5% (i.e., 27 individuals in 2007 and 86 individuals in 2016). However, during the shorter time-span of four years (2012 to 2016), the *Gyps* vulture population has decreased by 15.68% (from 102 individuals to 86 individuals).

As Bhavnagar has geographical area of 8334 sq.km, the crude density of vultures in this district can be considered to be 0.01 ind./sq.km. The crude density of Long-billed Vulture can be considered to be 0.009 ind./sq.km

d) Surendranagar District

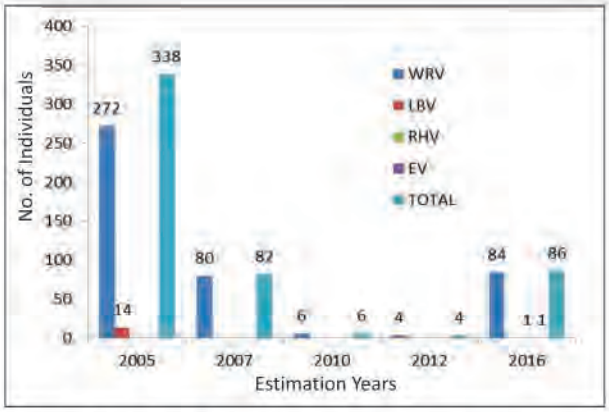


Fig. 3.26 a: Population of four species of vulture in Surendranagar district-2005 to 2016

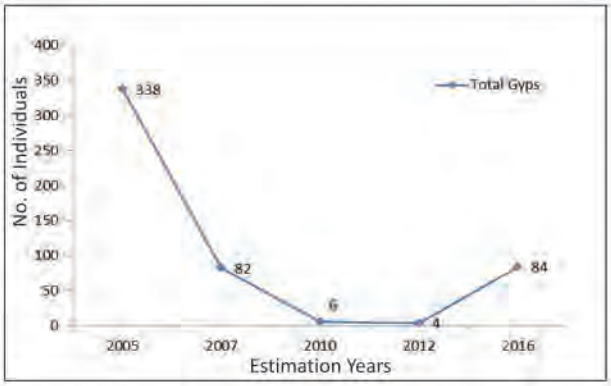


Fig. 3.26 b: *Gyps* vultures population variation in Surendranagar district-2005 to 2016

Fig. 3.26 a and Fig. 3.26 b reveal following facts:

a) Surendranagar district has been inhabited mainly by White-rumped Vulture (WRV). A total of 84 WRVs were recorded during May 2016 surveys.

b) As 80 WRVs were recorded in 2007, it can be said that its population has remained almost stable by May 2016(n=84).

c) On short-term basis, i.e., between 2012 and 2016, WRV population has in fact, increased by 2000%.

d) One individual of RHV and one individual of Egyptian Vulture have been recorded during May 2016 survey.

e) Fig. 3.26b indicates that during a decade's time-span of 2007-2016, *Gyps* population has almost remained stable (i.e., 82 individuals in 2007 and 84 in 2016 individuals).

As Surendranagar has geographical area of 9,271 sq.km, the crude density of vultures in this district can be considered to be 0.009 ind./sq.km.

3.3.5 Kachchh Region: In 2016, Kachchh region has supported both species of *Gyps* vultures as also Egyptian Vulture. However, Red-headed Vulture was not recorded. Crude density of all the four species and *Gyps* vultures in Kachchh region are 0.0016 individuals/sq.km and 0.0015 individuals/ sq.km, respectively. As far as *Gyps* vulture population over last one decade (2007-2016) is concerned, it was found to have decreased from 462 individuals in 2007 to 235 individuals in 2010 (49.13% decrease). Unfortunately, the *Gyps* vulture population has further declined from 235 in 2010 to 180 in 2012(23.4% decline). Further, it is very discouraging to see that Gyps vulture population has decreased to 70 individuals in

2016 (61.11% decrease from 2012). In nutshell, *Gyps* vulture population has massively declined over a decade's time (2007-2016) in Kachchh Gujarat region by massive 84.84%(i.e., from 462 in 2007 to 70 in 2016).

Kachchh District from the View point of Vultures:

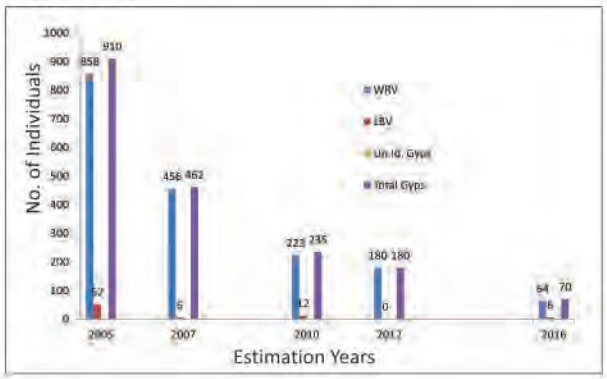


Fig. 3.27: *Gyps* vulture population in Kachchh region (2005-2016)

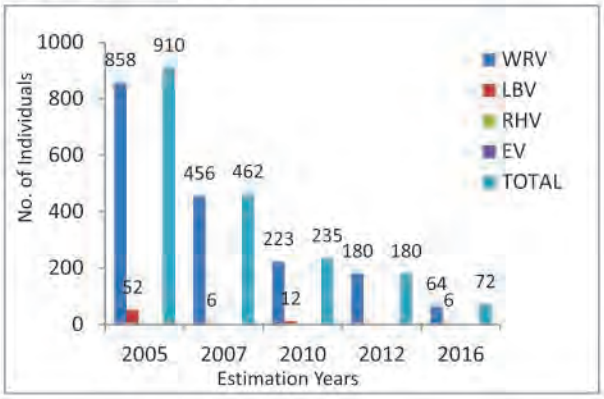


Fig. 3.28 a: Population of four species of vulture in Kachchh district - 2005 to 2016

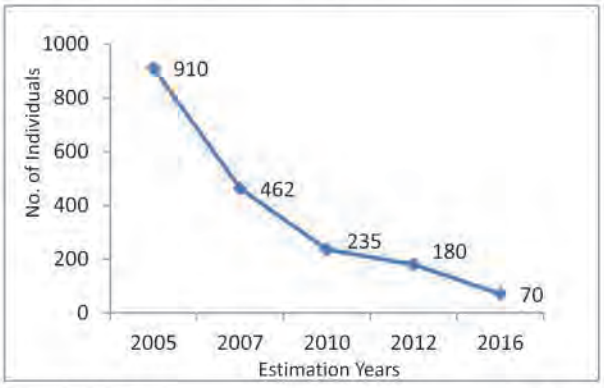


Fig. 3.28 b: *Gyps* vultures population in Kachchh district - 2005 to 2016

Fig 3.28 a and Fig.3.28 b reveal following facts:

a) Kachchh district has been inhabited mainly by White-rumped Vulture (WRV) as per May 2016 estimation. Nonetheless, very low number of Long-billed Vultures has been recorded during 2007, 2010 and 2016 vulture estimation. A total of 64 WRVs were recorded during May 2016 estimation.

b) As 456 WRVs were recorded in 2007, it can be said that its population has declined by 85.9% by May 2016(n=64).

c) On short-term basis, i.e., between 2012(n=180) and 2016(n=64), WRV population has in fact, decreased by 64%.

d) One individual of RHV and one individual of Egyptian Vulture have been recorded during May 2016 estimation.

e) Fig. 3.28b indicates that during a decade's time-span of 2007-2016, *Gyps* population has reduced by 84.8% (i.e., 462 individuals in 2007 and 70 in 2016 individuals). During the shorter time-span of four years (2012 to 2016), the *Gyps* vulture population has reduced by 61.1% (from 180 individuals to 70 individuals).

As Kachchh has geographical area of 45,652 sq.km, the crude density of vultures in this district can be considered to be 0.0016 ind./sq.km. *Gyps* vulture crude density in Kachchh can be considered as 0.0015 ind./sq.km. The crude density of WRV alone can be considered as 0.0014 ind./sq.km whereas that LBV alone can be considered as 0.00013 individuals/sq.km.