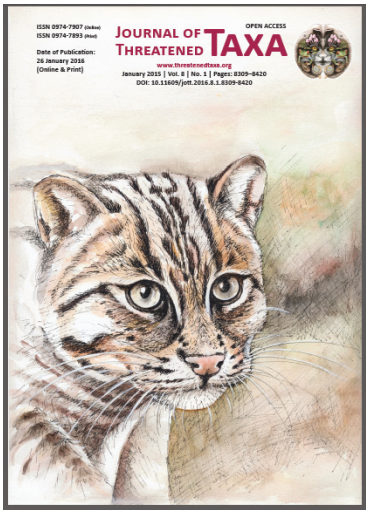

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STATUS AND POPULATION OF VULTURES IN MOYAR VALLEY, SOUTHERN INDIA

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Status and population of vultures in Moyar Valley, southern India

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Abstract: Four species of vultures were surveyed using road transects in two parts of the Moyar Valley, three of these are Critically Endangered by IUCN criteria and one is Endangered. The vulture study was done for the first time in Nilgiri North Forest Division and Sathyamangalam Tiger Reserve of Moyar Valley to determine the flock size in the three species of vultures and also to get a rough estimation of vultures. The results show higher flock size and higher densities in Nilgiri North Forest Division than in Sathyamangalam Tiger Reserve and the most numerous of these was the White-rumped Vulture. There is also evidence of seasonal movements in Nilgiri North Forest Division. These data represent the first systematic survey results from the area and demonstrate the significance of the Moyar Valley for all four Endangered vulture species, probably the main stronghold remaining in southern India. They are White-rumped Vulture *Gyps bengalensis*, Indian Vulture *Gyps indicus*, Red-headed Vulture *Sarcogyps calvus* and Egyptian Vulture *Neophron percnopterus*. The study recommends that immediate long-term conservation efforts should be taken to save the Critically Endangered vultures in the Moyar Valley.

Keyword: Conservation, Flock size, Moyar Valley, population, seasonal variation, vultures.

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Author Details: Dr. R. Venkitachalam is a Research Associate at Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore. He completed his Ph.D on Status and Ecology of Threatened vulture species in Moyar Valley, Tamilnadu. He so far completed research projects on Hornbills in the Eastern Ghats, one on Ecosystem monitoring (Component Ornithology) in Keoladeo National Park, involved captive management programme on vultures conservation in India and two projects on in situ Conservation of vultures in Tamil Nadu. At present he is studying dynamics of ecosystem services in Western Ghats of Tamil Nadu. Dr. S. Senthilnathan is working as Assistant Professor in the Department of Zoology, Chikkanna Government Arts College, Tirupur. He has more than twenty years research experience and done a commendable work on environmental studies. He is an awarded of UGC Research Associateship and CSIR Scientist Pool Officership in his credit. He has also worked with several research institutions like CAS in Marine Biology, Annamalai University, Salim Ali Centre for Ornithology and Natural History (SACON), Coimbatore and CEE, Ahmadabad. He completed the World Bank projects under PWD, Tamil Nadu and published several papers in the national and international in the field of environmental science in reputed journals.

Author Contribution: RV conceived and designed the experiments, performed the experiments and analyzed the data.
RV and SS wrote the paper.

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INTRODUCTION

White-rumped Vulture and Indian Vulture were the most abundant large raptors present in almost all bio-geographical zones of the Indian subcontinent and absent in the Trans-Himalaya and the Andaman & Nicobar Islands (Ali & Ripley 1983). Vulture species are threatened across India (Prakash 2012) and in most parts of the world (Ogada et al. 2012). The major reason for vulture declines in the Indian subcontinent was the use of veterinary diclofenac for cattle (Green et al. 2004; Oaks et al. 2004). Population declines of vultures indicate dysfunctional ecosystems because the population dynamics of top order predators often reflect the ecosystems they inhabit (Newton 1979). The drug diclofenac was banned in India for veterinary purposes from 2006. This threat persists despite the ban and ongoing efforts of various organizations to save vultures that have recently resulted in a further step by the Ministry of Health, Government of India which posted the gazette notification on 17 July 2015, restricting larger multi-dose vials for humans to single unit 3ml packs only, to curb the illegal veterinary use of the human drug in cattle. Similarly, The Director of Veterinary and Animal Husbandry banned another vulture killer drug, ketoprofen in three districts of Tamil Nadu in September 2015 such as Coimbatore, Nilgiri and Erode. These districts fall within the Vulture Safe Zone (VSZ) in Tamil Nadu. VSZ is centered on a surviving wild vulture colony. Based on range size of White-rumped Vultures determined using satellite telemetry, a VSZ includes an area with a radius of at least 100km in every direction (i.e., a circular area with a 100km radius). This equals a total area of over 30,000km^2 (IBCN, 2014). VSZs are a means of focusing effort on priority actions to remove diclofenac and other vulture NSAIDs (Non-Steroidal Anti-Inflammatory Drug) for a network of areas where vultures survive. Saving Asia's Vultures from Extinction (SAVE) refers to these VZSs as provisional and when the threats of diclofenac and other vulture toxic NSAIDs have been removed will declare a provisional VSZ as a true VSZ (SAVE 2014a). The VSZ concept was pioneered in Nepal, and introduced in other parts of the country. Without steps such as this, vultures remain under serious threat (SAVE).

So far no systematic studies are available on vultures in southern India, especially in Tamil Nadu. Few opportunistic observations and short notes were available on vultures in Tamil Nadu. Badshah (1968) reported that the White-rumped Vulture was common in Tamil Nadu except near seacoasts (BirdLife International, 2001) and Gokula et al. (1996) reported that the White-rumped Vulture and the Indian vulture are resident in the Mudumalai Wildlife Sanctuary. The Indian vultures were previously recorded breeding on cliffs in the Nilgiri and Palani hills of Tamil Nadu (Sathyamurthi 1970). Hence, the study was undertaken to estimate the population and distribution pattern of the vulture species in detail in Nilgiri North Forest Division (NNFD) and Sathyamangalam Tiger Reserve (STR) of Moyar Valley.

MATERIALS AND METHODS

Study Area

The Moyar Valley located between 11.701289^{0}N & 76.587062^{0}E and 11.472443^{0}N & 77.147608^{0}E encompasses the Nilgiri plateau in the southeast, Thalamalai plateau in the northeast, and Mudumalai Tiger Reserve in the west (Fig. 1). The approximate length of the valley is 50km falling within the Tamil Nadu and Karnataka states. Mudumalai Tiger Reserve and Sathyamangalam Tiger Reserve of Tamil Nadu and Bandipur Tiger Reserve of Karnataka within the Moyar Valley are protected areas. The altitude of the valley ranges from 290m to 1950m. Extremes of climate are experienced with temperatures varying between 17–37.5 ^{0}C. During the northeast monsoon season, the extreme eastern part of the Valley receives heavy rainfall and during the southwest monsoon the western parts of the Valley receives heavy rainfall.

There is a 260m deep gorge in the valley called Moyar Gorge, which is located in the eastern end of Nilgiri district, which separates the Segur plateau and the Mysore plateau in the northwest. The study area sprawling over 600km^2 covers part of Masinagudi Range of Mudumalai Tiger Reserve, Segur Range, Singara Range, Nilgiri Eastern Slope Range of Nilgiri North Forest Division and Bhavanisagar Range of Sathyamangalam Tiger Reserve in the northeast. The different types of vegetation and the healthy prey and predator base support the four vulture species in the valley.

Line transect method

In Moyar Valley, vultures were counted on road transects; tarred roads and metal roads are maintained by the Tamil Nadu Forest Department to easily access the villages in the protected areas of STR and NNFD (Fig. 1). These roads were selected for vulture survey. The transects were driven between 08:00 and 17:00 local time at 20–30 kmph in the protected areas. These transects were conducted twice each month from

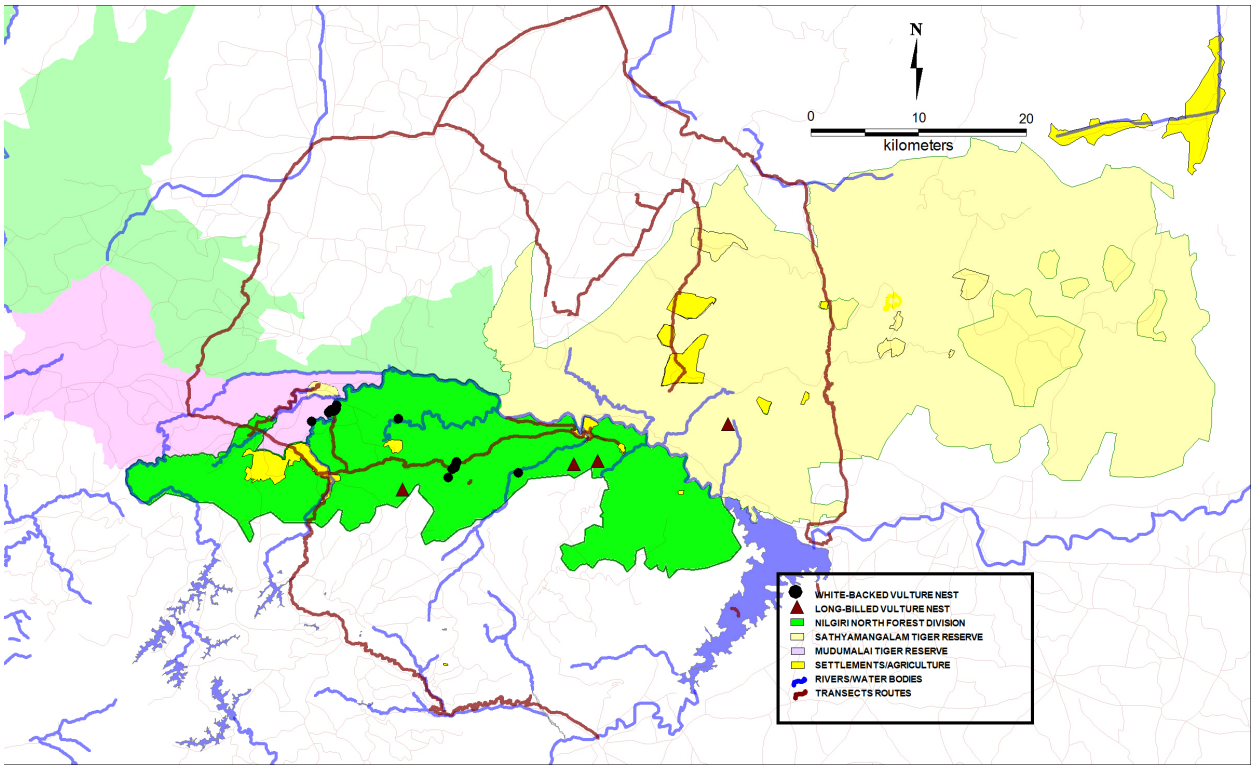

Figure 1. Study Area showing vulture survey transect routes and vulture nest distribution in Moyar Valley

January to December in 2012 and 2013. The routes followed in 2013 were the same as in the previous surveys. The total length of transects of the present study covers a distance of 1277km in STR and 1308km in NNFD of Moyar Valley. Vulture nest searches were carried out during the months of October to June. We walked on elephant footpaths, alongside streams and river to search for vulture nests. Vulture species were counted from vantage points using a telescope (29X) and with a binocular (40X10) and nesting trees were marked by using GPS (global positioning system) (Images 1–4).

Statistical Analysis

Basic statistics such as, arithmetic mean, standard deviation and standard error were calculated for all the replicative variables and are given as X ± SD or X ± SE. Statistical analyses were performed by using Windows based statistical packages—Microsoft Excel, MINITAB (Ryan et al. 1992), and SPSS (Statistical Package for Social Science: Nie et al. 1975). The significance of the Pearson correlation co-efficient was tested using t test. The non-parametric test used was chi-square test for testing the association between variables. For hypothesis testing $P<0.05$ and $P<0.01$ were considered and these levels of significance are indicated as appropriate. Statistical inferences were made following Sokal & Rohlf (1995) and Zar (2003). Although chi-square results are given in many tables and graphs, where the data were used in percentages, the analyses were done only on frequencies.

Image 1. Indian Vulture *Gyps indicus*

Image 2. Egptiyan Vulture *Neophron percnopterus*.

Image 3. Red-headed Vulture *Sarcogyps calvus*

Image 4. White-rumped Vulture *Gyps bengalensis*

RESULTS

Flock size of three vulture species was significantly higher in NNFD when compared to STR of Moyar Valley (Table 3). White-rumped Vultures showed a significant difference in the flock size in NNFD and STR. This was demonstrated statistically with a significant difference in the flock size between the study sites for White-rumped Vulture (c^2=3.68; df =1; $p < 0.05$). Though there is variation in mean encounter rate of White-rumped Vulture, it was not statistically significant (c^2= 0.86; df =1; $p > 0.05$).

The flock size of the Indian Vulture was very low and found insignificant between the NNFD and STR (Table 3). There was no difference in the overall number of Red-headed Vultures sighted between NNFD and STR. In the present observation, there is a significant variation in the total number of vultures sighted between NNFD and STR, hence an attempt was made to study the seasonal variations of vulture abundance in Moyar Valley.

Seasonal variation in the flock size and encounter rate of vultures in Nilgiri North Forest Division

Seasonal variations in the number of vultures sighted and encounter rate of three species of vultures varied in NNFD. The White-rumped Vulture population (Fig. 2) and encounter rate (0.92±0.17) was highest during post-monsoon period compared to other seasons (Table 1). Indian Vulture sightings were relatively higher during monsoon period when compared to post monsoon and summer (Fig. 2; Table 1). No seasonal variations were noticed in Red-headed Vulture numbers across different seasons in the NNFD.

Seasonal variation in the flock size and encounter rate of vultures in Sathyamangalam Tiger Reserve

The mean population of White-rumped Vultures was significantly highest during summer season (April, May, June and July) followed by monsoon (August,

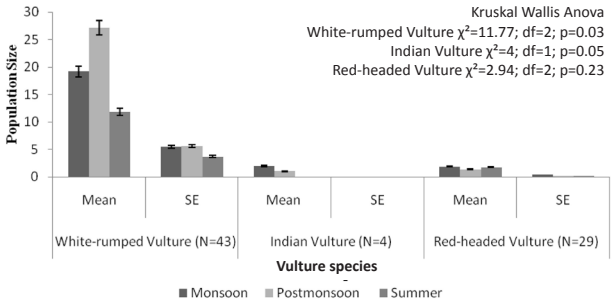

Figure 2. Seasonal variation population size of different species of vultures in Nilgiri North Forest Division

Table 1. Seasonal variations in the encounter rate of different species ofvultures in Nilgiri North Forest Division (NNFD)

Parameters	Seasons	White-rumped Vulture (n=43)		Indian Vulture (n=4)		Red-headed Vulture (n=29)	
		Mean	SE	Mean	SE	Mean	SE
Encounter rate (/km)	Monsoon (August, September, October, November)	1.14	0.310	0.44	-	0.48	0.101
	Post-Monsoon (December, January, February, March)	0.92	0.179	0.33	0.00	0.46	0.069
	Summer (April, May, June, July)	0.50	0.130	-	-	0.37	0.061
	Kruskal-Wallis Anova	c^2=5.79; df=2;p=0.055		c^2=4; df=2;p=0.046		c^2=0.91; df=2;p=0.636	

- No value

Table 2. Seasonal variations in the encounter rate of different species of vultures in Sathyamangalam Tiger Reserve (STR).

Parameters	Seasons	White-rumped Vulture (n=24)		IndianVulture (n=15)		Red-headedVulture (n=11)	
		Mean	SE	Mean	SE	Mean	SE
Encounter rate (/km)	Monsoon (August, September, October, November)	0.79	0.253	0.41	0.140	0.43	0.066
	Post-Monsoon December, January, February, March)	0.41	0.120	0.36	0.084	0.21	0.017
	Summer (April, May, June, July)	0.60	0.233	0.41	0.124	0.33	0.087
	Kruskal-Wallis Anova	c^2=0.23; df=2;p=0.89		c^2=0.77; df=2;p=0.68		c=4.88; df=2;p=0.087	

Table 3. Flock size and encounter rate of Vulture comparison between the Nilgiri North Forest Division and Sathyamangalam Tiger Reserve

Parameters	Study area	White- rumped Vulture (n=67)		Indian Vulture (n=19)		Red-headed Vulture (n=40)	
		Mean	SE	Mean	SE	Mean	SE
Flock size	NND	18.51	2.863	1.25	0.250	1.66	0.143
	STR	12.79	3.980	2.87	0.515	1.36	0.152
	Kruskal-Wallis Anova	c^2=3.68; df=1;p=0.055		-		c^2=0.755; df=1;p=0.39	
Mean Encounter rate	NND	0.81	0.120	0.36	0.028	0.43	0.043
	STR	0.64	0.137	0.40	0.080	0.32	0.042
	Kruskal-Wallis Anova	c^2=0.86; df=1;p=0.35		-		c^2=0.75; df=1;p=0.36	

- No value

Table 4. Mean and Median crowding of Vultures in Moyar Valley.

Species	Min	Max	Mean crowding	95% Confidence Interval	Median
White-rumped Vulture (n=67)	1	79	38.27	29.9 to 47.8	31
Indian Vulture (n=19)	1	08	3.88	2.65 to5.77	3
Red-headed Vulture (n=40)	1	04	1.89	1.63 to 2.33	2

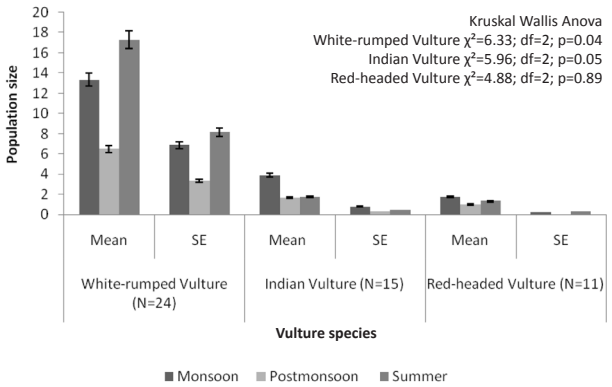

Figure 3. Seasonal variation population size of different species of vultures in Sathyamangalam Tiger Reserve

September, October and November) and post monsoon seasons (December, January, February and March) (Table 3). The mean population (Fig. 3) and the encounter rate of Indian vultures were found to be highest during monsoon season when compared to the other seasons (Table 2); however the encounter rate of Red-headed

Vulture showed uniform distribution and no seasonal variation was observed (Table 2). It is clear that the mean encounter rate of all the three vulture species did not show any variation between seasons (Table 2). Nevertheless there is a clear seasonal variation in the White-rumped Vulture population and encounter rate per kilometer in both NNFD and STR (Tables 1,2; Figs. 2,3).

The mean crowding and median group size of the present study were highest for White-rumped Vulture with 38.27 and 31 respectively. The mean crowding ranges from 30 to 48 individuals in a single White-rumped Vulture group. In the Indian vulture the mean crowding was low (3.88) and it ranged from 2.65–5.77. Statistical mean crowding for the Red-headed Vulture was 1.89 and did not show any variation (Table 4). The mean and median crowding results concluded that mean crowding varied greatly and the mean group size of White-rumped Vulture was highly varied in skewed (aggregated) distribution group size in both NNFD and STR.

Breeding populations recorded

Thirty-six pairs of White-rumped Vulture active nesting population were observed on the trees along the riparian habitat in NNFD and Mudumalai Tiger Reserve (Fig. 1) and four pairs of Indian vultures were breeding on the rocky cliffs in both NNFD and STR of Moyar Valley (Venkitachalam et al. 2015).

DISCUSSION

This is the first systematic survey of three species of vultures, viz., White-rumped Vulture, Indian Vulture and Red-headed Vulture in the NNFD and STR of Moyar Valley of Tamil Nadu. Significantly larger vulture flocks were recorded in NNFD than in the STR. The flock size of Indian vulture and Red-headed Vulture was very low and statistically non-significant between the study sites. The present study results however reveal that there is a significant variation in the total numbers of vultures sighted between NNFD and STR, and we also attempted to examine any seasonal variation of vulture numbers in Moyar Valley.

The mean populations of the three species of vultures varied according to the seasons in the both study areas NNFD and STR of Moyar Valley although these variations were only significant for White-rumped Vulture. Population size of White-rumped Vulture was found to be highest during post monsoon season compared to summer and monsoon seasons in NNFD. In STR White-rumped Vulture was found to be highest during summer when compared to other seasons. In monsoon, the time available for forage is limited and thermal production is very uncertain because of the relatively low temperature and in summer, the high availability of day light hours, and the almost continuous formation of thermal lifts helps disperse the breeding and non-breeding vultures to forage. The vultures start breeding from post monsoon and summer onwards, and variations on the counts could simply reflect less movement by incubating vultures. Nest surveys provide a measure of the size of the breeding population, hence yield an important measure of the local status of these long-lived, slow breeding vultures (Margalida et al. 2011). White-rumped Vultures were not observed nesting in STR although they were frequently recorded soaring, roosting and feeding in STR. The Red-headed Vultures are solitary species occurring during the present study period and these were recorded with similar frequency throughout the year. Juveniles of Red-headed Vultures were recorded during the study period, indicating that the Red-headed Vulture may be breeding in or around the study area of Moyar Valley. Statistical mean and median highest aggregated populations of vultures were White-rumped Vulture followed by Indian Vulture and Red-headed Vulture. However, the prey, predator base in the thorny savanna forest helps vultures to easily locate animal carcasses and the lesser intrusion of the vulture killer drugs has led to the presence of vultures in the landscape. The mammalian predators scat analysis revealed that though the diet of the three predators consisted of 15 to 21 prey species, wild ungulates formed a major portion of their diet (88.4–96.7 %) in the Mudumalai Tiger Reserve (Ramesh et al. 2012), which is adjacent to the Nilgiri North Forest Division. We strongly recommend that immediate in situ monitoring efforts such as revisiting annual nest monitoring, synchronized and well coordinated seasonal and carcass surveys should be conducted in the Nilgiri North Forest Division, Sathyamangalam and Mudumalai tiger reserves to understand the species-wise populations of the highly threatened vultures.

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