TECHNICAL SESSION - I

STATUS, SURVEY AND POPULATION ESTIMATION OF VULTURES

THE CURRENT THREATS AND STATUS OF ASIAN VULTURES

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ABSTRACT

Nine of the world's 23 vulture species occur in Asia and indeed all nine occur in India, but five of these are on IUCN's Red List, four of them in the highest threat category: Critically Endangered. There have been very few more dramatic, fast and wide scale species declines of any birds or other taxa than those of South Asian *Gyps* vulture populations since the 1990s. The formerly most abundant of these species across the region, the white-rumped vulture *Gyps bengalensis*, declined by 99.9% over less than 20 years. The main cause, at least for the *Gyps* vultures, was shown to have been the veterinary drug diclofenac which was being widely used to treat cattle, and which proved to be lethal to vultures feeding on cattle carcasses that had been treated shortly before death. Three priority actions were identified in 2004 as urgently required in order to prevent the total extinction of at least three endemic species: Removal (through effective banning) of the veterinary drug diclofenac, the identification of safe alternatives, and the establishment of captive populations for later reintroduction back to the wild. But several challenges have meant that instigating a sufficiently quick and coordinated approach was not something that would happen automatically.

The fact that detecting the drug in dead vultures requires very sophisticated and sensitive testing; the vultures live long enough after ingestion; that they die well dispersed away from the toxic carcass – all mean that only through rigorous scientific analysis could the correct conclusions regarding the main cause of decline be made. International boundaries and restrictions regarding the transport and export of samples further added to the challenge. Speedy rigorous scientific publication in peer-reviewed journals was a key step, and the engagement of in-country scientists and institutions was essential. Ongoing rigorous scientific inputs was also important, and then the communications of these (including collection and analysis and writing up of monitoring work both for vultures and the drugs concerned) led to Government attention and key legislative changes (i.e ban of veterinary diclofenac in 2006).

In February 2011, seven years after the diagnosis of the main diclofenac problem (although other veterinary drugs (NSAIDs) had meanwhile emerged as also being toxic to vultures), a consortium of 14 partners (now 19) from across the region signed up to work together under the banner 'Saving Asia's' Vultures from Extinction' (SAVE), and these meet and report annually. Partners are mainly NGOS but also include key government institutions. A detailed action plan ('Blueprint') was developed in 2014 outlining the main activities required to save the most threatened species up to 2015, and this is reviewed annually.

This plan has since been adopted by a multi-lateral governmental committee (Regional Steering Committee of the four South Asian countries India, Bangladesh, Nepal and Pakistan) which was created soon after the formation of SAVE and provides a further forum for agreed priority actions to be taken up at higher levels. Most recently, a Multi-species Action Plan for all vulture species has been coordinated by the Raptors MoU of the Convention of Conservation of Migratory Species (CMS), which has again adopted ***the SAVE Blueprint*** as a central resource, but due to the wider remit of all vulture species in Asia, Africa and Europe, it also encompasses a somewhat wider set of actions. The combined effect of these three initiatives is a significant degree of coordination regarding the key steps required in Asia. However, a number of challenges remain, and the priority areas of safety-testing of veterinary drugs for vultures, regulation of veterinary NSAIDs, the release of birds back to the wild, and the development of Vulture Safe Zones are all crucial, and the releases and vulture safe zones offer high profile opportunities to engage and attract support more widely, and to publically test the safety of the environment for releases and the potential recovery of the species in the wild.

Key Words: Asia, Vulture, Threats

Overview of South Asian vulture declines

Nine of the world's 23 vulture species occur in Asia and indeed all nine occur in India, but five of these are on IUCN's Red List, four of them in the highest threat category: Critically Endangered (Table 1). There have been very few more dramatic, fast and wide scale species declines of any birds or other taxa than those of South Asian Gyps vulture populations since the 1990s. The formerly most abundant of these species across the region, the white-rumped vulture *Gyps bengalensis*, declined by 99.9% over less than 20 years (Prakash *et el.,* 2012). The main cause of these declines, at least for the Gyps vultures, has been clearly shown to have been the veterinary drug diclofenac (Oaks *et al.*, 2004, Green *et al.*, 2007, Prakash *et al.,* 2012) which was being widely used as a painkiller and anti-inflammatory to treat cattle, and which proved to be lethal to vultures feeding on cattle carcasses that had been treated shortly before death. Three priority actions were identified in 2004 as urgently required in order to prevent the total extinction of at least three endemic species (ASARPW 2004, MoEF 2006, Pain *et al.,* 2008): Removal (through effective banning) of the veterinary drug diclofenac was the key step required, the identification of safe alternatives, and the establishment of captive populations for later reintroduction back to the wild

were also prioritised. But several challenges have meant that instigating a sufficiently quick and coordinated approach was not something that would happen automatically.

The fact that detecting diclofenac in dead vultures requires very sophisticated and sensitive testing techniques; that the vultures live long enough after ingestion that they die well dispersed away from the toxic carcass – mean that only through rigorous scientific analysis could the correct conclusions regarding the main cause of decline be made. International boundaries and restrictions regarding the transport and export of samples further added to the challenge. Speedy rigorous scientific publication in peer-reviewed journals was a key step, and the engagement of in-country scientists and institutions was essential. The initial breakthrough was made in Pakistan (Oaks *et al.*, 2004), but almost immediately demonstrated to be true for India and Nepal (Shultz *et al.*, 2004, Prakash *et al.,* 2012) and this work was then extended to demonstrate just how devastating the effects have been across the subcontinent. Ongoing rigorous scientific inputs have also been important, with key involvement of the Indian Veterinary Research Institute (IVRI) and then the communications of these (including collection and analysis and writing up of monitoring work both for vultures and the drugs concerned) which attracted Government attention and key legislative changes (ie bans of veterinary diclofenac in 2006 and full gazettement in 2008).

Table 1. The current IUCN Red list status of the Asian vulture species:

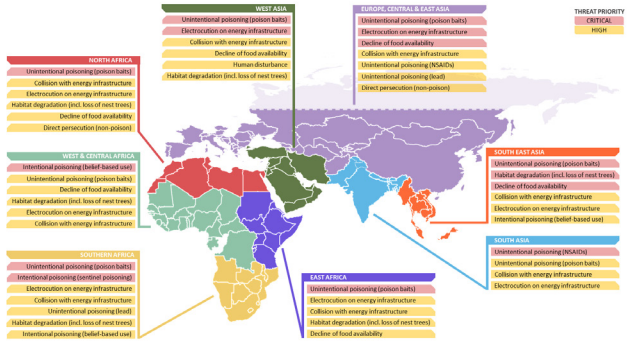
English name	Scientific name	IUCN Redlist status
White rumped Vulture	*Gyps bengalensis*	Critically Endangered
Indian Vulture	*Gyps indicus*	Critically Endangered
Slender-billed Vulture	*Gyps tenuirostris*	Critically Endangered
Red-headed Vulture	*Sarcogyps calvus*	Critically Endangered
Egyptian Vulture	*Neophron percnopterus*	Endangered
Himalayan Griffon	*Gyps himalayensis*	Near threatened
Cinereous Vulture	*Aegypius monachus*	Near threatened
Bearded Vulture	*Gypaetus barbatus*	Near threatened
Eurasian Griffon Vulture	*Gyps fulvus*	Least concern

Coordinating a conservation response for South Asia

In February 2011, seven years after the diagnosis of the main diclofenac problem (although other veterinary drugs (Non-Steroidal Anti-Inflammatory Drugs - NSAIDs) had meanwhile emerged as also being toxic to vultures), a consortium of 14 partners (now 19) from across the region signed up to work together under the banner 'Saving Asia's' Vultures from Extinction' (SAVE), and these meet and report annually (for full description see Bowden 2017). Partners are mainly NGOS but also include key government institutions such as IVRI. A detailed regional action plan ('Blueprint') was developed by this partnership in 2014, outlining the main activities required to save the most threatened species up to 2015, and this is reviewed annually. This plan has since been adopted by a multi-lateral governmental committee (Regional Steering Committee of the four South Asian countries India, Bangladesh, Nepal and Pakistan) which was created soon after the formation of SAVE and provides a further forum for agreed priority actions to be taken up at higher levels. Most recently, a Multi-species Action Plan for all vulture species has been coordinated by the Raptors MoU of the Convention of Conservation of Migratory Species (CMS), which has adopted and endorsed the SAVE Blueprint as a central resource, but due to the wider remit of all vulture species in Asia, Africa and Europe, it also encompasses a somewhat wider set of actions (Botha *et al.,* 2017). The combined effect of these three initiatives is a significant degree of coordination regarding the key steps required in Asia. However, a number of challenges remain, and the priority areas of safety-testing of veterinary drugs for vultures, regulation of veterinary NSAIDs, the release of birds back to the wild, and the development of Vulture Safe Zones are all crucial, and the releases and vulture safe zones offer high profile opportunities to engage and attract support more widely, and to publically test the safety of the environment for releases and the potential recovery of the species in the wild.

It is clear from the CMS Vultures Multi-species Action Plan (MsAP) and from SAVE priorities (Table 2) that the threats faced by vultures in SE Asia are quite different from South Asia where the NSAIDs remain the predominant threat. This is summarised in the threats map from the MsAP (Figure 1)

Figure 1. Map of current predominant threats to vultures for each region including South Asia (from Botha *et al.* 2017)



With vulture population levels now at drastically reduced levels following the effects of diclofenac (99.9% have already gone for white-rumped vulture, Prakash *et al.,* 2007), other localised threats may play an important role and demand conservation attention. But it is important that these threats and mortality must not distract from addressing the mainly invisible and ongoing threat of NSAIDs. For example in Gujarat there have been important efforts to prevent the kite-flying mortality, especially associated with the annual kite-flying festivals. Probably the most important of the secondary threats to vultures in India are poison-baits (retaliatory killing of tigers, leopards, dogs, elephants, cows which can all unintentionally kill vultures) and this is a major threat to vultures in other regions especially Africa (Figure 1). It needs targeted awareness efforts, and ensuring that government compensation schemes are operating efficiently can be an important way to reduce this threat. This threat was apparently earlier more prominent in South India but coordination with efforts being made to prevent eg tiger poisoning can also benefit vultures in addressing this threat. A further significant localised threat is electricity infrastructure and both electrocution and collision. Wires in locations close to feeding or breeding sites (there can be ways to avoid cattle carcass dumps being sited where this makes cables a high risk), can help significantly reduce this risk. The siting of wind-energy turbines needs to take vulture flyways into account and there is an urgent need for sensitivity mapping of the whole country (especially as this is a growing pressure) to prevent the power company proposing hazardous locations. Pylon design is another important factor for species such as Egyptian vulture which often perch on such and electrocution risks can be avoided with appropriate designs adopted. The final relevant threat can be the destruction of nesting trees, which again requires awareness work at a local level. Food shortage is not regarded as a current threat in India, although changing carcass disposal practices may make this a problem in future. With vulture populations generally reduced by over 95% and even 99.9% for white-rumped vultures, it is unlikely that food availability has also reduced by this extent so far. It is however a topic that needs careful monitoring for the future, as it is a problem in other regions outside South Asia.

All vulture populations are under pressure in India, and for several species the declines have been so drastic that it seems unlikely they can ever fully recover. Developing a coordinated network and through initiating 'Vulture Safe Zone' initiatives appears to be a good way forward at a local level, and it is hoped that the outputs of the Ooty workshop can help in this respect for South India.

Table 2. The current conservation priorities for South Asian vultures - from 7th Annual SAVE Report from November 2017 – (SAVE 2018)

- Veterinary licenses to be withdrawn for two drugs – ketoprofen and aceclofenac - based on the good existing evidence that they are unsafe for vultures.
- An effective system of regulation of veterinary drugs, based upon safety-testing on vultures is continued for all current painkillers (NSAIDs) and for all potential new ones entering veterinary practice.
- Evaluate safety to vultures of nimesulide as a priority.
- Identify additional vulture safe NSAIDs (alternatives for vets).
- Defend and communicate the 2015 multi-dose ban of human diclofenac formulations to relevant authorities & stakeholders (India).
- Major efforts urgently needed within South Asia to address the immediate and increasing gap in funding for vulture conservation which now jeopardises the programme. [2018 proposal to work with BNHS to investigate CSR funding options for SAVE priority vulture conservation in India and elsewhere in Asia]
- Promotion of network and approach of 'Vulture Safe Zones' across South Asia with expansion to include trans-boundary cooperative efforts.
- Maintain and support the existing vulture conservation breeding programmes throughout South Asia.
- Create a safe environment for further soft releases of captive vultures at identified sites (100km radius) in Nepal and first soft releases in India in 2018, requiring satellite monitoring of the released birds.
- Improved availability of well-formulated meloxicam products thereby facilitating their popularity with veterinary practitioners.
- Use the Convention of Migratory Species' Vulture Multi-species Action Plan as a tool to promote SAVE priority actions and engage with governments. Inform CMS about significant changes (e.g. changes to threats) in the SAVE region.
- Closely support National Vulture Recovery Committees and the Regional Steering Committee in order to facilitate the urgent implementation of the 2012 Delhi Regional Agreement and SAVE priorities

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THE GOOD, THE BAD AND THE UNKNOWN: NSAIDS AVAILABLE IN VULTURE-RANGE COUNTRIES

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ABSTRACT

Gyps vultures are highly intolerant to the non-steroidal anti-inflammatory drug (NSAID) diclofenac. Common and widespread use of diclofenac to treat domesticated ungulates, the carcasses of which constitute the primary food for vultures, caused catastrophic declines in vulture populations throughout South Asia. Veterinary diclofenac is now banned and vulture populations are no longer declining as fast as they were before the ban. Vulture populations may even be starting to recover, but the total number of vultures that persist is small and they are therefore vulnerable to additional threats. The most disturbing additional threats are other veterinary NSAIDs that are as toxic or nearly as toxic to vultures as diclofenac and freely available in South Asia. SAVE (Saving Asia's Vultures from Extinction) are aware of 14 NSAIDs sold for veterinary use in South Asia. We use drug safety testing on vultures and post mortem examinations of wild vultures to determine which of these NSAIDs are toxic to vultures and which are non-toxic to vultures. Both methods of research are challenging, but ongoing. We currently know that only one NSAID – meloxicam – is not toxic to vultures; and that five other NSAIDs – aceclofenac, carprofen, flunixin, ketoprofen and nimesulide – are toxic to vultures. Further, eight NSAIDs are of an unknown toxicity to vultures. We are desperate to know the toxicity of all NSAIDs, to find more vulture-safe ones and to bring about bans on other vulture-toxic NSAIDs. It is essential that all conservationists working in South Asia know which NSAIDs threaten vulture populations so that they can contribute to building environments safer for vultures. To this end, we have produced NSAID Alert summaries for each vulture-toxic NSAID covering the evidence for toxicity and its effectiveness in comparison to meloxicam that can be used to educate and engage communities, professionals and decision makers.

Key Words: NSAID, Vulture-Range, Countries

Introduction

Non-steroidal anti-inflammatory drugs (NSAIDs) are effective at pain relief and many also reduce inflammation and/or high fevers. In South Asian countries, NSAIDs are commonly used in domesticated ungulates that are ill or injured. Further, NSAIDs are used in large doses in dying animals to give them a painless death. This is particularly common in India where cows and sometimes buffaloes are considered sacred. As a result, the carcasses of these cattle, traditionally left for scavengers to dispose of, regularly contain high concentrations of NSAIDs that were not metabolised before the animal's death. It is an unlucky coincidence that the primary scavengers in South Asia – that is, the *Gyps* vultures – are highly intolerant to NSAIDs in general and one in particular, called diclofenac. During the 1990s and 2000s, diclofenac was the NSAID of choice among South Asian veterinarians and farmers. Millions of doses were administered to cattle, contaminating the carcasses of many and poisoning hundreds of thousands *Gyps* vultures (see Pain *et al.,* 2008).

Gyps vulture populations crashed, like no avian population had done before. The number of white-rumped vultures *Gyps bengalensis* (aka Oriental white-backed vulture) in India dropped by 99.9% in 15 years (Prakash *et al.,* 2007). Catastrophic population declines also occurred in the other two *Gyps* species resident to South Asia – the long-billed vulture *Gyps indicus* (aka Indian vulture) and the slender-billed vulture *Gyps tenuirostris* – (Prakash *et al.*, 2007) and the other two vulture species resident to South Asia – the red-headed vulture *Sarcogyps calvus* and the Egyptian vultures *Neophron percnopterus* (Cuthbert *et al.,* 2006). In addition, population declines occurred in the Himalayan griffon *Gyps himalayensis* (aka Himalayan vulture; Acharya, 2010), probably occurred in the steppe eagles *Aquila nepalensis* and possibly other species scavenging birds of prey (see Sharma *et al.,* 2014). While we only know that *Gyps* vultures are high intolerant to diclofenac through safety testing experiments (Oaks *et al.*, 2004; Swan *et al.,* 2006a), the other species showed declines of similar timing and magnitude to those of the *Gyps* vultures (Cuthbert *et al.*, 2006) or, in the case of the steppe eagle, showed diclofenac residue and signs of poisoning in wild individuals at post-mortem examinations (Sharma *et al.,* 2014) therefore, there is little doubt that diclofenac caused death and decline in these species and possibly other scavenging birds of prey. Given that South Asia was home to either all or the largest proportion of the global populations of these birds, these declines resulted in the up-listing of the three *Gyps* vultures and red-headed vulture to critically endangered, the Egyptian vulture to endangered and the Himalayan griffon to near threatened (IUCN 2017).

The mass killing of vultures in South Asia was not intentional. No one knew diclofenac was toxic to *Gyps* vultures until the populations had already crashed. In 2003, conservationists uncovered the toxicity of diclofenac to *Gyps* vultures through a safety testing experiment and the impact diclofenac had had on the Pakistan populations through the examination of many dead individuals (Oaks *et al.*, 2004). In 2004, conservationists showed that diclofenac contaminated cattle carcasses across India (Taggart *et al.,* 2007), had killed many *Gyps* vultures (Shultz *et al.*, 2004) and was the main or sole cause of population declines in the country (Green *et al.,* 2004, 2007). Also in that year, conservationists discovered through safety testing that

another NSAID available in South Asia, called meloxicam, was non-toxic to *Gyps* vultures (Swan *et al.,* 2006b; Swarup *et al.*, 2007). Thus, at the end of 2006, the evidence was clear, the case for stopping the use of veterinary diclofenac was strong and a vulture-safe alternative to diclofenac existed. Conservationists presented these findings to South Asia's governments and, in 2006, India, Pakistan and Nepal banned veterinary diclofenac to save their vultures. Starting in 2012, surveys of vultures in India, Pakistan and Nepal have shown encouraging trends – all populations are no longer declining as fast as they had been before the ban on veterinary diclofenac; and some populations have stabilised and others have even begun to recover (Chaudhry *et al.,* 2012; Prakash *et al.*, 2012, 2017).

In 2012, the fight to save *Gyps* vultures in South Asia was seen as a success story, and in many ways it was, because in 10 years: a mysterious vulture-killer was uncovered; a suitable solution was found; governments took fast and strong action to conserve vultures; and declines in vultures at least slowed. However, the fight was not over; in fact, conservationists had won just three battles of a larger war. Further, the total number of vultures in South Asia remains dangerously low. In India, the best estimates of current population sizes were approximately 6,000 white-rumped vultures, 26,500 long-billed vultures and 2,500 slender-billed vultures (Prakash *et al.,* 2017). Outside India, approximately 4,000 white-rumped vultures survive in South and South-East Asia, but the number of long-billed vultures and slender-billed vultures is only a couple of hundred. Population sizes for the red-headed vulture and Egyptian vulture are also dangerously low (see Galligan *et al.,* 2014). Therefore, South Asia's vultures were vulnerable to additional threats.

Veterinary diclofenac was a big money-spinner for many pharmaceutical companies and only it, not diclofenac for human use, had been banned; so, following the ban, South Asian pharmaceutical companies increased their production and distribution of diclofenac in multi-dose vials (30 ml), which were supposedly for use in people, but appropriately-sized for use in cattle (see Cuthbert *et al.*, 2011). Misuse of this source of diclofenac resulted in the continued deaths and declines of *Gyps* vultures in India (Cuthbert *et al.*, 2016; Prakash *et al.*, 2017). Conservationists brought this circumvention of the ban to the attention of authorities and, in 2015, the government of India restricted the manufacture of all diclofenac to single dose vials (3 ml). The vial size restriction would not affect human healthcare, but make dosing cattle more complicated and costly. Ultimately, NSAID-users are predicted to switch preference to easier to use and cheaper to buy alternatives, which would collapsing the market for diclofenac and thereby end much of its production in India. Two pharmaceutical companies legally challenged this new regulation in a lengthy court case, but the multi-dose vial of diclofenac ban, as it was dubbed, was upheld in 2017. Another two battles won, but still not the end of the war because the diclofenac problem is only part of a bigger problem for vulture conservation in South Asia.

Diclofenac is certainly the most vulture-toxic NSAID that we know. However, diclofenac is not the only vulture-toxic NSAID that we know. In fact, we know of five more NSAIDs – namely, aceclofenac, carprofen, flunixin, ketoprofen and nimesulide – used in veterinary use in South Asia that kill *Gyps* vultures. We also know of only one vulture-safe NSAID – that is, meloxicam. In addition, there are at least eight other NSAIDs available for veterinary use in South Asia – namely, aspirin, dipyrone (Analgin), ibuprofen, phenylbutazone, piroxicam, mefenamic acid, naproxen and tolfenamic acid – that are of an unknown toxicity to vultures. The latter group should be consider potentially vulture-toxic given that most NSAIDs tested on vultures to date are found to be actually vulture-toxic. Thus, 13 out of 14 NSAIDs available for veterinary use in South Asia are actually or potentially vulture-toxic – this is the bigger problem for vulture conservation in South Asia. Perhaps worse than the large and increasing number of vulture-toxic NSAIDs, is the fact that none of these drugs are banned nationally in any of the South Asian countries.

The market share of diclofenac throughout South Asia is shrinking, but the market for NSAIDs is not. Meloxicam is attaining much of the market in the wake of diclofenac, but other actually and potentially vulture-toxic NSIADs are vying for part or all of that market share. In northern India, pharmacists most often sell meloxicam for use in cattle, but the number of shops selling actually and potentially vulture-toxic NSAIDs (not including diclofenac) combined is the same as those selling meloxicam. There exists a real threat that one or more of these actually and/or potentially vulture-toxic NSAIDs become the prominent painkillers in South Asia and the region's vultures will become extinct.

In this paper, I will review the good (vulture-safe), the bad (actually vulture-toxic) and the untested (potentially vulture-toxic) NSAIDs available in South Asia. I will present the evidence for toxicity or non-toxicity to vultures attained from the outcome of therapeutic treatment of vultures, NSAID safety testing on vultures and post-mortem examinations of vultures found dead in the field. I will end by calling conservationists, veterinarians, researchers and decision makers to action.

The Good

Meloxicam is the only vulture-safe NSAID known. The evidence for the non-toxicity of meloxicam to vultures comes from therapeutic treatment of vultures (Cuthbert *et al.,* 2007), safety testing on vultures (Swan *et al.,* 2006b, Swarup *et al.,* 2007) and post-mortem examinations of vultures found dead in the field (Cuthbert *et al.,* 2016). Meloxicam is also a safe and effective painkiller for domesticated animals and safer and more effective than vulture-toxic NSAIDs.

A survey of the therapeutic use of meloxicam among veterinarians caring for captive birds found the drug did not kill or cause ill effects in *Gyps* vultures (Cuthbert *et al.,* 2007). The survey included 39 cases of meloxicam use in six species of *Gyps* vulture.

The maximum level of exposure reflects the greatest likely exposure to the drug encountered by that species in the wild. For a given drug and given vulture species, the maximum level of exposure is calculated from the mean body weight of the species, the mean weight of a large meal for that species and highest tissue-specific residue concentration of the drug in cattle treated with a typical dose. Two experiments

showed that oral doses of meloxicam above the maximum level of exposure did not kill or cause hyperuricemia or any other ill effects in 45 out of 45 individual *Gyps* vultures from three species (Swan *et al.*, 2006b, Swarup *et al.*, 2007). Oral doses of meloxicam below the maximum level of exposure did not kill or cause hyperuricemia or any other ill effects in 15 out of 15 individual *Gyps* vultures from three species. These experiments also showed that tissues from cattle and buffalo dosed with meloxicam and fed to *Gyps* vultures, with some doses above and some dose below the maximum level of exposure, did not kill or cause hyperuricemia or any other ill effects in 33 individual *Gyps* vultures.

A survey of NSAIDs residues in dead wild vultures, found 2 out of 48 had meloxicam residue (Cuthbert *et al.,* 2016). One of the 2 presented with visceral gout (i.e., evidence of renal failure); however, that individual tested positive for nimesulide as well. In the same survey, nimesulide residue alone was associated with visceral gout in 4 dead vultures, demonstrating that it is a vulture-toxic NSAID and thereby responsible for killing the individual testing positive for both meloxicam and nimesulide.

In addition, therapeutic use of meloxicam is not associated with death or illness in a diversity of other predatory and scavenging bird species (Cuthbert *et al.,* 2007). This sample included 700 individuals from 54 species. Further, oral doses of meloxicam above the maximum level of exposure did not kill or cause hyperuricemia or any other ill effects in 5 Egyptian vultures*,* 5 cattle egrets *Bubulcus ibis*, 5 crows *Corvus spp.* and 5 common myna *Acridotheres tristis*, which also scavenge from cattle carcasses (Swarup *et al.*, 2007).

A review of the published literature assessing meloxicam found it was an effective treatment for pain, inflammation, stress and dysfunction in a variety of veterinary and husbandry situations and in a variety of domesticated animals (T. H. Galligan unpublished data). Additionally, meloxicam was shown to increase immune response, pregnancy rate and productivity in cows, as well as productivity in calves. Overall, 79% of studies reported a positive effect of meloxicam treatment. In comparison to such studies assessing flunixin and ketoprofen, more studies of meloxicam showed a positive effect and less studies showed a negative, mixed or no effect of meloxicam (see SAVE 2016b, c). No good comparison could be made between meloxicam and aceclofenac/diclofenac or nimesulide because only one study for each of these NSAIDs examined an effect (See SAVE 2016a, d).

In summary, 132 cases exist where individual *Gyps* vultures have been exposed to meloxicam. None of these cases have resulted in death or illness. In addition, 720 cases of meloxicam exposure in other bird species have not resulted in death or illness either. Importantly, 79% of studies examining an effect of meloxicam in livestock found a positive one. Further, more studies found a positive effect and less studies found a negative, mixed or no effect of meloxicam than the known vulture-toxic NSAIDs. Meloxicam is not only vulture-safe, but livestock-safe and -effective.

The Bad

Aceclofenac, carprofen, diclofenac, flunixin, ketoprofen and nimesulide are all vulture-toxic NSAIDs. The evidence for the toxicity of these NSAIDs to vultures comes from therapeutic treatment of vultures, safety testing on vultures and post-mortem examinations of vultures found dead in the field. As veterinary painkillers for domesticated animals, these NSAIDs are not as safe and effective as meloxicam or their safety and effectiveness has essentially not be assessed.

Diclofenac is highly toxic to *Gyps* vultures. Two studies that safety tested diclofenac in *Gyps* vultures found: oral doses just below the maximum level of exposure (i.e., 65-82% of the maximum level of exposure) killed 15 out of 15 individuals tested; oral doses further below the maximum level of exposure (i.e., 8-49%) killed 2 out of 4 individuals tested; and oral doses far below the maximum level of exposure (i.e., >1-3%) killed 1 out of 6 individuals tested (Oaks *et al.*, 2004, Swan *et al.,* 2006a). Post-mortem examination found kidney damage and visceral gout in all individuals that died. Blood sampling of some individuals before death found elevated uric acid concentrations.

Two studies that surveyed the cause of death in wild *Gyps* vultures, found all individuals (i.e., 39 individuals) that tested positive for diclofenac also presented visceral gout; and all individuals (i.e., 17 individuals) that tested negative for diclofenac presented visceral gout (Oaks *et al.*, 2004, Shultz *et al.,* 2004). Therefore, wild *Gyps* vultures were exposed to lethal levels of diclofenac.

Aceclofenac is a pro-drug for diclofenac (Sharma *et al.,* 2012). An experiment examining the behaviour of aceclofenac following its administration in cattle showed that nearly the entire drug was quickly converted to diclofenac (Galligan *et al.*, 2016). Therefore, a carcass of a cow given aceclofenac shortly before death would contain diclofenac at a similar concentration to a carcass of a cow given diclofenac shortly before death. Safety testing aceclofenac in *Gyps* vultures is unnecessary because it is known that diclofenac kills *Gyps* vultures.

A review of the published literature assessing aceclofenac/diclofenac found a single study. That study showed a positive effect, but the fact that it is the only study of its kind makes it difficult to compare to the effectiveness of other NSAIDs.

Ketoprofen is often given in large doses to dying cattle, which is revealed in surveys of NSAID concentrations in cattle carcasses. As a result, the maximum level of exposure calculated using the recommended dose for ketoprofen (i.e., 1.54 mg/kg vulture body weight) is substantially less than that calculated using the actual dose of ketoprofen needed to explain the maximum concentrations of the drug found in cattle carcasses (i.e., 5 mg/kg vulture body weight; see Taggart *et al.*, 2009). A study that safety tested ketoprofen in *Gyps* vultures found oral doses below the maximum level of exposure based on the recommended dose killed 1 out of 2 individuals tested; and oral doses above the maximum level of exposure based on the recommended dose killed 7 out of 11 individuals tested (Naidoo *et al.,* 2010). However, had that study used the maximum level of exposure based on the

actual dose being given, then oral doses of ketoprofen below this maximum level of exposure killed 8 out of 13 individuals. All deaths caused by ketoprofen caused elevated blood uric acid, kidney damage and visceral gout.

A review of the published literature assessing ketoprofen found 63% of studies reported a positive effect and the remainder reported either a mixed, negative or absent effect. In comparison to meloxicam, fewer studies reported a positive effect of ketoprofen and more studies reported a non-positive effect.

Carprofen is not easily absorbed by cattle. An experiment examining the behaviour of carprofen following its administration in cattle showed high concentrations at the injection site in some individuals. Safety testing carprofen in *Gyps* vultures found that the average concentration in cattle tissue at the injection site caused elevated blood uric acid, kidney damage and death in 1 out of 2 individuals tested (Naidoo *et al.,* 2018).

Flunixin caused visceral gout and death in 2 out of 4 *Gyps* vultures uncovered in survey of the therapeutic use of the drug among veterinarians caring for captive birds (Cuthbert *et al.*, 2007). The same study found flunixin caused visceral gout and death in 6 out of 20 other bird species, including scavenging birds of prey. A survey of dead vultures found 5 out of 5 *Gyps* vulture carcasses had visceral gout and flunixin residue, but no residues of other NSAIDs or toxins (Zorrilla *et al.*, 2015, I. Zorrilla unpublished data).

A review of the published literature assessing ketoprofen found less than half (i.e., 44%) of studies reported a positive effect and the remainder reported either a mixed, negative or absent effect. In comparison to meloxicam, fewer studies reported a positive effect of flunixin and more studies reported a non-positive effect.

Nimesulide residue has been found in association with visceral gout in 4 out of 5 *Gyps* vultures (Cuthbert *et al.,* 2016). A review of the published literature assessing nimesulide found a single study. That study showed a negative effect.

In summary, the number of cases where individual *Gyps* vultures have died from exposure to diclofenac/ aceclofenac, ketoprofen, carprofen, flunixin and nimesulide are 57, 8, 1, 7 and 4, respectively. Safety testing experiments provides direct evidence for the toxicity of diclofenac, and thereby aceclofenac, ketoprofen and carprofen to *Gyps* vultures. Post-mortem examinations of dead vultures found in the field and those therapeutically treated with NSAIDs provide indirect evidence for the toxicity of diclofenac, and thereby aceclofenac, flunixin and nimesulide. None of these actual vulture-toxic NSAIDs can be said to be more safe or effective at treating aliments in domesticated ungulates than meloxicam. In fact, some (diclofenac and nimesulide) are possibly unsafe and/or ineffective given the lack of studies demonstrating the opposite.

The Unknown

Aspirin, dipyrone (Analgin), ibuprofen, phenylbutazone, piroxicam, mefenamic acid, naproxen and tolfenamic acid are all NSAIDs of unknown toxicity to vultures. It is not possible to predict whether these NSAIDs are toxic by simply comparing their structure or classification to that of actually toxic NSAIDs. Further, it would not be possible to convince decision makers that any of these NSAIDs should be banned based on structure or classification. Cases of vulture deaths following therapeutic treatment provide clues about the toxicity of certain NSAIDs to vultures. However, safety testing on *Gyps* vultures is the necessary direct evidence that is needed to determine whether a certain NSAID is toxic or non-toxic to vultures. In vitro studies showing cell death following administration of NSAIDs is not a substitute for safety testing in vultures because what happens at the cellular level does not always translate to what happens at the organism level. Conservationist need to know with high certainty that a given NSAID is vulture-toxic and, more importantly, vulture-safe, which can only come from safety testing experiments. Finding dead wild vultures with visceral gout and certain NSAID residues provide indirect evidence of toxicity, but also direct evidence that wild populations are being killed by that NSAID. Reviews of veterinary reports, NSAID safety testing and searches and examinations for dead vultures must be undertaken promptly to know the toxicity of all NSAIDs available in South Asia.

Actions

The war on vulture-toxic NSAIDs continues and there are still many battles to fight. Some of the battles are unforeseeable, but permanently ending the veterinary use of the 5 actual vulture-toxic NSAIDs and temporarily stopping the veterinary use of the 8 potential vulture-toxic NSAIDs until they are safety tested are two apparent battles that can be fought now. Below are my suggestions how conservationists, veterinarians, researchers and decision makers can help.

Conservationists need to understand the bigger problem of vulture-toxic NSAIDs (see SAVE 2016a, b, c, d). They need to share the bigger problem widely among communities. They should talk to farmers, veterinarians (both registered and unregistered), forest officials, livestock officials, drug control officials, politicians and other conservationists. Conservationists should aim to engage these groups with ethical, emotional, spiritual, economical and legal arguments for conserving *Gyps* vultures of which there are many. In their conversations, they should promote the use of only pure meloxicam as a vulture-safe veterinary NSAID. They should not promote the use of meloxicam products that contain paracetamol, as safety testing on this combination of drugs or paracetamol alone has not been undertaken and therefore these could be vulture-toxic. Conservationist can ask farmers and veterinarians to pledge to not use vulture-toxic NSAIDs; ask government officials to spread messages down and up their chain of command, among departments and the agricultural and pharmaceutical industries (prepare letters, papers or presentations for them to argue the case); and ask decision makers for local control on actually and potentially vulture-toxic NSAIDs. Conservationist should not be distracted by all the possible causes of vulture mortalities (e.g. poison baits, collision with power, kite-string injuries) and by unsubstantiated causes of decline (e.g. lack of food, lack of nesting sites, climate change), but rather focus on the bigger problem as vulture-toxic NSAIDs are the only cause of

decline in *Gyps* vultures that has been substantiated. Further, conservationists need to approach vulture conservation on a united front. They can visit the SAVE (Saving Asia's Vultures from Extinction) website (www.save-vulture.org) for further information, guidance and support, including NSAID Alert summaries for each actual vulture-toxic NSAID covering the evidence for toxicity and its effectiveness as a veterinary drug in comparison to meloxicam.

Veterinarians can make an enormous contribution to vulture conservation by using only pure meloxicam in domesticated ungulates. Again, meloxicam and paracetamol combined products should not be used. If every veterinarian in South Asia only used pure meloxicam from this day forth then the markets for all the actual and potential vulture-toxic NSAIDs would crash and *Gyps* vulture populations would begin to recover. Of course, not all veterinarians are going to read this paper nor converse with a vulture conservationist; therefore, veterinarians must spread the word among their own (see SAVE 2016a, b, c, d). Veterinarians can even influence non-registered veterinarians by setting an example and changing the NSAID market. Veterinarians working with captive and wild birds that have used NSAIDs on vultures or other birds of prey could provide clues to the toxicity of NSAIDs of present unknown toxicity.

Researchers can enhance our knowledge of the toxicity of certain NSAIDs to vultures. Ten NSAIDs currently available in South Asia have yet to be safety tested. Some safety testing is underway by SAVE partners, but there is no reason why other researchers cannot contribute to this work. We are happy to share our rigorous experimental protocols for safety testing that minimise the welfare concerns and risk of death for the domesticated ungulates and vultures involved. There is also a need to know the tolerance of other scavenging birds (e.g., Egyptian vulture, black kite *Milvus migrans*, crows *corvus spp.*) to certain NSAIDs, including those that have been already tested on *Gyps* vultures, like diclofenac/aceclofenac. It is important to note that safety testing is relatively expensive; and permission is often needed to attain wild birds, particularly protected species, as well as to conduct experiments on domesticated and wild animals. Researchers can also search for dead vultures and other scavenging birds opportunistically or systematically, conduct post-mortem examinations and analyse tissues for NSAIDs to expand our understanding of which ones are killing birds. Finally, researchers may come up with novel ways to contribute to the evidence-base conservationists require; however, researchers should remain focussed on the bigger problem of vulture-toxic NSAIDs. Along these lines, there is plenty of scope to study human and market behaviour involved in producing, selling, buying and using NSAIDs.

Decision makers at the national level have the power to solve the bigger problem in vulture conservation once and for all. The four most important actions these decision makers could take are: the permanent banning of aceclofenac in veterinary formulations and vials larger than 3 ml (see SAVE 2016a); the permanent banning of all other actually vulture-toxic NSAIDs in veterinary formulations and vials larger than 3 ml that are known now and in the future (see SAVE 2016b, c, d); the temporarily banning of all potentially vulture-toxic NSAIDs in veterinary formulations and vials larger than 3 ml that are known now and in the future until each is shown to be either vulture-safe or vulture-toxic through rigorous safety testing experiments; and the ordering of mandatory safety testing on pharmaceutical companies for all untested NSAIDs that are known now and in the future. These actions should be implicated simultaneously and without exception. The decision makers that bring about these actions would create a vulture safe zone throughout their entire country within one year. Admittingly, these are big actions – much bigger than banning veterinary and multi-dose vials of diclofenac – but necessary to solve the bigger problem. The alternative courses of action – besides doing nothing at all, of course – is: to not ban vulture-toxic NSAIDs if these have small market shares; to ban actually vulture-toxic NSAIDs one at a time; to wait for safety testing experiments to show NSAIDs are toxic before executing control measures; and to rely on conservationists to plan, fund and implement safety testing experiments. Alas, this is the course of action most South Asian decision makers are taking at present, which is too inefficient, ineffective and downright dangerous. In 2006, decision makers in India, Pakistan and Nepal (Bangladesh followed suit in 2010) were commended by the international community for taking strong action to stop the catastrophic population declines in their countries *Gyps* vultures; now, in 2018, South Asian decision makers need to take stronger action to allow these birds to recover.

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STATUS AND CONSERVATION OF WHITE-RUMPED VULTURE IN INDIA: AN OVERVIEW

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Of the five species of *Gyps* vultures occurring in India, the Indian White-backed or White-rumped Vulture (*Gyps bengalensis*) was the most common species in the Indo-Gangetic plains until about a decade before close of the 20th century. It thrived on carcasses of large wild herbivores from open forests, and of large domestic livestock from the countryside. This vulture was also commonly seen at carcasses all over Peninsular India right down to Kanniyakumari District. However, the vulture population in the southern peninsula, particularly Kanniyakumari district where the author grew up, showed noticeable decline after mid-20th century. This decline was evidently caused by dwindling of its food supply in the forests, and the countryside.

Degradation and destruction of natural forest or conversion of the natural forest into commercial plantations, in and around Kanniyakumari district, has resulted in depletion of large wild herbivores, hence a reduction in the food source for *Gyps* vultures. As for domestic livestock carcasses, these decreased because of change in the life lifestyle of farmers. Traditionally, the farmers raised cattle for milk, for organic manure, and for manual labour such as pulling carts, drawing irrigation water, and plowing. Carcasses of cattle which died of old age or disease, were flayed by hide collectors, and then left in the open for vultures to clean up the soft parts.

However, with the introduction of mechanised ploughing, motorised pumps and chemical fertilizers, farmers depended less and less on cattle for agriculture, resulting in decline of village cattle. As for those who kept high-yielding dairy cattle, they had access to modern veterinary medical aid, which minimized death of cows through diseases. Further, most of these animals did not get to die of old age because they were sent for slaughter when they became economically nonviable. Thus, the sustenance of vultures was highly affected, resulting in their population decline.

Gyps vultures need regular supply of meat from large mammal carcasses in order to maintain a viable population in any area. Individual vultures scanning the ground from the sky, daily, for carcasses depend upon each other for finding food (Grubh, 1980). When one vulture zeroes in on a carcass, others notice it; and all gather around the meal soon. If their number plummets too low, they cannot undertake such communal search for effective foraging.

White-rumped vultures became extremely rare in Kanniyakumari district and the surroundings, decades before diclofenac (a new non-steroid anti-inflammatory drug, which is widely used by veterinarians), was introduced in India. Since the rest of the southern peninsula, too, share similar socio-economic situation, these areas, too, were presumably governed by the very same factors that influenced vulture decline in Kanniyakumari district (pers. obs.).

As for the Indo-Gangetic plains, where cows are generally not slaughtered for meat, the scenario was rather different. Even while the vulture population was dwindling in the southern states, vultures flourished here. The numbers increased to such an extent that it was not uncommon to view as many as 3000 white-rumped vultures at a single site in Delhi during the eighties of the 20th century (pers. obs.).

This phenomenal proliferation was caused by the superabundance of food originating from dairies, gaushalas (cow shelters) and primitive slaughter houses. Many people sent their spent cows or oxen to gaushalas (cow shelters) or even released them in the streets where they eventually died, thus making available a steady supply of food for vultures (pers. obs.). Vultures often camped near dairies, gaushalas and primitive slaughter houses where there was assured food supply. They roosted on trees at night, and fed during the day.

Vultures have a habit of taking advantage of thermals to soar in the sky for their various survival needs. Usually they used to soar in dense spirals between 11 and 12 hours in order to gain height and then drift off to various locations of their choice (Grubh, R.B. 1980). This is the usual time of day when aircraft would encounter vultures, especially during critical aircraft flight phases such as initial climb and final approach. As a result, the white-rumped vulture and even the Indian vulture (*G. indicus*) became major potential problem birds for civil and military aircraft in India. While commercial airlines suffered huge financial losses due to engine damage and delayed flights, the Indian Air Force lost many fighter planes and, more importantly, valuable fighter pilots at the peak of their career.

Considering this bird-strike hazard potential of vultures, recommendations were made (Grubh, RB. 1990) for ecological control of these birds by setting up modern abattoirs and modern carcass processing plants at key locations throughout the country. These would drastically minimize the availability of edible waste that could sustain a population of vultures in and around airport cities. These recommendations were also, brought, later on, to the attention of members of a bird hazard prevention meeting specially convened in Delhi by the then Scientific Advisor to the Minister of Defence, in the year 1996. This committee unanimously accepted these recommendations for implementation with a sense of urgency.

About a year after this meeting, there were widespread reports of the drastic decline of vulture population around towns and cities in major parts of India. Initially it appeared

to be the result of prompt and effective implementation of the above recommendations, and that the unhealthy proliferation of vultures has been effectively contained through ecological control methods. However, that was not to be the case. While there has been gradual improvement in the quality of slaughter houses in India, modern carcass processing plants were yet to be seen, and the supply of livestock carcass from villages and dairy farms too had not diminished perceptibly. In fact large numbers of putrefying carcasses were seen at several carcass dumping sites, unattended by vultures.

A speculation was floated by some researchers that some unknown virus or another disease factor was possibly the cause of vulture decline (Risebrough, Robert W. 2000). Later, this speculation was replaced by a hypothesis that diclofenac, introduced in India around the same time was the cause of vulture population decline in the neighboring country Pakistan, (Oaks *et al*. 2004). Soon a simulation model was developed by Green, Rhys E. (2004) based on some data and several assumptions that even if only 1% of carcasses were contaminated by diclofenac, the Indian *Gyps* vulture populations would fall drastically. A welcome outcome of this hypothesis, however, was the banning of this harmful drug in India, in the year 2006, for veterinary use.

As for the population recovery of vultures in India, it is happening slowly. As some current studies indicate, there are some populations (*Gyps* spp. including *G. bengalensis*) surviving in isolated pockets. It is understood that the dedicated scientific team working through the Department of Zoology and Wildlife Biology of the Government Arts College in Udhagamandalam, Tamil Nadu, is taking laudable efforts to study these populations for their long-term conservation in southern India. The BNHS is taking positive efforts to increase the population of wild vultures, by captive breeding and releasing them into the wild.

Vulture conservationists may bear in mind the fact that restoring the ecologically unhealthy superabundance of vultures around towns and cities, which seriously impacted aviation in the recent past, is not restoring ecological balance. What is important is to restore a healthy number of vultures in the forest and the countryside where they have an important role to play as the best natural scavenger available for cleaning up large animal carcasses. Happy co-existence of vultures and man in India is possible, and must be restored.

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STATUS OF VULTURES IN KERALA

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ABSTRACT

According to historical records, four species of vultures were present in Kerala in the beginning of 20th century, viz. Red-headed Vulture *Sarcogyps calvus*, Indian Vulture (Long-billed) *Gyps indicus*, White-rumped (Oriental White-backed) Vulture *Gyps bengalensis* and Egyptian Vulture *Neophron percnopterus*. The population of these vultures began to decline, due to various reasons, from the late 1960s onwards and became virtually extinct in most parts of the state by the late 1970s except for a small resident population of White-rumped and Red-headed Vultures in Wayanad Wildlife Sanctuary (344 km 2), bordering the forested areas of Tamil Nadu and Karnataka. An ornithological survey covering all the bird habitats of the state conducted from 2009 to 2011 confirmed this fact as no vultures were sighted anywhere else in Kerala. There were two records of Cinereous Vulture *Aegypius monachus* (1988 and 1994) and another of Himalayan Griffon *Gyps himalayensis* (2016) in the state. The vulture population in Wayanad Wildlife Sanctuary has been monitored periodically since 2003. During every visit to the sanctuary, about 10 to 20 Oriental White-backed Vultures and 2 to 4 Red-headed Vultures were seen, soaring mostly. A synchronized survey conducted in the sanctuary in December 2013 counted 35 White-rumped, 5 Red-headed and 2 Indian Vultures. At carcasses of wild ungulates, congregation of vultures numbering more than 50 had been seen on occasions. White-rumped Vultures have been found to breed in three colonies situated in three different forest ranges of the sanctuary. The breeding colonies have been monitored regularly since 2003. Up to 12 nests were located in each breeding season. The average breeding success was found to be 65%. The breeding population seemed to be stable except for the all-time low nesting in the 2016- 2017 season with only 4 nests out of which only one was successful. NSAID prevalence surveys were conducted in the drug stores of Wayanad district in 2008, 2011 and 2013. It was found that diclofenac was still available in 2013 in at least one store. Other drugs harmful to vultures e.g. Ketoprofen, Nimesulide etc. also were available in the market. Wayanad Wildlife Sanctuary being contiguous with Bandipur National Park, Rajiv Gandhi National Park (Nagarhole) of Karnataka and Mudumalai Tiger Reserve of Tamil Nadu, a joint action plan will have to be designed so as to make any effective conservation strategy.

Key Words : Vulture, Kerala, NSAID

Introduction

Ornithological literature regarding Kerala since the beginning of 20th century shows that four species of vultures occurred here (Ferguson 1903-04, Baker & Inglis, 1930; Neelakantan, 1959; Ali, 1969, Robertson & Jackson, 1992).

1. Egyptian Vulture *Neophron percnopterus*
2. Red-headed Vulture *Sacrogyps calvus*
3. White-rumped (Oriental White-backed) Vulture *Gyps bengalensis*
4. Indian (Long-billed Vulture) *Gyps indicus*

From the literature, it could be seen that White-rumped Vulture was common till the 1960s, while the other three species were present in small numbers, but were never abundant (Table 1). But, sightings of all species of vultures became increasingly rare from late 1960s onwards and they became virtually extinct in most parts of the state by late 1970s.

Table 1. (Adapted from Sashikumar, 2011)

Species	Ferguson 1903-04	Baker&Inglis 1930	Neelakantan 1959	Ali 1969	Neelakantan 1986	Robertson& Jackson 1992 (Periyar Tiger Reserve)	Sashikumar *et al.* 2011a, 2011b, 2015
S. calvus	Single specimen from south Travancore	As in Ferguson 1903-04	Common in low numbers	? Resident, seen most commonly, not abundant	Rare	Occasional individuals	Seen only in Wayanad WLS
G. indicus	Rare	Rare	Not mentioned	? Resident, not common or abundant	Rare	Seen regularly up to 1954, not seen since.	Not seen
G. bengalensis	Common, breeding	Common	Common, breeding	Resident, common but not abundant	Rare	Increasingly rare since the 1960s.	Seen only in Wayanad WLS
N.percnopterus	Common in drier parts	Common in drier parts	Rare	Resident, not common	Rare	Single record in 1954	Not seen

An ornithological survey covering all the bird habitats of the state conducted from 2009 to 2011 confirmed this fact as no vultures were sighted anywhere else in Kerala except in Wayanad Wildlife Sanctuary (Sashikumar *et al.*, 2011 b, 2015). There were two records of Cinerous Vulture *Aegypius monachus* (Sreekumar 1991, Sashikumar *et al*, 2011a), which probably were stragglers. A juvenile Himalayan Vulture *Gyps himalayensis* was recovered in exhausted condition in January 2013 at Akamala, Thrissur district (Praveen *et al.*, 2014), and another one was caught on the camera trap put up by the forest department at an elephant carcass in Wayanad Wildlife Sanctuary in 2016 (Vinayan P A, pers.comm.).

Sashikumar (2001) has attributed the reason of the decline of vultures in Kerala to the combined effects of:

1. Changes in habitat
2. Changes in livestock management and socio-cultural attitudes
3. Use of pesticides and direct poisoning
4. Increase in human population density and awareness of social hygiene
5. Changes in food habits and social taboos.

Occurrence of vultures has been reported only from the Wayanad Wildlife Sanctuary of Kerala in recent years. Since 2003, I have been monitoring the vulture population, especially the breeding, at this sanctuary.

Wayanad Wildlife Sanctuary

Located in the Wayanad district of Kerala at the eastern part of the Wayanad plateau along the Kerala - Karnataka – Tamilnadu border, this sanctuary has an area of 344 sq.km (Fig.1). The sanctuary is in two separate segments: Tholpetty Range at north is contiguous with Nagarhole Wildlife Sanctuary (Karnataka); Kurichyat, Bathery and Muthanga ranges of the southern segment are contiguous with Bandipur Tiger Reserve (Karnataka) and Mudumalai Tiger Reserve (Tamil Nadu) (Fig.1). The forest type is moist-deciduous and about 1/3 of the area is plantations of teak, rosewood, eucalyptus etc. The sanctuary supports most of the herbivores and carnivores found in the south Indian jungles and more than 200 species of birds have been reported. Temperature varies from 12 to 32° C and the average annual rainfall is 2000mm.

The Sanctuary has a good population of herbivores like Elephant, Spotted Deer, Sambar etc. The wild ungulates are preyed up on by Tiger, Leopard and Wild Dogs, the major carnivores. There are more than 30 tribal settlements within the Sanctuary (many of these are now being relocated outside the sanctuary) where a sizeable population of livestock is reared. While grazing in the forest, some of these are occasionally predated by the carnivores. During the summer months, elephant herds from the drier areas of the neighboring protected areas migrate to Wayanad Wildlife Sanctuary; the stress during migration and dehydration results in deaths of several elephants every summer from February to May. The carcasses of wild ungulates and elephants form the major source of food for vultures in this area.

Monitoring

The sanctuary was visited at least once a month. The number and species of vultures seen and their activity were recorded at each visit to the sanctuary. The vultures were counted while travelling within the sanctuary through forest roads for a distance of about 30 km. Soaring vultures were observed from vantage points also, mostly the *vayal* (open grassy marshes) in the forest. Information on the carcasses and the vultures present were noted.

Nesting activities were observed each season from September to May, from the nest building stage till the juvenile vultures flew out of the nest. The nest trees were marked for identification once the incubation started and monitored till the end of the season. The nesting colonies were visited at least once a month through the breeding cycle. The study spanned 14 years from 2003 to 2017.

The monitoring was done from 2003 to 2008 under the Vulture Monitoring Programme of the Bombay Natural History Society. During 2010 this was conducted as part of the Malabar Ornithological Survey initiated by the Kerala Forests and Wildlife Department and also under the Western Ghats Vulture Survey project sponsored by BNHS-CEPF. In 2013- 2014, the study was conducted as part of the RASTA-ATREE-CEPF project on vulture conservation in Wayanad district. Data for 2014-2017 was gathered from annual vulture monitoring programme of Hume Centre for Ecology and Wildlife Biology, Wayanad..

Vulture population

During every visit to the sanctuary, an average of 15 White-rumped Vultures and 2 to 4 Red-headed Vultures were seen, soaring mostly. Indian Vultures were seen very rarely only. A synchronized survey conducted in the sanctuary in December 2013 counted 35 White-rumped, 5 Red-headed and 2 Indian Vultures. At the carcasses, congregation of vultures numbering more than 50 had been seen on occasions. It is assumed that vultures from the adjacent areas also congregate at the available carcasses in the sanctuary.

The vultures here are extremely alert and fly away at the slightest disturbance, indicating that this is a genuine forest population, not much in contact with humans. Apart from one or two sightings reported near a slaughterhouse at Panamaram, about 20 km from the sanctuary (Ajayan pers. comm.), no vultures have been seen outside the forested area in Wayanad.

Breeding of White-rumped Vultures

Three small colonies of White-rumped Vultures have been located in three different ranges of the sanctuary, viz. Kurichyat, Bathery and Tholpetty. The colony at Kurichyat used to have a maximum of 11 nests, Bathery up to 6 and Tholpetty up to 3. The nests were placed on tall trees in the vicinity of *vayal* or forest roads and always had a source of water nearby. At Kurichyat, the undergrowth of the nesting area used to be cleared under the management of *vayal* (Jayaprasad, 2002; Sunilkumar, 2012). This practice seems to have been discontinued after 2009 and probably after that, the nests have been shifted closer to the forest road, where the undergrowth is being cleared on both sides for fire prevention.

The breeding cycle began in September-October with nest building, egg was laid in late October or early November, chick hatched in late November or early December and the young flew out of the nest in May. In the breeding season of 2013 – 2014, the chick at a nest in Tholpetty range left the nest only in June.

Our observation showed that White-rumped Vultures in the Wayanad had a good rate of breeding success (a nest from which a fledgling flew out was considered as a successful nest) at an average of 65 % (Fig.2); compared to the breeding colonies of north India, this was very high (Vibhu Prakash pers. comm.). No mortality in adult vultures had been reported in or around the breeding colonies. Two dead juvenile vultures were found – one in the nest itself – at the breeding colony at Kutrichyat in April 2009. Post-mortem was conducted on one of the carcasses by, but the cause of death could not be ascertained (Arun Zacharia pers. comm.). No data is available on the mortality of the fledglings once they left the nest and there is no exact information on the annual recruitment into this population.

Red-headed Vultures, seen regularly in the sanctuary albeit in small numbers, were not found to breed here. Juvenile birds of this species also are sighted often indicating that this species may also be breeding here or in the neighbouring areas.

Prevalence of NSAID

Surveys were conducted in the drug stores of Wayanad district in 2008, 2011 and 2013 using standard methodology (Cuthbert *et al.* 2011). The pharmacies were visited and asked for veterinary non-steroidal anti-inflammatory drugs (NSAID) to treat cattle. In all, 13 brands of NSAIDs were offered for sale. It was found that diclofenac in large packaging (30 ml) was still available in 2013 in at least one drug store. Other drugs harmful to vultures e.g. aceclofenac, ketoprofen, nimesulide etc. also were available in the market. This shows that the threat of NSAIDs to the vulture population of the area still persists.

Conclusion

Our study shows that the small population of the two species of vultures has been more or less stable for the last 15 years. The all-time low number of nests in the 2016 – 2017 season is a cause of concern, though.

Recommendations

1. Regular monitoring and documentation of the vulture population, breeding colonies should be carried out by the forest department or the NGOs working in this field.
2. Management practices, especially the *vayal* management should be continued in the sanctuary.
3. The prevalence of diclofenac and other NSAIDs should be strictly monitored and their availability should be totally eliminated in Kerala, especially in Wayanad and the neighboring districts by the Drug Controller. Offenders should be punished.
4. Monitoring of carcasses should be continued till a substantial data is generated for proper assessment.
5. Wayanad Wildlife Sanctuary being contiguous with Bandipur National Park, Rajiv Gandhi National Park (Nagarhole) of Karnataka and Mudumalai Tiger Reserve of Tamil Nadu, a joint action plan will have to be designed so as to make any effective conservation strategy.

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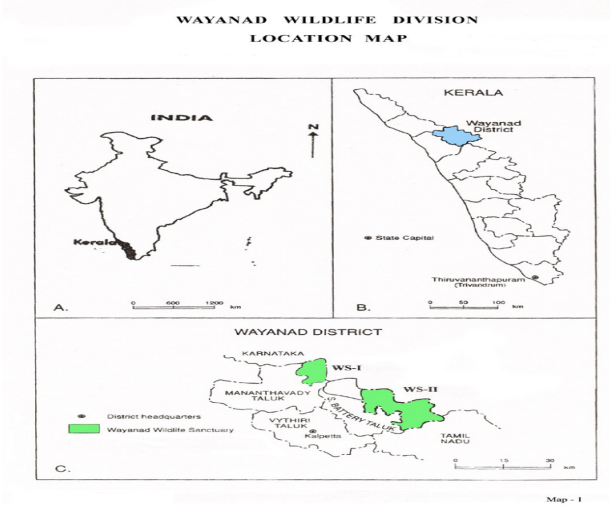

Fig. 1 Wayanad wildlife sanctuary

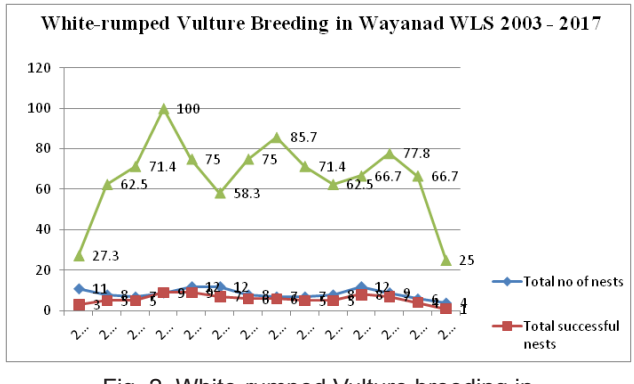

Fig. 2. White-rumped Vulture breeding in Wayanad WLS - 2003 – 20017

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POPULATION ESTIMATION OF VULTURES IN MOYAR VALLEY: SWEEP SURVEYS

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ABSTRACT

Vultures in Moyar valley has not been studied in detail until recently no specific or authentic data on their size or population threats like Brigand Veerappan and other factors limited entry into jungles in the past decades also till the catastrophic decline during 90's, vultures were not in red list even the diclofenac and NSAID effect was mostly restricted to population around habitation no status on wild population and very little study done even the observations of ERC Davidar was related to tiger and elephants and a passing remark on vultures (that too Sigur plateau). This prompted an exercise to judge at least a range of population in wild Moyar valley since it is the last refuge in southern India launched with the help of Amateur birders of Tamilnadu & Kerala timely help of Forest Dept. (Coimbatore Circle) started in 2015 and continued till date sweep surveys with synchronized observations over two days sweep surveys are the best method to judge the probable population when no previous records are available and studies are almost nil effectively glaring double counts minimized methodology of time and direction reduces serious double counts at two places of the same zone facilitation of the range of vultures in the zone, i.e. approximate numbers or reliable estimate breeding statistics also support this the comparative figures suggest a stable population around 150+ in this biotope and some lateral migration during monsoon

Key Words: Vultures, Moyar Valley, Survey

Introduction

It is seen that both the Gazetteer of Nilgiris and erstwhile British Ornithologists like Jerdon, Whistler, etc. observed that vultures are very common in Nilgiris, especially Moyar Valley with Scavenger(Egyptian) vultures being the commonest among Badaga villages (Primrose, Jerdon). However, it is a fact that very few studies have been done on vultures in wild. The observation of ERC Davidar relates to 1990s when cattle killed by tigers were poisoned by villagers of Segur plateau. It does not give any idea of the vulture population at that time but a relative statement based on abundance at that time. All the population crash and decline discussed are with reference to the population that was existing around towns, cities and villages in huge numbers till early 1990s (Dr.Robert B Grubh, personal communication). We do not have reliable statistics or figures on the numbers that thrived in this valley before 2005. Added to these factors, the operation of the brigand Veerappan in these habitats was a great deterrent to many researchers and surveys as safety was at stake and the villagers were also caught in the nexus, thus making the area unsuitable for research of any kind.

In this back drop, the idea of a rapid or sweep survey assumes a great importance since the entire valley could be thoroughly scanned by expert birders at the same time excluding serious double counts (synchronised survey). Also such an exercise will reveal the presence of other raptors along with roosting sites, nesting sites and communal congregations. Also it will give a fair number of vultures that could be using this valley. With a view to get a fair number of raptors and also their preferences in this biotope with reference to ground realities, this survey was organised in 2015; 2016; & 2017-- the first two years with the help of Tamilnadu Forest Dept (Coimbatore Division) and the last with the Dept and Sanctuary Nature Foundation.

Methodology

The success of the survey hinges on having well qualified personnel for conducting the field work. It is essential that the field crew have sufficient experience and training so that the resulting data are complete and reliable. Ideally biologists should be hired who have extensive experience conducting formal surveys, including field work in remote areas. When a sufficient number of qualified biologists are not available, compromises must be made. It is important that field personnel know that where they are, how to get back to where they started, and what to do in poor weather conditions or when things go wrong. Even well recorded scientific observation is of little use when the crew are not sure of where they were. This is also important for basic safety, especially when surveys are conducted in remote areas. It does not matter whether this experience is gained as part of general recreation (eg. Backpacking) or while conducting actual research.

The area to be surveyed must be defined at the start of a season so that an appropriate system of selecting sites within that area can be implemented.

Species habitat or range

This type of survey focuses on a particular species, typically one that is formally listed or believed to be rare. A single species survey would include all habitat for that species within either the entire geographic range or an area of interest such as a National forest or state park. Focusing surveys on particular species limits the habitat types that need to be surveyed. Unless one is familiar with the habitat preferences of a particular species, there is a tendency to focus on other areas. It is also important, however, to search areas that are believed to be marginal or unsuitable for the species of interest.

A complete survey includes all habitats within the survey area eg. the entire length of the terrain. Areas that are clearly unsuitable for the species are not included. Surveys focusing on a particular species may also be complete within the appropriate habitat for that species. Complete surveys conducted in a naturally defined area,

such as a valley or river valley, provide the best information. Some biologists believe that individuals routinely move from one population to another. Without this dispersal, the populations may not be self-sustaining over a period of time. If surveys are conducted in anticipation of significant change in Management practices, complete surveys are to be conducted, not sample surveys. Surveys based on sampling regime are not sufficient when there are potentially serious impacts on population of rare or declining species.

Advantages: A complete survey has advantages over other techniques, because there is no bias in selecting sites and no need to extrapolate the data.

Disadvantages: Primary disadvantage is time and cost. In a large Park or wilderness, it may be a deterrent.

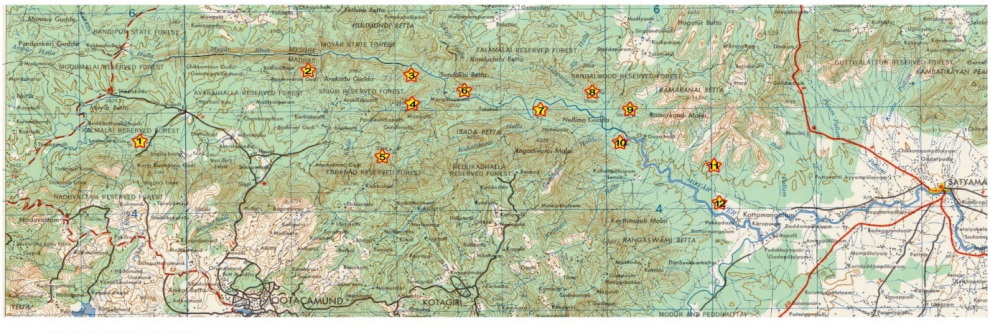
Each team aided with an expert birder was asked to take a slow trek from early morning (depending upon visibility factor) for a minimum period of two hours in a particular path or transects laid for other surveys. The prime time of noon should not be missed, since vultures soar only when hot thermals climb. Similarly, another two hours trek in the evening in another transect was done. The last transect could be the repeat of first one or a new one, to cover the area to satisfaction.

During other times, any interesting observation or details could be noted to give a fair idea on bird behaviour and habitat utilization etc.

Study Area

The study area extended from Boothanathham village near Moyar Power Station in Sigur Reserve and upto Bhavanisagar dam in Sathyamangalam division all along the course of river Moyar. In view of the sightings at Singara range and Sigur range, areas around Singara and Siriyur were also included (These form the sink habitat of Moyar valley). (Please refer to the map given below).

In addition to the observations, the bird watchers were also instructed to note the direction and time of the flight of raptors encountered with numbers. This was done in order to eliminate double counts between adjacent camps as plotting of these in a map will reveal the lateral movement of birds. Similarly roosting sites, nesting sites are to be clearly marked in the data sheets.



1. Singara
2. Jagulikadavu
3. Asuwaramattam
4. Aadikombai
5. Sriyur
6. Mangalapatti

7. Thengumarahada
8. Moolapatti
9. Karuvanaroyar Kovil
10. GT Patti / Nandhipuram
11. Varakatu kombai
12. Bhavanisagar

Results

Timing	Number of birds			
	2015	2016	2017	Grand Total
06.01 AM - 9.00 AM	````39	```63	```22	```124
09.01 AM - 12.00 PM	````74	``117	```57	```248
12.01 PM - 3.00 PM	````18	```18	```26	`````62
3.01 PM - 6.00 PM	````20	```30	```15	`````65
Grand Total	```151	``228	``120	```499

Discussion

- The results indicate a stable tendency in the last three years and the variation is low
- The weather in the first two years was sunny, hot and without strong winds
- The weather in 2017 was cloudy, rainy and humid with low light as monsoon had set in, albeit faintly, with winds.
- There was a perceptible shift in sighting of vultures in 2017, as more numbers were seen from Moyar valley of Satyamangalam, compared to the earlier two years, though the shift may be not in great numbers.
- In 2017, the breeding had almost concluded and juveniles were flying out on their own, which could have influenced a slight drop in numbers, compared to previous years.
- Giving allowance to observer bias and repetitions (that was restricted to only few camps), the population may well be around 150

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POPULATION ESTIMATION OF VULTURES IN MOYAR VALLEY, TAMIL NADU: ROAD TRANSECT SURVEY

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ABSTRACT

Nine species of vultures are recorded in Indian sub-continent. The vulture species threatened across India and in most parts of the world. The major reason for vulture decline in India was use of the veterinary drug for cattle. However, diclofenac is not only vulture-toxic Non-steroidal Anti-inflammatory Drug (NSAID) other NSAIDs such as ketoprofan, aceclofenac, carprofen, phenlbutazone, nimesulide and flunixin drugs also toxic to vultures. There are six vulture species are recorded in the Moyar Valley of Tamil Nadu. They are Oriental White-rumped Vulture *Gyps bengalensis* (OWRV), Indian Vulture (Long-billed) *Gyps indicus* (LBV), Red-headed (King) Vulture *Sarcogyps calvus* (RHV), Egyptian Vulture *Neophron percnopterus* (EV), Himalayan Griffon *Gyps himalayensis* and Cinereous Vultures *Aegypius monachus*. The OWRV, LBV and RHV listed as critically endangered, EV listed as endangered, Himalayan Griffon and Cinereous Vultures listed as Threatened category by the IUCN. The OWRV, LBV, EV and RHV are resident in the landscape. The OWRV and LBV active nesting population were observed in the landscape. However the EV and LBV have been breeding in the adjoining landscape of Karnataka. Record of few RHV juvenile vultures in the landscape indicates that till RHV breeding in the Nilgiri Biosphere Reserve. Recently two migratory vultures namely Himalayan Griffon and Cinereous Vulture were recorded in two different occasions in the landscape as well as in the adjoining states of Kerala and Karnataka. The systematic vulture study was conducted for the first time in the Nilgiri North Forest Division (NNFD) and Sathyamangalam Tiger Reserve (STR) of Moyar Valley to determine the population of vulture and also to get rough estimation of vultures. The vultures were counted on road transect; tarred road sand metal roads were selected for the survey. The road transect were driven between 8:00 to 17:00 local time at 20-30 kmph in the protected areas. These transects were surveyed twice in a month from January to December in 2012 and 2013. The routes followed in 2013 were the same as the previous survey. Vulture nest searches were carried out from October to June. Vulture species counted using a pair of instruments such as binocular (40X10) and telescope (20X). Vulture photographs were taken with Nikon D 5200 digital camera for further identification. The survey result shows that the flock size of the OWRC significantly higher in NNFD when compared to STR of Moyar Valley. The flock size of the LBV was very low and found insignificant between NNFD and STR. There was no difference in the overall RHV sighting between NNFD and STR. There is a significant variation in the total number of vulture sighted between NNFD and STR that the OWRV population and encounter rate was highest during post monsoon season when compared to monsoon and summer season. No seasonal variation noticed in RHV and LBV across the season in NNFD. In STR the mean population of OWRV was significantly highest during summer followed by monsoon and post monsoon. The mean population and encounter rate of LBV showed highest numbers during monsoon season when compared to other seasons in STR. On the other hand the RHV showed uniform distribution and no seasonal variation was observed in STR. However there is a seasonal variation in population and encounter rate per kilometer in both NNFD and STR for the OWRV. The median group size and mean crowding were highest for OWRV, mean crowding was very low for LBV and RHV did not show any variations. The active nesting of OWRV was observed on the trees along the riparian habitat in NNFD and Mudumalai Tiger Reserve. On the contrary LBV breeding on the rocky cliffs in both NNFD and STR. The government and non-governmental organizations are involved for to save last surviving small population of vultures through research, advocacy and awareness. The current mortality of vultures in the landscape is another challenge for conservationists. A long term ecology studies such as (nest monitoring, NSAID survey & transect survey) advocacy and conservation awareness only hopes for announcing the landscape as a permanent safe zone for vultures.

Key Words: Conservation, Flock Size, Moyar Valley, Sesonal Variation, Population

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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 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

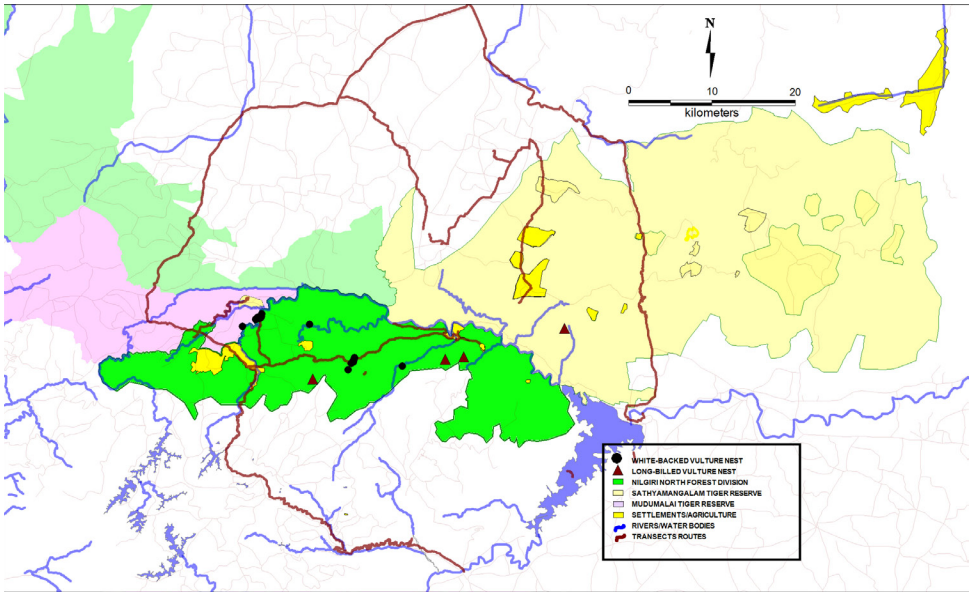

Figure 1. Study Area showing vulture survey transect routes and vulture nest distribution in Moyar Valley

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,

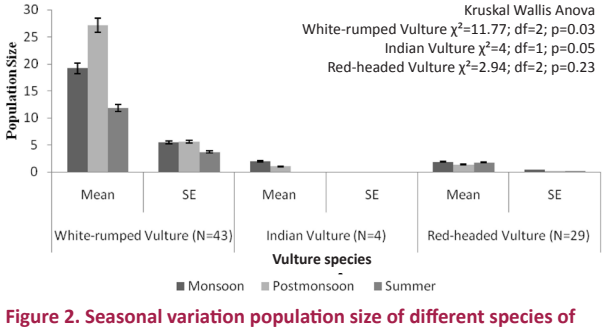

Figure 2. Seasonal variation population size of different species of vultures in Nilgiri North Forest Division

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

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

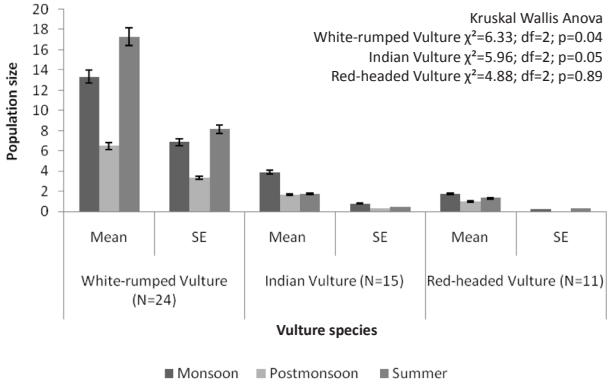

Figure 3. Seasonal variation population size of different species of vultures in Sathyamangalam Tiger Reserve

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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CONSERVATION STRATEGIES FOR SECURING CRITICALLY ENDANGERED WHITE-RUMPED (GYPS BENGALENSIS) AND LONG BILLED (GYPS INDICUS) VULTURE SPECIES IN THE TAMIL NADU PART OF THE NILGIRI BIOSPHERE RESERVE.

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ABSTRACT

Here we present the results of a study about the conservation strategies for securing critically endangered White-rumped (*Gyps bengalensis)* and Long billed (*Gyps indicus)* vulture species in the Tamil Nadu part of the Nilgiri Biosphere Reserve from 2015to 2016 (Two years).Nest site count was made for population estimation, breeding ecology was carried out by direct field observation, diclofenac and other threats were assessed by questionnaire survey and management recommendations were suggested from the findings of the project. This present study has identified a total of seven nesting and one roosting location used by two vulture species. Of which four of them were belonging to the White-rumped vulture and three of them were a Long-billed vulture. A total of nine villages is recorded in and around the nesting and roosting colonies of two vulture species. The mean kilometer distance between villages and White-rumped vulture nesting habitat was 2±0.44 and the Long-billed vultures' nesting habitat was 2.41±0.17. Thorn forest was effectively used by vultures (NNFD (n=1586; 16.18±2.53), STR (n=327; 8.38±1.26) and MTR (n=75; 4.41±2.27).

Among four White-rumped vulture nesting colonies, the Jagalikadavu nesting colony has recorded a maximum number of individuals (68; 79±3.19). Long-billed vulture population was high in Nilgiri Eastern Slopes nesting colony (4.06±0.30). A total of 52 White-rumped vulture nests were recorded in 38 nesting trees. Jagalikadu nesting colony has recorded 28 nests in 21 trees. Two tree species namely *Terminalia arjuna* (37 trees with 51 nests) and *Spondias mangifera* (one tree with one nest) were used for nest construction. A total of eight plant species materials were used by White-rumped vultures for nest construction. Of which *Chloroxylon swietenia* twigs were maximum used with the Mean±SE (30±3.06). Most of the nests were located towards the North East direction (n=21). This was mainly because of to get maximum sunlight in order to obtain thermal energy to fly.

Among the 52 White-rumped vulture nests, 40 nests were observed as active nests evidenced by frequent usage of a nesting pair. Out of 40 incubations, 24 hatchlings came out with the 58% of the breeding success of White-rumped vulture in all four nesting colonies altogether. On the other hand, 100% (n=2) fledge out was recorded from 2 incubations of a Long-billed vulture. This was an important outcome of the project to emphasize that the need for long-term monitoring of vultures in order to find out the reasons behind for 58% of the breeding success of White-rumped vultures.

Totally thirteen veterinary personnel were interviewed during this project period. Of which four of them were Veterinary Assistants (Quacks) and other were Veterinary Assistant Surgeons (Doctors). All of them were very well aware on the ban of the use of diclofenac in veterinary practice and its effects on vulture population as well. It was quite interesting to note that all of them use Melaxicum as a painkiller for veterinary practice. Another healthy trend is the Tamil Nadu Government is providing the Melaxicum to Government veterinary dispensaries. Our drug store survey result revealed that a total of ten diclofenac composition painkillers are being currently prescribed by the doctors for human use. An alarming message is that 30 ml vials are still available in the drug stores.

During our study, we have recorded a total of forty-two White-rumped vulture deaths between 2013 and 2016. Of which thirty-four individuals were adult and eight were immature. A post-mortem was conducted only for eight individuals. Other 32 individuals were seen with skeletal and feather remains unable to conduct a post-mortem. The autopsy laboratory result revealed that the tissues of the vultures were contaminated by ***Organo phosphorus and urea*** which is a poison used as an insecticide in agriculture practice and one was died due to its neck lock between the vertebral bones of the domestic buffalo carcass while it was feeding. One immature was fell down and eaten by wild boars. This present study has recorded none of the death was caused due to Diclofenac. Therefore this study strongly suggests that retaliatory killing is effectively influencing on vulture population than Diclofenac. This year plenty of livestock carcasses were available to vultures due to monsoon failure. Still, the breeding success was just 58%. Therefore this present study concluded that long-term monitoring to be initiated in order to implement and take forward many management recommendations which are prescribed from this project for the long run conservation of wild viable the country's southernmost vulture population.

Key words : Conservation strategies, White-rumped vulture, Long billed vulture, Tamil Nadu, Nilgiri Biosphere Reserve

Introduction

Scavengers play an important and critical role in the food chain without which the recycling or proper disposal, especially that of dead and decaying materials will be either stopped or delayed. The vultures are excellent scavengers on dead bodies and their status is critically tagged with the present situations (Mandel *et al.,* 2008). There are 22 species of vultures in the world which belong to two taxonomically distinct groups (Amadon, 1977; Sibely and Ahlquist, 1990). New World vultures are under the order Falconiformes of family Cathartidae and Old World vultures are Accipitridae family. Due to lot of variations in geographical and environmental gradient nine species are reported to be present in India namely White-rumped Vulture (*Gyps bengalensis*), Slender-billed Vulture (*Gyps tenuirostris*), Long-billed Vulture (*Gyps indicus*), Egyptian Vulture (*Neophron percnopterus*), Red-headed Vulture (*Sarcogyps calvus*), Indian Griffon (*Gyps fulvus*), Himalayan Griffon (*Gyps himalayensis*), Cinereous Vulture (*Aegypius monachus*) and Bearded Vulture or Lammergeier (*Gypaetus barbatus*) (Ali and Ripley, 1983). *Gyps* are a group of obligate scavengers that typically breed colonially or semi-colonially. *Gyps* vultures specialize in feeding the soft tissues that make up the bulk of animal carcasses and therefore comprise the majority of vultures numerically. Vultures are known to inhabit tall trees in forests, smaller trees in open areas, rocky cliffs, old monuments and countryside (Thompson *et al.*, 1990; Liberatori & Penteriani, 2001; Donazar *et al.*, 2002; Monadjem & Garcelon, 2005; Carrete *et al.*, 2006; Thakur & Narang, 2012; Harris, 2013; Ramakrishnan *et al.*, 2014).

Vulture population have declined in many parts of their former ranges owing to food shortages and loss of habitat (Pain *et al.*, 2003). However, since the early 1990s there has been a catastrophic decline in three *Gyps* species in the Indian subcontinent namely, White-rumped (*G.bengalensis*), Long-billed (*G.indicus*) and Slender-billed Vultures (*G. tenuirostris*) (Prakash 1999, Virani *et al.*, 2001, Prakash *et al.*, 2003).In response to these population crashes, all of these three were reclassified as 'Critically Endangered', placing them among the species most threatened with global extinction (BirdLife International 2001). Oaks *et al.* (2004) found that the Diclofenac, a widely used painkiller and anti-inflammatory drug administered to livestock and humans caused mortality in vultures in Pakistan. A postmortem examination of dead or dying birds from India and Nepal also showed the high incidences of Diclofenac residues and visceral gout (Shultz *et al.*, 2004). The results of these studies suggested that Diclofenac contamination was the major cause of vulture population crash across vulture range countries in Asia. However, other causes such as habitat destruction, food shortage, human persecution, poisoning and pesticide use have also caused a gradual decline in vulture population (BirdLife International 2001).

In southern India there are seven species of vultures recorded namely, White-rumped (*G. bengalensis*), Long-billed (*G. indicus*), Red-headed (*Sarcogyps calvus*), Egyptian (*Neophron percnopterus*), Himalayan Griffon (*G.himalayensis*), Eurasian Griffon (*Gyps fulvus*) and Cinereous vultures (*Aegypius monachus*) (Sashikumar, 2001; Davidar & Davidar, 2002; Thejaswi, 2004; Subramanya & Naveen, 2006; Davidar, 2007; Umapathy *et al.*, 2009; Ramakrishnan *et al.*, 2010, 2012 & 2014 ; Praveen *et al.*, 2014; Samson *et al.*, 2014a,b ; Venkitachalam & Senthilnathan, 2015; Venkitachalam & Senthilnathan, 2016; Samson *et al.*, 2015; Samson & Ramakrishnan, 2016a,b; Samson *et al.*, 2016a,b,c) were recorded.

The Tamil Nadu part of the Nilgiri Biosphere Reserve (5540 sq. km) reported 6 species of vultures. Of which 4 of them holds sizeable numbers except for Eurasian Griffon. They are mainly dependent on wild carcasses (90%) as their diet (Ramakrishnan *et al.*, 2010). This project's study area is part of the Nilgiris & Eastern Ghats Landscape which is considered to have the single largest Asian elephant population in the world. It also probably holds the largest tiger population in the country and their wild prey ensures continuous food availability to vultures. Among the lesser carnivores wild dog packs quickly consume their prey leaving behind skeleton remains. Leopards always prefer small or medium sized prey and usually hide the remains on the tree branches inaccessible to vultures. The tiger generally prefers large size prey and tend to consume their prey over a number of days which is accessible to vultures. The previous study by Davidar & Davidar (2002) reported that the given study area had a good number of vultures but had been lost mainly due to retaliatory killing of carnivores through poisoning of carcasses. This area is now harboring sizeable numbers of vulture populations and is considered to be the India's southernmost wild viable breeding population. Since captive breeding programmes have been undertaken in the northern Indian States, the conservation of this wild breeding vulture population is need of the hour. Due to lack of sustained studies there has been no science-based management in place to conserve this vulture population. Considering this lacunae this study was attempted in the Tamil Nadu part of the Nilgiri Biosphere Reserve to bring out feasible conservation perspectives of White-rumped and Long-billed Vultures between 2015 and 2016.

Study Area

The Nilgiri Biosphere Reserve (NBR) is the first and foremost biosphere reserves established in the year 1986 in India. The reserve is situated in the Western Ghats, in the Nilgiri Hills range of South India and is considered as an International Biosphere Reserve. It was declared under the Man and Biosphere Programme (MAB) of UNESCO and is also under consideration by the UNESCO World Heritage Committee for selection as one of the World Heritage Sites. The reserve encompasses 5,520 km² surrounded by Karnataka (1527.4 km²), Kerala (1455.4 km²), and Tamil Nadu (2537.6 km²) states. The Biosphere lies between 11o 36' to 12o 00' N Latitude and 76o 00' to 77o 15' E Longitude. Central location: 11°30'00 N, 76°37'30 E. The NBR has protected areas namely, Mudumalai Tiger Reserve (321.1 km²), Sathyamangalam Tiger Reserve (745.9km²) Wayanad Wildlife Sanctuary(344km²), Bandipur Tiger Reserve (874km²), Nagarhole Tiger Reserve (643 km²), Nugu Wildlife Sanctuary, Mukurthi National Park (78 km²) and Silent Valley National Park (89.52km²). This reserve also includes Nilgiris North Division (448.3 km²) and Nilgiris District, South Division (198.8 km²) and Coimbatore Division (696.2 km²) in

Tamil Nadu (Map1). The reserve extends from the tropical moist forests of the windward western slopes of the Ghats to the tropical dry forests on the leeward east slopes. Rainfall ranges from 500 mm to 7000 mm per year. The reserve encompasses three eco-regions, the South Western Ghats moist deciduous forests, South Western Ghats montane rain forests, and South Deccan Plateau dry deciduous forests. The Nilgiri Biosphere Reserve is very rich in plant diversity. About 3,300 species of flowering plants of which 1232 are endemic to the Nilgiri Biosphere Reserve. The fauna of the Nilgiri Biosphere Reserve includes over 100 species of mammals, 350 species of birds, 80 species of reptiles and amphibians, 300 species of butterflies and innumerable invertebrates. Of the vertebrate species recorded, 39 species of fish, 31 amphibians and 60 species of reptiles are endemic to the Western Ghats also occur in the Nilgiri Biosphere Reserve. NBR is one of the critical catchment areas of peninsular India. Many of the major tributaries of the river Cauvery like the Bhavani, Moyar, Kabini and Chaliyar, Punampuzha, etc., have their source and catchment areas within the reserve boundary. The forests of NBR are spread over a vast area and cover various ecotypes. The overall classification of the different forest types are as follows: Evergreen,Semi-Evergreen, Moist Deciduous, Southern Montane Wet Temperate, Dry Deciduous, Dry Scrub Woodland, Grasslands and Evergreen Forest. The present study was attempted in Mudumalai Tiger Reserve, Nilgiri North Forest Division and Sathyamangalam Tiger Reserve in the Tami Nadu part of the Nilgri Biosphere Reserve.

Materials & Methods

Population Estimation

Nest and Roost Site Count

At the initial stage of the project a questionnaire was circulated among the local people and various forest field staff in order to locate roosting and nesting colonies of White-rumped and Long-billed Vultures. Once roosting and nesting locations were confirmed we monitored the colonies with vulture counts twice in a month. The rivers and nullahs (streams) were also surveyed since White-rumped Vultures preferred to roost and nest in tall trees nearby. The population size of vulture species was estimated in the roosting sites and nesting colonies in the morning (0630 to 0930 hrs.) and late evening (1730 to 1930 hrs.) by foot surveys as described by Baral (2005). We assumed fidelity of nesting colonies, fixed time of roosting and geographic closure, no movement into (immigration) or out of (emigration) colonies to estimate population size and the vulture mortality rate. The nesting and roosting colonies were thoroughly searched for dead vultures to estimate mortality rate.

Breeding Ecology of Two Vulture Species

To study the nesting and breeding ecology of two vulture species namely, White-rumped Vulture and Long-billed Vulture, on average each nesting colony was visited 4 times in a month during breeding season (September to May) to check the status and number of vultures present in each colony. All observations were with binoculars (Nikon 52×10) from an appropriate distance (100-300m) in nesting colonies. Focal animal sampling method was used to monitor the status and behavior of breeding population of the two vulture species in nesting colonies (Postupalsky, 1974; Acharya *et al.*, 2009; Awan *et al.*, 2017). During the visits, five to ten minutes were spent to observe the breeding status of each nest in the colonies. All observations were made from 0700 hrs to 1200 hrs. Nests were identified by the presence of the fresh nesting material and whitewash (excreta) below the nest or by the presence of the incubating vulture in the nest. All the nests were identified and nesting trees were tagged and monitoring for future work (Postupalsky, 1974). Nest exposure on the nesting trees as well as rocks was determined by compass. Nest location on trees were determined by visual estimation viz., top of the crown and limb (offshoot growing directly out of a tree trunk). Confirmation of active (occupied) and abandoned (unoccupied) nests was based on the criteria laid down by Postupalsky (1974). An active breeding pair was defined as one that laid an egg, and non-breeding pair was one that occupied the nest at least for three weeks but did not lay an egg. Breeding success was calculated based on the number of fledglings divided by the number of breeding pairs. On each visit a nest was considered occupied by a pair when two adult vultures were observed at the nest, one standing and one incubating or one incubating adult was present or one adult with chick or a young chick alone was present in the nest. Information on mortality, especially of adult mortality was recorded at nesting colonies (Baral *et al.,* 2005; Steenhof & Newton, 2007). A colony was considered as active, if it was occupied by at least one active egg (Xirouchakis and Mylonas, 2005).

People's perception on vulture conservation and assessment of diclofenac usages and others threats

People's attitude towards the vulture conservation was assessed through a questionnaire survey. The questionnaire detailed (i) general background of the respondents (ii) livestock holding pattern and, (iii) local knowledge and perception of vulture conservation. Most questions were close-ended, although some open-ended contingency questions were included. The variables such as livestock population, medication of livestock, the extent of use of Diclofenac, methods of carcasses disposal, compensation/ ex gratia details and wild animals' depredation on livestock, etc (Subadi, 2005; Baral & Gautam, 2007) were collected in the villages that were located in the vicinity of vulture habitats. Diclofenac prevalence survey and its usages were determined again by questionnaire surveys with veterinary doctors and quacks including drugs stores adjoining vulture habitats to document various veterinary practices for treating livestock in villages fringing vulture habitats. Other threats were quantified by direct field observation during the field trips.

RESULT

Based on the questionnaire and foot surveys White-rumped and Long-billed Vultures nesting and roosting locations were identified, confirmed in MTR, NNFD, and STR. A total of 7 nesting and 1 roosting location were recorded in the NNFD of which 4 of them belonged to the White-rumped Vulture and 3 of them to Long-billed Vulture. White-rumped Vultures preferred to construct their nests on trees along the

riparian forest whereas the Long-billed Vultures construct their nests on cliffs of the slopes and gorges. A total of 8 villages were recorded in and around the nesting and roosting colonies of two vulture species altogether. Of which Siriyur tribal settlement is located nearest to White-rumped Vulture nesting colony (0.29km). On the other hand, the Ebbanad revenue village is located nearest to Long-billed Vulture nesting colony (2.24km). The mean distances of villages located from White-rumped Vulture nesting habitat was 2±0.44 and the Long-billed Vulture nesting habitat was 2.41±0.17. (Table 1 & Map 5).

A total of 1963 individuals were recorded in 126 sightings comprising of 4 vulture species. White-rumped Vultures was recorded in higher numbers (n=1814 (23.87 ± 3.23)) followed by a Long-billed Vulture (n=83 (2.86±0.33)), Red-headed Vulture (n=60 (3.35±0.38)) and Egyptian Vulture. (n=6 (2.00±0.58)) in the Nilgiri North Forest Division followed by A total of 120 individuals of vultures were recorded in MTR with 41 sightings comprising 4 vulture species. Of which, White-rumped Vulture was recorded in highest numbers (n=98) followed by a Red-headed Vulture (n=14), Egyptian Vulture (n=6) and Long-billed Vulture (n=2) in Mudumalai Tiger Reserve and in STR, a total of 436 individuals were recorded in 69 repeated sightings. White-rumped Vulture was recorded in highest numbers (n=728; 9.97±1.29) followed by a Long-billed Vulture (n=68; 1.86±0.13) Red-headed Vulture (n=40; 1.85±0.23) and Egyptian Vulture (n=4; 1.5±0.5).

The occurrence of vultures with respect to different vegetation types in NNFD shows that more sightings were recorded in Thorn Forest (n=1586; 16.18±2.53) and sizable numbers were also sighted in Mixed Deciduous forest (Foothill forest) (n=377 13.46±3.97) followed by in MTR showed that more sightings were recorded in Thorn Forest (n=75 4.41±2.27) followed by Dry Deciduous Forest (n=21 1.5±0.20), Moist Deciduous Forest (n=12 3±1.08) and Riparian Forest (n=12 2±0.82) and in STR showed that more sightings were recorded in Scrub and Thorn Forest (n=327; 8.38±1.26) followed by Scrub and Mixed Deciduous Forest (n=75; 5±1.79), Dry Mixed Deciduous Forest (n=16; 2.66±0.33), Deciduous Forest (n=11; 1.57±0.20) and Moist Deciduous Forest (n=7; 3.5±0.5).

The population status of White-rumped Vultures at 4 nesting colonies the Jagalikadavu nesting colony recorded a maximum number of individuals (68.79±3.19) as well as adults (47.95±2.71) and immatures (20.79±0.74) followed by Anaikatty Nesting Colony (47.88±1.64), Ebbanad (30.7±0.63) and Siriyur nesting colonies (3.12±0.58) (Table 8). Long-billed Vulture population was high in Nilgiri Eastern Slopes nesting colony with the maximum number of population (4.06±0.30) as well as adults (3.12±0.20) and immature (1.15±0.10) followed by Moyar valley roosting colony (1.93±0.19) and Ebbanad nesting colony (1.88±0.11) (Table 8).

A total of 38 nesting trees comprising 52 nests of White-rumped vulture was recorded in 4 nesting colonies in the study area. A number of nests (n=28), as well as nesting trees (n=21), were recorded in the Jagalikadavu nesting colony followed by Anaikatty nesting Colony (13 nests in 9 nesting trees), Ebbanad nesting colony (8 nests in 6 nesting trees) and Siriyur nesting Colony (3 nests in 2 nesting trees). There were only 2 tree species preferred by the White-rumped Vultures to construct their nests in all four nesting colonies altogether. Of which *Terminalia arjuna* (37 trees with 51 nests) was highly preferred tree species. One nest in one tree *Spondias mangifera* which recorded

The results of the nest position revealed that about 60% of the nests (n=31) were placed on the top (crown) of the nesting trees. On the other hand, 40% of the (n=21) nests were located at the limb of the nesting trees. Most of the nests were located towards the North East direction (n=21) followed by South West (n=14), South East (n=13) and North West (n=4)

Among the 52 nests, 40 nests were observed as active nests evidenced by frequent activities of a nesting pair. The Jagalikadavu nesting colony had recorded the maximum number of active nests (n=23) as well as abandoned nests (n=5) followed by Anaikatty nesting colony (9 active nests and 4 abandoned nests), Ebbanad nesting colony (6 active nests and 2 abandoned nests) and Siriyur nesting colony (2 active nests and 1 abandoned nest)The breeding success was calculated from a total number of fledglings divided by a total number of nests seen in incubation for each nesting colony. Overall 58% of breeding success was recorded in all four White-rumped Vulture nesting colonies altogether. Among the 4 nesting colonies, Siriyur nesting colony found 100% of breeding success, followed by Ebbanad nesting Colony (67%) and Jagalikadavu nesting Colony (61%). Least breeding success was observed in Anaikatty nesting colony (33%) 2 nesting colonies of Long-billed Vultures were recorded on rocky slopes in the study area. Totally 4 nests were recorded. 3 were active nests concluded by frequent activities of the nesting pairs. Nilgiri Eastern Slopes nesting colony recorded the maximum number of active nests (n=2) as well as an abandoned nest (n=1). The Ebbanad Valley has recorded just 1 active nest. 67% breeding success was recorded in two Long-billed Vulture nesting colonies altogether. Among the two nesting colonies, Nilgiri Eastern Slopes nesting colony observed 100% of breeding success

A total of 13 veterinary personnel were interviewed of which 9 Veterinary Assistants Surgeons (doctors) and 4 were Veterinary Assistants (quacks). All were aware of the ban on the use of Diclofenac in veterinary practice and its effects on vulture population as well. They were using Melaxicam as a painkiller for veterinary practice. It is interesting to note the Tamil Nadu Government provided meloxicam to Government Veterinary hospitals for livestock practices. The veterinary persons also opined that an average of 31 cases was attended by them per month of which most of the cases were attributed to sickness (n=20) and carnivore attacks (n=11). The drug store survey results revealed that a total of 10 Diclofenac composition painkillers were currently prescribed by the doctors. As per Government's Gazette Notification dated 17th July 2015 (attached) doctors can prescribe only 3 ml and 1 ml vials for human uses. It's interesting to note that 30 ml vials are still available in the drug stores. A total of 42 White-rumped Vultures died between 2013 and 2016. 34 individuals were adults and 8 were juveniles. Post-mortem could only be conducted on 8 individuals and the results revealed that

their tissues were contaminated by ***Organophosphorus and urea.*** The former is a poison used as an insecticide in agriculture practice. 1 vulture died while feeding when its neck got stuck between the vertebral bones of a domestic buffalo carcass. Skeletal and feather remains from 32 individuals was insufficient for mortem analysis (Table 21). 1 immature fell from its nest and was eaten by wild boars.

DISCUSSION

Among the vulture species, the decline of *Gyps* vulture population was alarming in the Indian subcontinent with high mortality rate and breeding failure (Prakash, 2001). It is likely to lead to their extinction if the problems are not urgently addressed (Birdlife international, 2001). Hence, this population study was taken up in the Tamil Nadu part of the Nilgiri Biosphere Reserve (NBR) in order to protect the country's southernmost viable wild population. This project focused on two critically threatened vulture species namely, White-rumped (*G. benghalensis*) and Long-billed Vulture (*G. indicus*) to determine population status, nesting ecology, threats from Diclofenac and other NSAIDs, etc. This study recorded totally 7 nesting colonies: 4 colonies of White-rumped Vultures and the remaining 3 of Long-billed Vultures. We found the White-rumped Vulture nesting colonies located at an average distance of 2 kms from human habitation while it was 2.28 kms in the case of Long-billed Vulture. Previous literature were also supported that the location of breeding Colonies near to human habitation in Nepal and Gujarat (Baral *et al.*, 2005; Baral and Gautam, 2007; Dave, 2011; Harris, 2013). The distribution of vultures in the study area showed remarkable variation according to vegetation and habitat types with most sightings and nesting colonies in Thorn Forest areas mainly because of its open vegetation structure. Thus vegetation structure played a vital role on the vulture's ability to find out animal carcasses with their acute eyesight. Brown (1985) established two hypotheses concerning vegetation structure and carcass finding by vulture species in South-West Africa, Namibia. In his first hypothesis, he had quoted that the increased vegetation density caused by bush encroachment decreases the likelihood of vultures locating a carcass, as they rely almost entirely on eyesight when foraging. In the second hypothesis, vultures, which are heavy birds adapted for soaring and unsuited for flapping flight in confined spaces, will not land at carcasses they have located if they do not have sufficient space in which to take off again. This hypothesis was supported by Schultz (2007), who showed that Cape Vultures (*Gyps coprotheres*) in the Waterberg region of Namibia were unable to locate carcasses when the vegetation density was greater than 2,600 trees per ha. Land-use patterns influence raptor diversity and density (Herremans & Herremans-Tonnoeyr 2000).

Although this project focused on White-rumped Vulture and Long-billed Vulture, information on Red-headed vultures (*Sarcogyps calvus)* was also collected. We recorded a total of 60, 40 and 14 individuals of Red-headed Vultures in NNFD, STR, and MTR respectively. Earlier literature revealed that Red-headed vultures are fresh carcass feeders in nature and will track the predator's presence for their food (Naoroji, 2006; Chhangani, 2007). This is substantiated by the evidence of 6 Red-headed Vultures recorded in 8 incidences where the movement of tigers was high in our study areas (Ramakrishanan *et al.*, 2012; Samson *et al.*, 2016b). This study observed a fluctuation in White-rumped Vulture numbers ranging between 33 and 82 in Jagalikadavu, 1 and 16 in Siriyur and 29 and 54 in Anaikatty and 29 and 34 at Ebbanad nesting colonies. A similar trend was also noticed for Long-billed Vulture population 1 and 3 in Ebbanad, 1 and 3 in Moyar Falls, and 2 and 6 in NES range during our field work from June 2015 to May 2016. In the month of June, the vulture populations were less in the nesting colonies and gradually increased and reached its maximum numbers at the end of the breeding season in May. A similar pattern was also noted by Baral *et al.* (2005) for White-rumped Vulture population in Nepal and in Rajasthan by Chhangani and Mohnot (2004). During non-breeding seasons the adults flew far away from the nesting colonies in search of food, and sometimes away for as much as 2 days to acquire food. With food availability close to their nests it enabled them to spend longer time in parental care and feeding their young in the breeding season. Therefore, maximum number of vultures was seen in and around nesting colonies mainly during breeding months. This study observed breeding season was from September to May and non-breeding season from June to August in NBR. In all 4 nesting colonies, the White-rumped Vulture preferred to construct their nests on *Terminalia arjuna* trees. This could be due to tree height and basal girth, which kept away people and other wild animals, especially elephants (Road, 2010). The *Terminalia arjuna* is the only tallest tree species seen abundantly along the riparian forests of Southern India. We observed that the White-rumped Vultures usually preferred the same tree for nesting and roosting in the study area. Our observation is also in accordance with Baral *et al.*, (2005), as single tree preference (Kapok tree) by White-rumped Vultures in Nepal. The total white-rumped vulture population at four nesting colonies altogether ranging between 92-186 individuals in 52 constructed nests and 23 occupied nests with 58% breeding success. The previous studies in Rampur Valley showed that there were 72–102 individuals of White-rumped Vultures in six nesting colonies during their breeding season, with 50% breeding success at 70 occupied nests (Baral *et al.*, 2005). In Pakistan, a total of 2281 occupied nests were recorded between 2000 and 2004 and the nest success was observed in 1231 nests with the breeding success of 51% (Gilbert *et al.* 2006). In Africa, it was estimated that 48% of breeding success in White-backed vultures (*Gyps africanus*) (Martinez *et al.*, 1997). Among earlier studies in Asia as well as Africa this study has recorded highest percentage of breeding success despite the various disturbances cited in the preceding section makes for a strong argument of the viability of this wild population. In this study we also observed a total of 56% (n=29) of nest abandoned White-rumped Vulture species during the breeding season from October to December 2015. Newton (1979 & 2002) stated that certain pairs may occupy a territory for only a few days or a few weeks, or may even build a nest, but the process stops here. Not all raptor pairs occupying nesting territories lay eggs every year. A major factor influencing egg laying is food supply and in poor food years, territorial pairs in

some populations fail to lay eggs. On the other hand, nest abundance was seen due to mortality of chicks and nesting pair (Baral *et al.* 2005) and anthropological threats in the nesting areas would also cause the nest abundance criteria (Moran Lopez *et al.* 2006). We observed troops of Hanuman langur (*Presbytis johinii*) and Bonnet macaque (*Macaca radiate*) near nesting trees and this may cause disturbance to a breeding population of white-rumped vulture in nesting colonies. Their play antics of jumping and shaking the branches of nesting trees could make the nesting adults to abandon their nest (n=14). The literature review supported that the langurs were causing a disturbance in the nesting of vultures in Nepal (Subadi 2007), and also in Africa monkeys and baboons have been reported to interfere in the normal breeding of African vultures (Mundy *et al.* 1992; Emmett 2003; Roche 2000 & 2006). This study found that most of the livestock holders were illiterate and depended on livestock as their major livelihood. Awareness about the Diclofenac and its effects on vulture populations was very poor. On the other hand knowledge on vulture's importance and their role in the ecosystem was well known by the livestock holders. The livestock holders opined that the vulture population is declining in their area. Generally, the livestock holders treat their injured livestock by traditional methods and sometimes they bring veterinary doctors or quacks only for extreme cases. The questionnaire survey from the veterinary doctors revealed that they use Melaxicum as a painkiller (a safe drug for vultures). It was gleaned from the vulture mortality records also. So far none of the vulture deaths were scientifically or clinically proved to be caused by Diclofenac, and instead attributed to poisoning of the carcass (Laboratory Report is enclosed as Annexure-I). Hence this study strongly suggests that education is needed for the livestock holders to change their attitude towards retaliatory killing.

A similar effort has to be made to the forest department also in order to ensure adequate and quick payment of compensation/exgratia to the livestock holders to stop the further poisoning of the carcass, which is considered as a severe threat to this vulture population rather than Diclofenac. Davidar (2002) reported that the retaliatory killing activity of livestock holders was the reason for declining of Tiger and vultures in the Sigur Plateau followed by Ramakrishnan *et al* (2010) stated that the Diclofenac is not a culprit for declining vulture population in this region as the vultures feeding on wild carcasses (including tiger killed livestock) as their major diet. Arumugam & Arivazhagan has recorded dead Hyena (1) and White-rumped vultures (1) and Jungle Crow (1) in Mudumalai Wildlife Sanctuary (MTR interpretation center). Three Wild dogs deaths due to ***Organophosphorus and Urea*** also had been recorded in Mudumalai Tiger Reserve (Vijayaragavan Pers. Comm.). The reason for this issue is mainly because of increasing tiger population in a contiguous stretch of Tiger Reserves on both ends of the Sigur Plateau. As of now even though negative effects of Diclofenac was not recorded scientifically in this vulture population, multiple awareness programmes are needed for the proper disposal of contaminated carcasses and Diclofenac use in veterinary practice. Green *et al* (2004) stated that based on demographic modeling, it has been found that less than 1% of lethal level of Diclofenac can cause a rapid population decline to vulture. Therefore, educating livestock holders, farmers and veterinary personnel may help to secure healthy food for vultures.This presence of Organo-Phosphorus and Urea of White-rumped vultures envisages that long-term monitoring is needed by establishing a laboratory for the analysis of various poisonous chemicals as well as NSAIDSs (Diclofenac) from the tissues of dead vultures. The toxicology analysis by Oaks *et al.*, (2004) on many dead vulture tissues in Pakistan found the presence of Organochlorides, Organophosphate, Carbamates and heavy metals.

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STATUS OF VULTURES IN BANDIPUR TIGER RESERVE

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ABSTRACT

Gyps vulture populations are declining rapidly due to the non-steroidal anti-inflammatory drug (NSAID) diclofenac across the Indian subcontinent. Secured breeding areas for vultures in the present context are Wildlife sanctuaries, National parks, Tiger and Elephant (Elephas maximus)reserves with statutory binding and rigorous protection under the wildlife act of 1972. Looking into the broader spectrum of protection, conservation and efficacies of species survival declared protected areas in India act as the only hope for the endangered species of vultures. The decline of vulture population was quite sudden, 97 per cent of vultures have disappeared from India's skies in the past 15 years. Hence the fly ways and flight records of vultures are also outside the protected areas it appears keeping vigil of breeding, foraging and feeding areas within the protected areas that gives protection of its survival. We regularly surveyed for vultures using **AREA SEARCH METHOD** from 2003 to 2016. We looked into earlier data of our bird surveys conducted in 2002-2003. Where 17 sites were surveyed for one year in four phases in BNP and at 12 sites *Gyps* vulture species were recorded. On wards a continuous area search on regular interval, to record vulture sightings and its breeding sites in BNP was done, this report is a compilation of all the sightings including breeding sites. In 2003 around 125 birds *INCERT pub 2005* were counted, in 2007 only7 birds, in 2008(*2) 60 birds, in 2010*(pub KFD report*²)* around 479 birds were recorded. In 2013 a total of 311 birds were reported *"Ecological study in Bandipur Tiger Reserve" pub report ksfmbc-jica project.* During 2012, 169 birds and 2016, 251 birds were counted.

Byladakuppe in Moliyur range of BTR had a breeding cliff that was disturbed because of a road and fire watch tower built by the forest department. Before 1996 breeding record was mentioned by forest department staff and by my personal observation during "*Status study of Indian Black woodpecker in Western Ghats 1996*¹*. Rampura bordering waynaad wildlife sanctuary had 3 breeding trees and Banoor had 2 breeding trees that are still habited by vultures

Kabini River and Nugu River back waters where Elephant *(Elephas maximus)* congregation generally happens during peak summer makes a good feeding site at Kabini River and Nugu River back waters and Elephant (Elephas maximus) deaths occurs due to natural reasons, live stock death also occurs along border villages make another good feeding sites. Compilation of data from 2003 to 2016 will encourage management strategies in the conservation of vultures and to monitor their habitat in the park, and also for future evaluation on conservation of avi-fauna in Bandipur Tiger Reserve (BTR). We looked into the availability of Diclofinac in Gundlupet town, Chamarajanagar district, H.D.Kote and also with veterinary attendees in villages surrounding Bandipur Tiger Reserve and found it was very easily available. Save vulture pamphlets in local language were given in schools and colleges in the surrounding villages of BTR. A bike rally was conducted with the help of Arulagam in Gundlupet that was supported by Karnataka Forest Department BTR.

Key Words: Vulture, Bandipur Tiger Reserve, Karnataka

Preface

Birds as Bio indicators and vultures as the primary indices were the theme in this study. During the bird survey conducted in BNP in 2002-2003. Totally 17 sites were surveyed in BNP and at 12 sites gyps vulture species were recorded. This report is a compilation of all the sightings. The future work on birds will orient vulture species diverse adaption in BTR (BNP). The authenticated data on birds compiled during 2003 by the ornithologists and amateurs puts a clear picture of bird research is the last in line of inquire to understand the correlation of avifauna in our protected areas. But this compilation of random data from 2007-2016will encourage management strategies in the conservation of bird life and to monitor their habitat in the park, and also for future evaluation on conservation of avi-fauna in Bandipur Tiger Reserve.

Introduction

Looking at the broader spectrum of conservation and management of National parks, wildlife sanctuaries and Indian wildlife in general, birds are among the least considered. Today 13% of world birds have been recorded in India including 141 endemic to the country, the richness in species contributed by varied climate, geographical position coupled with rich vegetation and the overlap of three bio-geographical areas, Viz. Palaearctic, Indo-malayan and Afro-tropical. Identifying, cataloguing and compiling of bird data is in practice since the British days, which has helped in prompt management of sites required for wildlife and natural history. Birds as bio-indicators subsequently have proven in identifying the rich bio-diversity of particular site, as primary indicators, they have even proved the degradation by their disappearance. Bandipur Tiger Reserve being situated en-route to Mysore-Ooty Road was declared a National Park and brought under Project Tiger in 1973. The park is one of the richest wildlife areas in India, and lies on the northern most part of the Nilgiri biosphere reserve which is considered a major hotspot in the Western Ghats and Western Ghats is one of the 25 bio hotspots of the world. Bandipur Tiger Reserve is flanked by Rajeev Gandhi National Park (Nagarahole Tiger Reserve) to Northwest, Mudumalai Tiger reserve and National park to the South and Waynad Wildlife Sanctuary to Southwest and is quite famous for its big Mammal's assemblage and unique diversity.

Location of Bandipur Tiger Reserve

11° 35° 34° N, 76° 12° 17° E, 11° 57° 02° N, 76° 51° 32° E. **Total Area**: 1020 Sq. Kms National Park, 882 Sq Kms Tiger Reserve. **Total Ranges**: 13.

Vegetation

Five different vegetation types which are primarily found in Bandipur Tiger Reserve (BNP), looking into the importance of vulture sightings and breeding locations this report was generated.

The southern tropical moist deciduous type

The west parts of Begur, Ainur marigudi and Beerambadi constitute the typical moist deciduous type covering Bambusa arundinacea and species of top canopy are Tectona grandis, *Lagerstroemia lanceolata, Terminalia tomentosa, Terminalia balerica, Dalbergia latifolia, Angiesus latifolia, Stereospermum xylocarpum, Ficus infectoria and ficus sps.*The lower canopy consists of *Emblica officianalis, Mallotus philippinensis, Zyzyphus xylocarpus, vagueria spinosa, Grewia tiliaefolia, Gmelina arborea, Bridelia fetusa, Bauhinia racemosa, cassia fistula,.etc.* The under growth consists mainly of *Kydia calycina ,Solanum ferox and Solanum indicum,Helicteris isora, Hemidesmus indicus, Holarhena antidysenterica, Lantanacamara,Eupatorium,* etc.

Diverse habitat spread over 3 south Indian states and Nilgiri Biosphere Reserve. Congregation of elephants in Kabini and Nugu river backwaters. Tiger, leopard and other carnivore and relative Herbivore population is an excellent assemblage for Gyps vultures' survival in Bandipur.

The Southern tropical dry deciduous type:

The central area covers the above type with poor growth of vegetation and open canopy predominantly *Anogeissus latifolia, Tectona grandis, Terminalia tomentosa,T Belerica, T Chebula T paniculata, Pterocarpus marsupium,Dalbergia latifolia, Santalum album,Kydia calycina, Bridelia fetusa, Shorea talura, Cassia fistula.*

The under growth covered mostly with grasses and Lantana bushes breaking with eupatorium, Phoenix humilis has come up in-between this.

1.Scrub Jungle : Mainly confined to eastern most part of Moyar with poor rainfall, stunted tree growth, rising on shallow hard soil with almost no humus and open canopy, usually the vegetation comprises of *Terminala chebula, Shoria talura, Santalum album, Anogeissus latifolia, Azadirachta Indica, Acacia leucophloea, Acacea catechu, Zizyphus sps*, Desmodium which usually form the undergrowth. *Acacia intsia* is the common climber, grass is generally abundant.

2. Riverine: Nuguriver or Moolehole as it is called when running inside the park area and Kabini river back waters are the two major Riverine area considered for the bird survey.

3. Grassy hills: Gopalaswamy hills were selected for the survey as one of the important grass hills present covering Shola type of forest within the hill range.

Climate

November to mid February the cold season vale the forest and trees look leafless, the hot season continues from mid February to mid June. Wet season starts with monsoon showers from June to September. The hottest days experienced during March and April, and the coldest being February.

Temperature:

A moderate mean annual temperature of the park being 24$_{o}$C with maximum 30°C andMinimum of 18$_{o}$C. Fog usually during winter and rainy season experienced at Gopalswamy hills, Bandipur and Moolehole areas.

Rain fall:

The southwest mansoon effects from mid June upto September with an average rainfall of 1270mm – Kalkere, Ainoormarigudi and Bandipur sharing evenly. The western parts bordering Kerala receive the highest rainfall and the lowest being Moyar.

Altitude:

The highest peak in Bandipur range being Gopalswamy hills ranging 1454 Mtrs. The lowest altitude is along Varanchi stream, and Bandipur stands at 995.8 mtrs.

Water sources:

Numerous artificial ponds pocket the Tiger Reserve (BNP) with perennial rivers like Nugu River (Moolehole) and its tributaries Hebballa, Varanchi and Chippanahalla flowing northwards join hands. The Kabini river backwaters and its tributaries like Kannegala hole And Paladakadu in the Northwest part of the park constitute major water bodies.

Previous studies on Avifauna:

- The rich bird life of Bandipur Tiger Reserve had attracted Dr.Salim Ali during 1939, around 134 species was recorded from 15$_{th}$ to 26$_{th}$ November 1939.
- In the Management plan prepared by the Karnataka Forest Department recorded 179 bird species in Bandipur Tiger Reserve during 1974.
- The Wildlife department Kabini river lodge- Karapur, Mysore Dist. has recorded 274 species.
- Krupakar & Senani recorded 225 species during 1977.
- Dr.Ameen Ahmed and K.Yekantappa,IFS. Recorded 104 species as part of their survey on birds in Bandipur Tiger Reserve during 1998 and compiled list of all these was prepared.

Bird survey 2002 – 2003 Pre-monsoon or 1st phase of the Bird survey was conducted during 18th April to 21st, 4 bird surveys were conducted during a period of 1 year to consolidate data for analysis and comparison.

Methodology

- **Area search method** was used during all the vulture surveys in Bandipur Tiger Reserve.
- 2 times in a year a random survey was conducted to find gyps vulture status in Bandipur Tiger Reserve.

- Total number of birds, place and species were noted on a standard data sheet
- Field notes were made about activities like feeding, roosting, courtship, territorial display and breeding etc
- Sites were covered by walking in a slow pace. Vehicle was used on road, Boat was used to cover Riverine site.

Current knowledge

- The current knowledge of birds available on Bandipur Tiger Reserve and on vultures was more of a checklist, which was taken as the base for this survey.
- Egyptian vulture (*Neophron percnopterus*) 2 birds were recorded in BNP tourism area, 1 bird in 2003 near Chigare kadu Anti poaching camp in Moyar. 1 bird in Mangala village in 2008, 2 birds from Mangala village in 2010 and 2 birds near Melukamanahalli in 2011,
- Bird survey conducted in BNP during 2002-03 for 4 different seasons
- Compilation of personal observations and earlier records
- Status survey of distribution of Indian white bellied wood pecker (*Driocopus javenses*) in 1996-98. Records of vulture sightings and breeding sites are included.

Gyps vulture sightings recorded in BNP.

Years	RHV	LBV	WRV	EV	Total
2003	2	2	120	1	125
2007			7		7
2008	2	12	45	1	60
2009	4	15	135	2	156
2010	4	125	350		479
2011	1	6	122	2	131
2012	40	52	76	1	169
2013	50	44	215	2	311
2014	65	112	120	1	298
2015	15	58	7	2	82
2016	102	12	135	2	251

- Red headed vulture (*Sarcogyps calvus*) is a resident bird of BNP, with protection status from wildlife act of 1972 it is declared a Schedule I bird
- During 1996 this data is derived from the survey we did while working on Status survey of White bellied wood pecker (*Driocopus javensis*) no breeding record
- 2002-2003 bird survey recorded - 2 birds, 2008 – 2 birds, 2009 - 4 birds and 4and 1 in 2010 and 2011 respectively
- Long billed vulture (Gyps indicus) 1996 - 25 birds recorded from different areas during our survey on White bellied wood pecker (*Dricopus javensis*). 2 nos in 2003, during bird survey of Bandipur. 2008 – 2 birds, 2009 15 birds in Rampura area, 2010 again in Rampura, in 2011 – 6 birds from BNP tourism area
- Indian white backed vulture (*Gyps bengalensis*) being a resident and breeding bird of BNP, 132 birds were area, 2007 – 7 birds, 2009 - 350 birds, from Gundre - Banur area feeding on young Elephant (*Elephas maximus*) calf, 122 birds again from Kabini river back waters
- Birds of Bandipur 2008-09. “Estimation of population density of birds using food guilds” records of gyps vulture sightings and breeding sites which is the entrance gate to BTR (BNP). Several other records from outside the park boundary were noted but not included in this. Long billed vulture (Gyps indicus) is a resident bird in BNP and breeding records are quite rare, except for a few places from BNP. In 1996 found breeding in Rampura near Moolehole. Sharing trees with white backed vulture. 2002 and 03 bird survey conducted in BNP revealed breeding records from Rampura in Molehole range and Banur from Gundre range in BNP. 2008, 2009 2010 and 2011 breeding records from Rampura and Banur. This states that byladakuppe breeding site has been abandoned, but a long gap from 1996, 2003, it seems work was supposed to be done in this area for clear findings.
- Indian white backed vulture (*Gyps bengalensis*) is aresident and breeding in BNP. During 1996 breeding recorded in Byladakuppe* cliffs in Hediyala rangein BNP. Group of 40 birds were sighted. 2002-03bird survey in BNP revealed breeding groups from Rampura Moolehole range, Banur in Gundre range. 2008,2009,2010,2011 breeding records from Rampura and Banur in Gundre range in BNP. Regularly sighted by amateurs and once near BNP reception devouring Bonnet macaque (*Macaca radiata*) infant which had died. The bird was found pulling the dead animal towards lantana bush away from disturbance

Selecting isolated group of trees with high canopy provides security and also a vantage for look out. It also evades competition from other birds of prey.

Nesting birds are very silent and adults fly away when approached, perched nearby they keep vigil of the nest from faraway tree. Both *Gyps bengalensis* and *indicus* nest together in a single tree with different nests keeping social distance.

Elephant *(Elephas maximus)* deaths due to electrocution:

Elephant (Elephas maximus) deaths due to electrocution happens close to the forest, instead of burning the carcass the same can be lifted using cranes to shift it inside the forest after post-mortem. Natural deaths of calf or even adult should be left alone for scavengers like vultures and other mammals.

Appendices:

6. List of Globally Threatened Birds:

Birds under this category are those included in Threatened Birds of India – B N H S, Envis. IUCN threatened taxa.

Major threats:

- People in India traditionally have been conserving Birds and Wildlife with religious thinking that forbid them from killing animals, birds and destroying forest, which had socio-religious values.
- The development activities curbing the near need for modernity, over population, conversion of forested land to arable land and commendable change in the rural and urban life style are a few threat to bird life in India
- Fuel wood, collection of timber, cattle grazing at the fringes of the national park is a few serious threats to birdlife.
- Pesticides, detergent input, over fishing, and vanishing wetlands, are some threats to resident and migratory water birds.

Threats to gyps vulture species:

- Forest fire during dry season.
- Diclofinac is still available easily in Gundlupet, Sargur, Hediyala, Chamarajanagar district that are 20 kilometres in radius from Bandipur.
- Cattle population has increased predominantly surrounding Bandipur, hence demand for natural manure from neighbouring coffee and tea gardens has increased Cattle grazing inside forest.
- Livestock distribution to villages near nest sites from government agencies is adding threat.
- Cattle infestation near nesting trees is observed.
- Disturbance from people inside BNP for illegal NTFP collection and fire wood.
- Disturbance at nest sites from people, who visit the temple, water source nearby.
- Competition from relative birds of prey near nest sites.
- Burning of Elephant (*Elephas maximus*) carcass inside BNP by forest department has deprived vulture source of primary food. The energy transfer level as animal protein from Elephant (Elephas maximus) meat to vultures is at stake.

Recommendations:

- An annual vulture watch has to be organized by preparing a team of forest watchers, ornithologists and amateurs to help record vultures regularly in Bandipur.
- Neighbouring Moyar in Tamilnadu state and Waynaad in Kerala state borders ignored for conservation helps strategize Nilgiri biosphere reserve as one platform for conservation.
- Diclofinac should be banned from nearby areas.
- Disturbance from humans, temple tourism near breeding sites should be stopped.
- Elephant (Elephas maximus) deaths inside protected area should be left as it is after post-mortem, instead of burning or burying it.
- Elephant (Elephas maximus)deaths due to electrocution outside the protected areas should be lifted into protected area and left away for scavengers. Energy source from Elephant (Elephas maximus) to scavengers will be met.

Vulture conservation plan – WCF

- Total ban on availability of diclofinac in nearby towns and cities.
- Current status of gyps' vulture species in BNP to be done regularly.
- Stop all cattle grazing inside National Park.
- Keep distance from vulture breeding sites, and trees to be avoided even by beat guards.
- Keep constant vigils on gyps' vulture breeding trees?
- Avoid temple tourism near vulture breeding sites, even old and abandoned ones. Hence vultures re-visit nesting sites and re-build it.
- Propaganda of vulture conservation plan to stake holding villagers surrounding BNP.
- Keep record of vulture sightings by vulture watchers from the forest department.
- Protection of National parks as the last lung space for the in-numerable life forms.
- Use of alternative energy source, indirectly release pressure on forest.
- These are some of the acute elements, which is much talked than done, a local community headed conservation strategy should be planned to save the vultures.

Conclusion:

Each of the field study conducted to identify Gyps vultures was part of our study on "Birds of Bandipur" bird watchers from southern India participated in this exercise and findings has carved a new paradigm in correlating bird diversity in protected areas as bio indicators. Link tiger population to healthy vulture population is executed through these studies. Tiger as an umbrella species transfers energy

food source to other relative scavenging mammal species through its kill dispersal, helping scavengers like vultures through its kill as a major account. Tiger execute correlation with vulture population in particular biome.

The numbers of sightings, group and species status were recorded by bird watchers, apart from my own personal observations.

During 1996, while conducting field surveys in Byladauppe*, in Hediyala range in Bandipur, the adjacent cliff facing the Mahadeshwara temple, breeding records of White backed vulture was observed.

Today human population and temple tourism has disturbed the breeding vulture group, above all the hill top watch tower constructed by forest department hinder in condensing the breeding population and to abandon the cliff.

Rampura near Moolehole bisects Karnataka with Kerala state by Rampura river (Moolehole) which is close to waynaad wildlife sanctuary recorded 3 major trees full of gyps vultures White backed and long billed. The breeding vultures have shifted from Rampura to Waynad- 2002-03.

The above exercise is just an open expression of collective information but in no way a claim to conduit legitimate information totaling vulture population in Bandipur Tiger Reserve, instead evenly formatted information which can be evaluated for future.

We wish future Birders, Naturalists, Scientists, Wildlife managers or common man who is interested in bird life will agree to upgrade the information available in this paper, and commit to conserve nature and its resources.

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*2: Report on “*Density of birds using food guilds in BTR”* by *Rajkumar.D 2008*

*3: Cattle deaths in BTR report to NTCA by *Rajkumar.D* 2010

*4: Elephant (Elephas maximus) deaths due to natural causes and Electrocution, a natural food source to Vultures and scavengers – *Rajkumar.D*

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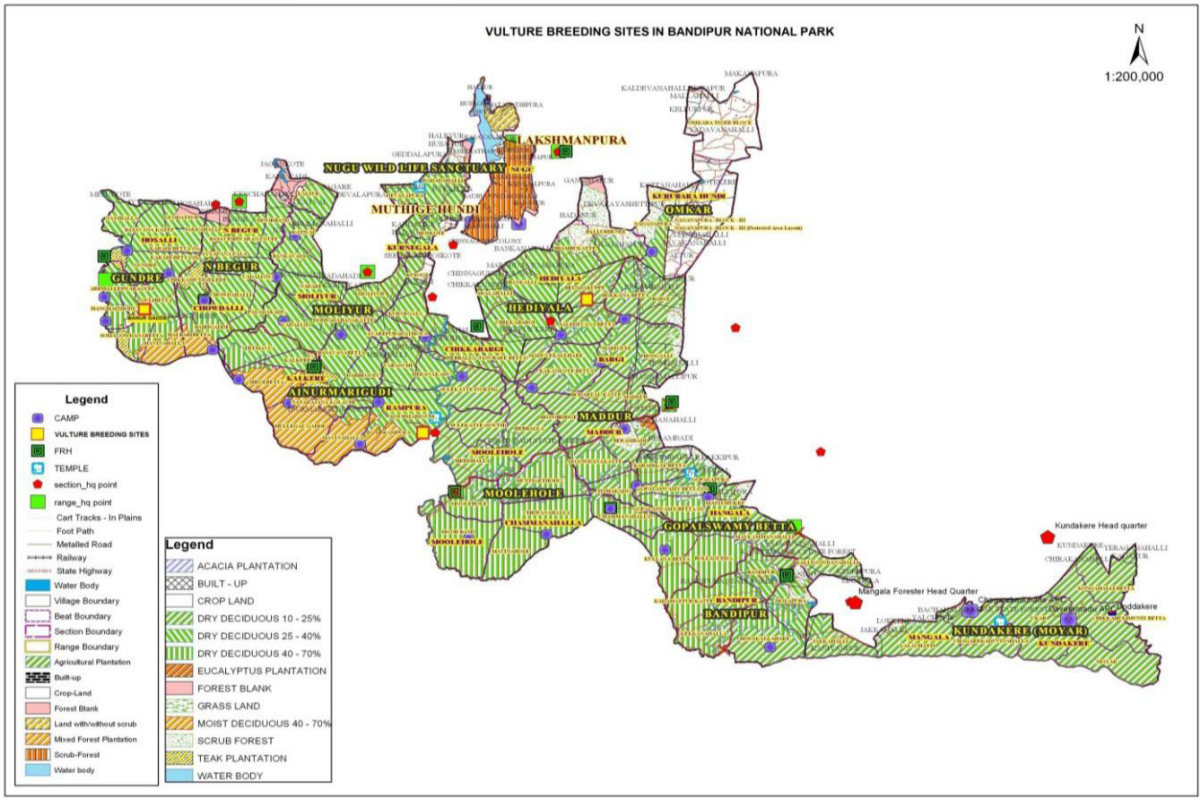
Breeding sites in BNP:

Banur, Rampura and Byladakuppe* are the Vulture breeding sites recorded in BNP.



7. Map of Bandipur Tiger Reserve where Gyps vultures breeding sites recorded.

POPULATION, BREEDING ECOLOGY AND CONSERVATION THREATS OF LONG-BILLED VULTURES (GYPS INDICUS) IN THE RAMADEVARABETTA VULTURE SANCTUARY (RVS) IN RAMANAGARA HILLS, KARNATAKA.

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ABSTRACT

Ramanagara is famous for some of the world's oldest granite outcrops and is also known as South India's earliest rock climbing hub. It is located about 50 kilometers southwest of Bangalore, on the busy Bangalore-Mysore highway. The region is covered in scrub forest and the hills are home to threatened bird species such as the Long-billed Vultures (LBV). Apart from its geological importance, Ramanagara is the home for the country's first vulture sanctuary called the *Ramadevarabetta Vulture Sanctuary (RVS)*. The hills at Ramanagara are one of the few locations in the inland South India where Long-billed Vultures nest in the present day. However, as per reports, Long-billed Vultures have suffered a steep and sudden decline of 97% since mid-1990s, as the vulture species faced serious threats, either by way of habitat destruction or, diclofenac - a widely used non steroidal anti-inflammatory (NSAID) drug in veterinary. With an effort to conserve the tiny population in the Ramanagara, a study was conducted in 2005 by a team of bird watchers lead by Dr. S. Subramanya, Ornithologist, towards the conservation of this threatened vulture specie. Through the process of declaration of Ramanagara as an important breeding habitat for the Long-billed Vultures, all stakeholders such as the Karnataka Forest Department, Department of Ecology-Government of Karnataka, research students, conservationists and filmmakers came together for the cause. This study lead to the declaration of 346.14 hectares of Ramanagara as Ramadevarabetta Vulture Sanctuary on 31st January 2012 by Government of Karnataka. As a recent update on numbers in 2010-11, there are about 15-20 Long-billed Vultures observed by the local people of Ramanagara, however, not documented through a study. As per the International Union for Conservation of Nature and Natural Resources' (IUCN) Red List of Threatened Species published in 2015, the Long-billed Vulture (Gyps indicus) is Critically Endangered (CR). Thus, one cannot remain complacent that a small population of Long-billed Vultures have found a safe home at Ramanagara, and a long-term observation based study needs to be started at the earliest. In the above context, the study initiated by Save Tiger First and commissioned by Karnataka Forest Department was in continuation to the study conducted in 2005. The aim was to study the habits and habitat of Ramanagara to estimate the present population of Long-billed Vulture (Gyps indicus), and monitor them. As part of the study the presence and absence of the Long-billed Vultures revealed that there are 4-5 LBVs currently that roost on the cliffs of Ramadevarabetta hill. Occasionally there are 7 LBVs seen. The study could only throw light on the disappearance of LBVs from other bettas and recorded human disturbance and natural predatory conflicts.

Key Words: Long-Billed Vultures, Ramanagara Vulture Sanctuary, Karnataka

Introduction

Vultures perform a vital role in nature's sanitation process by eating meat from carcasses (Houston 1974). While feeding, vultures reduce the potential spread of diseases that could affect other animals and humans (Ogada *et al.* 2012). The Long-billed Vulture also known as Indian vulture (Gyps indicus) is one of the three native, resident Gyps species in India and are part of a non- migratory scavenging raptor complex that was once widely distributed across most of northern India and Pakistan (Houston, 1985; Prakash, 1999; Gilbert *et al.*, 2002). Long-billed vultures nest almost exclusively in colonies on cliffs and ruins, although in areas, where cliffs are absent, they have been recorded nesting in trees (Rasmussen & Anderton 2005). The species is classified as Critically Endangered (IUCN Red List) because of a catastrophic decline of 90–98 % in the population of Gyps species (Prakash *et al.* 2007) due to diclofenac poisoning (Gilbert *et al.* 2004; Green *et al.* 2004). Other reasons that could have contributed in a minor way to the decline include changes in human meat consumption (BirdLife International 2013), carcass disposal practices (Chaudhry *et al.* 2012), and disease. The aim of the present study was to examine the population status and breeding ecology and conservation threats of Long-billed vultures in the Ramadevarabetta Vulture sanctuary in Ramanagara Hills, Karnataka.

Study Area

Ramadevarabetta Vulture Sanctuary (RVS) is situated in Ramanagara Taluk of Ramanagara District in the State of Karnataka and lies between the North Latitudes 12º 45' 963" to 12º 45' 115" N and between the East Longitudes 77º 18' 291" and 77º 17' 466" and is spread over an area of 346.42 hectares. It forms an important part of the drier forests in the state of Karnataka and River Arkavathy which is an important tributary of Cauvery River flows through the Sanctuary the sanctuary is part of the Mysore Elephant Reserve and supports highly endangered and endemic Vulture (Gyps benghalensis) and Long-billed Vulture (Gyps indicus). The sanctuary harbours leopard, wild dog, striped hyena, sloth bear, jackal, chital and the sanctuary has good population of sloth bear Sree Ramadevara Temple is present inside the Sanctuary as an enclosure.

Methodology

The population estimation of Long billed vulture in RVS was done by nest site count method. A total of four visit per month (Seven days interval) was done to estimate the

population size of the Long-billed vulture in the roosting and nesting colonies in the morning (0630 to 0930 hrs.) and in the evening (1530 to 1830 hrs.) (Baral, 2005). To study the nesting and breeding ecology of Long-billed Vulture, a total of six visits (Five days interval) in a month during breeding season (September to May) to check the status and number of vultures present in the nesting colony. All observations were with binoculars (Nikon 52×10) from an appropriate distance (100-300m) in nesting colonies. All observations were made in the morning from 0630 to 0930 hrs and and in the evening from 1530 to 1830 hrs. Nests were identified by the presence of the fresh nesting material and whitewash (excreta) below the nest or by the presence of the incubating vulture in the nest. Confirmation of active (occupied) and abandoned (unoccupied) nests were based on the criteria laid down by Postupalsky (1974). Breeding success was calculated based on the number of fledglings divided by the number of breeding pairs. Information on mortality, especially of adult mortality was recorded at nesting colonies (Baral *et al.,* 2005; Steenhof & Newton, 2007).

Results

A total of 253 sightings of Long-billed vultures were recorded in 76 visits with an average of 3.30 vultures per visit in Ramadevarabetta Vulture Sanctuary between September 2015 and March 2017 (19 months). Maximum seven and minimum one individuals at a time, were observed in this sanctuary. The highest number of Long-billed vulture sightings were observed in the month of October 2015 - a total of 27 sightings were observed in four visits in that month with an average of 6.25 individuals per visit. The lowest number of sightings was observed in the months of May, June and August 2015 - a total of 7 sightings were observed in four visits in each of these months with an average of 1.75 individuals per visit. A total of 2 nests were observed from 2015 to 2016 breeding season and one nest was recorded in 2016 to 2017 breeding season so far. Successful mating of the pairs, as well as incubation was observed in both the breeding seasons, however no chick appearance was recorded in both the breeding seasons. Therefore, considering this, both the breeding seasons were a failure for Long-billed Vultures in Ramadevarabetta Vulture Sanctuary.

Discussion

The Ramanagara hills are home to a wide variety of flora and fauna and the forest-covered slopes are of significant ornithological importance, supporting over 150 species of birds including the endemic Yellow-throated Bulbul *Pycnonotus xantholaemus.* Although the Hills of Ramanagara form part of the Important Bird Area (IBA) network in India (Islam & Rahmani 2004), they are threatened by quarrying and also plans of statues carving into the hills. Subramanya (2004) reported that Ramanagara hills have been a home to critically and globally endangered vulture species for a long time. Subramanya & Naveein (2005) observed that a total of eight Long-billed Vultures were on the ledges of the steep and high rocky cliffs in Ramadevarabetta State Forest, Ramanagara, Karnataka. These Long-billed vultures, according to the Bombay Natural History Society, appear to be the only known and last surviving population of the species in inland southern India (Vibhu Prakash verbally, June 2005). The first official record for Long-billed vulture breeding was registered in Ramadevarabetta hills in Ramanagara, Karnataka was in the year of 2006 a total of three nests with two chicks were observed with 9 to 10 individuals of Long-billed vultures (Subramanya & Naveein, 2006). In the year of 2012 January 31 extent of 346.14 hectares to declare as “Ramadevarabetta Vulture Sanctuary” to protect the Long-billed vultures in this landscape.

After 2006, this is the first work to monitor the Long-billed Vulture population and breeding in Ramadevarabetta Vulture Sanctuary. As part of the study, the presence and absence of the Long-billed Vultures revealed that there are 4-5 LBVs currently that roost on the cliffs of Ramadevarabetta hill. Occasionally, there are 7 LBVs seen. In present scenario, breeding sites of Ramadevarabetta Vulture Sanctuary facing the problems of habitat loss, anthropogenic activities such as festivals, movies shooting in historical monuments and uncontrolled tourism leads to the disturbance in the food chain. The study could only throw light on the disappearance of LBVs from other bettas and recorded human disturbance and natural predatory conflicts.

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STATUS OF VULTURES IN TELANGANA AND ANDHRA PRADESH

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ABSTRACT

The total nine variety of vulture species present in India, among these three vulture species found in Telangana and Andhra Pradesh i.e. Oriental white-rumped Vulture (*Gyps indicus*), Indian long-billed Vulture (*Gyps indicus*) and Egyptian Vulture (*Neophron percnopterus*). The *Gyps* vultures' population declined in India by 97% and by 92% in Pakistan. The widespread usage of Diclofenac drug led to the rapid population decline of vultures. Due to this, three vulture species were listed as 'Critically Endangered' by the IUCN and Egyptian Vulture is listed as Endangered. A very few population of vultures is observed in Andhra Pradesh Telangana especially sighting of Indian long-billed vultures at Palarapu cliff during 2013, then Telangana Forest Department has initiated the project entitled "Conservation of Indian long-billed Vulture (*Gyps indicus*) at Palarapu cliff" on 1st January, 2015-and still ongoing with the major objectives such as to find out the status of vultures in Telangana and Andhra Pradesh and to know the status of long-billed vultures in isolated habitats of Telangana.

We surveyed vultures across Telangana and Andhra Pradesh states from September to October, 2017. Road transect survey was carried out on state highways and roads which are running through the protected areas. No transects were repeated, at least 30 km gap was maintained between the transects. Initially past records of vulture locations were surveyed to confirm the occurrence of vultures in both states.

Breeding colony of Indian long-billed vulture (*Gyps indicus*) was located on the southern face of 80-90 meter high elevated rock cliff (108 meter total height of the cliff), named **"**Palarapu cliff" in the Bejjur Reserved Forest nearby the Nandigaon village at the confluence of Peddavaagu stream and Pranahita river. This habitat is located in Bejjur Reserved Forest of Kaghaznagar division, Telangana state. It is located near to the border of Telangana and Maharashtra states. The vegetation is southern tropical dry deciduous forest dominated by Indian Black wood (*Hardwikkia binata*). A 'machan' was erected on the river bank in front of the Palarapu cliff from where the breeding colony of vulture was monitored using Nikon 12x50mm binocular. After marking all the nests and roosting points, we counted all the individuals in regular basis during the day time.

During our survey two *Gyps* species have been reported in three locations from Andhra Pradesh i.e. Long-billed Vulture *Gyps indicus* (Sriharikota, n=2 and Domalapenta-Srisailam Tiger Reserve, n=1) and white-rumped Vulture *Gyps bengalensis* (Mamandur-Thirupathi, n=1). Only 9 individuals were recorded at the initial stage of the project named 'Conservation of Long-billed Vulture (*Gyps indicus*)' by the Telangana Forest Department at Palarapu cliff during the year 2013. Now this population is grown up to 26 individuals in 2015, 30 individuals in 2016 and 32 individuals in 2017. The Egyptian Vultures *Neophron percnopterus* were recorded from Kesreragutta-Municipal yard (n=6), Rajendra Nagar (n=3), Ameenpur Lake (n=4) and Bejjur Reserved Forest (n=1).

The vulture population is very low in both Telangana and Andhra Pradesh with an average of 30 matured individuals of Long-billed vultures which are existing at Palarapu cliff, Telangana. In this paper we have described on three vulture species population and their locations.

Key Words: Vulture, Telangana, Andhra Pradesh

Introduction

Totally there are nine species of vultures in India, among these three vulture species are found in Telangana and Andhra Pradesh i.e. Oriental white-rumped Vulture (*Gyps bengalensis*), Indian long-billed Vulture (*Gyps indicus*) and Egyptian Vulture (*Neophron percnopterus*). The Gyps vulture has declined in India 97% and 92% in Pakistan (Virani, 2006). Because of the evidence of widespread and rapid population decline, all three vulture species were listed by IUCN, the World Conservation Union, as 'Critically Endangered' (BirdLife International, 2013). And Egyptian Vulture is listed in Endangered category of IUCN. Very few populations of vultures are observed in Andhra Pradesh, in Telangana a unique site of Indian long-billed vultures was identified at Palarapu cliff in 2013, Telangana Forest Department has initiated project entitled "Conservation of Indian long-billed Vulture (*Gyps indicus*) at Palarapu cliff" on 1st January,2015, it is an ongoing project.

Methodology

We surveyed vultures across Telangana and Andhra Pradesh, from September to October 2017. Road transects were mostly on state highways and on roads running through protected areas. No transects were repeated, and adjoining transects were separated by at least 30 km. and also based on past records of vulture locations in both states have been surveyed.

Breeding colony of Indian long-billed vulture (*Gyps indicus*) is situated on the southern face of 80-90 meter high elevated rock cliff (108 meter total height of the cliff) , named **"**Palarapu cliff", in the Bejjur Reserved Forest near Nandigaon village at the confluence of Peddavaagu stream

and Pranahita river. This habitat located in Bejjur Reserved Forest of Kaghaznagar division, Telangana state. It is located near to the border of Telangana and Maharashtra states. The vegetation is Southern tropical dry deciduous forest dominated by Indian Black wood (*Hardwikkia binata*). In front of the Palarapu cliff (Breeding colony of vulture), a 'machan' was erected on the river bank from where the habitat was monitored using Nikon 12x50mm binocular. After marking all the nests and roosting points, we counted all the individuals in regular basis during the day time.

Results

During our survey two gyps species have been reported in three locations from Andhra Pradesh i.e. Indian long-billed Vulture *Gyps indicus* (Srihari kota, n=2 and Domalapenta-Srisailam Tiger Reserve, n=1) and Oriental white-rumped Vulture *Gyps indicus* (Mamandur- Thirupathi, n=1).

In the initial of project 'Conservation of Indian long-billed Vulture (*Gyps indicus*)' by Telangana Forest Department at Palarapu cliff, only 9 individuals found, this population has grown up to 26 individuals in 2015(Ravikanth & Ram Mohan, 2016), 30 individuals in 2016 and 32 individuals in 2017 were recorded. And Egyptian Vultures *Neophron percnopterus* are recorded from Kesrera gutta- Municipal yard (n=6), Rajendra Nagar (n=3), Ameenpur Lake (n=4) and Bejjur Reserved Forest (n=1).

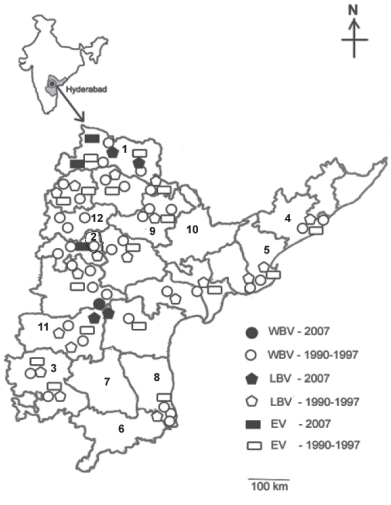

Fig – 1 Past Vulture sightings

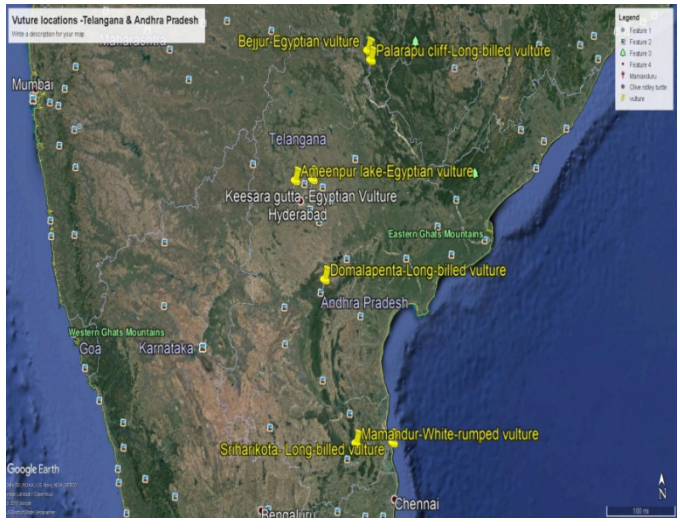

Fig 2 – Present Vulture sightings

CONCLUSSION

In collaboration with Central Zoo Authority (CZA) forest department established conservation, research and captive breeding program for Long-billed Vulture at Nehru Zoological Park, in Telangana State to increase population. Most detailed studies have taken place in Northern India, where vultures occurred at their highest densities in the past; less information is available from Southern India. Historically, six species of vultures: White-rumped Vulture *Gyps bengalensis*, Long-billed Vulture *G. indicus*, Indian Griffon Vulture *G. fulvus*, Egyptian Vulture *Neophron percnopterus*, King Vulture *Sarco Gyps* calvus and Cinereous Vulture *Aegypius monachus* are recorded in Andhra Pradesh (Ali & Ripley, 1983). Approximately 8,615 of Long-billed Vultures was recorded across 39 sites in 15 districts include both Andhra Pradesh and Telangana states. Especially in Telangana state they sighted vultures at Mancherial, Kawal and Utnoor in Adilabad District (Srinivasulu & Srinivasulu 1999). A small colony (N = 7 nests) of Long-billed Vultures was recorded in Pocharam Wildlife Sanctuary, Medak District, Telangana until 1998. Since then on, nevertheless, no individuals were sighted in this area (C. Srinivasulu, in litt. 02 August 2014). Recently, around 13 Long-billed Vultures were reported from Markapur in Srisailam Tiger Reserve, Mattadiguda in Utnoor and Dharmaraopet in Bellampally within Adilabad District, Telangana (Umapathy *et al.,* 2009). The vulture population is very low in both Telangana and Andhra Pradesh, an average of 30 matured individuals of Indian long-billed vultures are existing at Palarapu cliff (Ravikanth, M. *pers.comm*), Telangana. And Egyptian Vultures *Neophron percnopterus* are recorded from Keesrara gutta- Municipal yard (n=6), Rajendra Nagar (n=3), Ameenpur Lake (n=4) and Bejjur Reserved Forest (n=1). In Andhra Pradesh vulture population found is very low, Indian long-billed Vulture *Gyps indicus* (Srihari kota, n=2 and Domalapenta- Srisailam Tiger Reserve, n=1) and Oriental white-rumped Vulture *Gyps indicus* (Mamandur- Thirupathi, n=1).

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Table showing the vulture sightings

Species	Scientific name	Year or Date of sighting	Number of individuals	Location	District or Protected area	Coordinates	
Indian long-billed vulture	*Gyps indicus*	2015	26	Palarapu cliff, Bejjur RF	Kumrambheem Asifabad	19º21'29"8 N	79º91'38"3 E
Indian long-billed vulture	*Gyps indicus*	2016	30	Palarapu cliff, Bejjur RF	Kumrambheem Asifabad	19º21'29"8 N	79º91'38"3 E
Indian long-billed vulture	*Gyps indicus*	2017	32	Palarapu cliff, Bejjur RF	Kumrambheem Asifabad	19º21'29"8 N	79º91'38"3 E
Egyptian Vulture	*Neophron percnopterus*	5-Sep-2017	1	Bejjur	Kumrambheem Asifabad	19°21'3.14"N	79°51'28.45"E
Egyptian Vulture	*Neophron percnopterus*	9 Sep-2017	4	Ameenpur lake	Hyderabad	17°31'13.02"N	78°20'6.63"E
Egyptian Vulture	*Neophron percnopterus*	16 Sep-2017	6	Keesrara gutta	Hyderabad	17°31'47.94"N	78°41'17.70"E
Indian long-billed vulture	*Gyps indicus*	5 Oct-2017	2	Sriharikota	Nellore	13°44'41.18"N	80°12'47.98"E
Indian long-billed vulture	*Gyps indicus*	11 Oct-2017	1	Domalpenta	Srisailam Tiger Reserve	16° 6'19.75"N	78°53'54.93"E
Oriental white-rumped Vulture	*Gyps bengalensis*	24 Oct-2017	1	Mamanduru	Tirupati	13°44'51.42"N	79°27'47.54"E