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Spatial and Temporal Distribution of Hyena and its Risk to Human in Western Terai Landscape, Nepal

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Abstract

We used camera opportunistic records of Hyaena in camera traps set for tigers to understand distribution and density of Striped Hyena *Hyaena hyaenain* Bardia National Park (BNP) and Banke National Park (BaNP) during 2013 and 2016/2017. This paper illustrate about temporal & spatial distribution as well as human hyena conflict status in western lowland of Nepal. Direct observation and camera traps data were used to collect information on human-hyena conflict and its distribution respectively. We also compare the number of individuals with encounter rate in two national parks during the period. Fifteen days of camera trapping was done with a sampling effort of 5,550 trap nights during winter of 2013 and 2016/2017. Camera traps yielded a total of 695 Hyena photographs of 17 individuals from thirty seven independent detections within an effective trapping area of 148.45 km2.Solitary striped hyenas co-exist in Bardia and Banke National Park with sympatric carnivores like tiger *Panthera tigris*, leopard *Panthera pardus*, Asiatic Wild dogs *Cuonalpinus* and Jackal *Canis aureus*. We also documented deaths of ten striped hyenas in WestenTerai between 2009 and 2018 due to Retaliatory Killings (3), Poaching (2), Road accidents (2), Natural Death (2) and Poisoning (1). Livestock depredation by striped hyena was the major reasons for the retaliatory killings. The conservation outreach programs should be formulated to conserve the habitat and maintain the prey population of the striped hyena which would be helpful for long term conservation of the striped hyena in Nepal. The study revealed that camera based capture-recapture method is an effective tool for assessing the population size and its distribution of Striped Hyena in BNP and BaNP.

Keywords: Striped hyena • Camera trapping • Conflict • Conservation • Livestock • Distribution • Retaliation

Introduction

The Striped Hyena Hyaena hyaena is one of the most important large scavengers; its role in clearing off carrion in tropical ecosystems and in recycling mineral compounds from dead organic matter enhances its biological importance. In Nepal only the presence and absence survey of hyena has been done in only of particular area. So no any robust data has been recorded form Nepal till now. This research and survey is first time to estimate its abundance and habitat used in two national park of Nepal. They generally prefer arid to semi-arid environment and avoid open desert and dense thickets. The current distribution range of this species extends from East to Northeast Africa, through the Middle East, Caucasus region, Central Asia and into the Indian subcontinent.

Striped hyaena Hyaenahyaena is globally Near Threatened and nationally Endangered with less than 100 individuals in Nepal. Hofer and Mills considered a maximum population of 50 individuals in Nepal, possibly with as few as 10, they also estimated the global population of striped hyena to be 5,000 to 14,000 individuals. Striped hyenas prevail on the southern slopes of the Churia Hills in Nepal. The animal is also listed as protected in the National Parks and Wildlife Conservation Act 2029 (1973). It has a restricted distribution, which is limited to protected areas of the Terai. The species has been recorded outside protected areas; however these records are likely to refer to small numbers/stray individuals. Sightings of this species are not common and the population is considered to be in decline. The Striped Hyaena is distributed in the Terai region of Nepal within the protected areas of Bardia National Park, Chitwan National Park, Parsa Wildlife Reserve and Shukla Phanta Wildlife Reserve. Outside of protected areas they have been recorded in the districts of Bara, Kailali, Kapilbastu (Niglihawa VDC), west of the Bagmati to Kanchanpur and one dead Striped Hyaena was found in Udayapur District in August 2003. The Striped Hyaena occurs in grasslands of

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terai, dense forest and undulating grounds of foot hills. It also scavenges on carcasses of wild and domestic animals, such as Chital, Hog Deer and livestock respectively [1].

In this paper we are illustrated that Status, Distribution and Human Hyaena conflict. The camera trap based capture-recapture framework to estimate population of large carnivores, based on natural markings on their bodies, has proven to be amongst the most successful non-invasive method for species such as Tiger *Panthera tigris*, Leopard *Panthera pardus*, Jaguar *P. onca*, Geoffrey's Cat *Oncifelasgeoffroyi*, Snow Leopard *Uncia uncia* and Striped Hyena. Based on the camera trap data, the distribution (spatially and temporarily) explained in the parks. In addition, Human Hyaena conflict was recorded as retaliation killing because of human injured and livestock depredation.

Methods

Study area

We carried out this study in Bardia National Park (968km²), Banke National Park (550km²) and adjoining forests in southwestern Nepal (28°14'58.2" to 28°39'59.7" N, 81°09'53.7" to 81°47'41.9" E). It is a part of the trans-boundary Terai Arc Landscape. The survey was conducted to monitor tiger in the national parks which contains Chure (Sivalik) hill ranges to the north and bhabhar forests to the south, however Hyaena photographed as opportunistically. The national park contains an array of eight ecosystem types such as Sal forest, deciduous Riverine forest, savannahs and grasslands, mixed hardwood forest, flood plain community, Bhabar and foot hills of Chure range [2]. The major habitat of Hyaena as mixed Forest (Sal, Saj, Botdhairo, Bans, Bhorla, Khair, Jamun), Sal Forest (pure sal) and Riverine Forest (Khair, Sisso, Jamun, Bhelar). Altogether hyaena was photographed from 37 camera location among 338. In which they were trapped in 9 locations with tiger and 11 locations with common leopard. And all three carnivores were trapped in a single location. The other co-predators are Leopard cat, jungle cat, Dhole, Jackal. The major preys are chital, barking deer, wild boar, Indian hare, four horned antelope, Porcupine, mongoose, rabbit, Indian fox, birds. The majority of human communities are ethnic Tharu. They enter the park illegally and exploit the park resources like fodder, firewood, thatch, etc. They also try to kill wildlife either for food as traditional profession or for money. They place the snare for killing animal and sometimes striped hyaena was killed unintentionally so as to observe human hyaena conflict.

Camera trapping survey

We used opportunistic records of Hyaenas photographed in camera traps set for tiger monitoring during 2013 and 2016/2017in Bardia and Banke National Parks and adjoining forests. A total of 376 grid cells of 2 X 2 km2 were superimposed on a map of these two National Parks. Out of 376, 338of these were surveyed in 6 blocks successively during dry season in 2013 (February to May) and 2016/2017 (November to February). We placed the camera traps within the same grids in both surveys. Thirty-eight grid cells were not surveyed due to inacces¬sibility of the terrain or lack of suitable wildlife habitat within the grid. The camera trap location within each grid cell was selected following an extensive survey of tiger signs. In each sampling point a pair of motion sensor camera traps (CuddebackC1, CuddebackAttack, Reconyx 500 and 550) was installed at 45-60 cm aboveground on either side of the game trail, forest road or stream bed, maximizing the possibility of tiger capture. Camera traps were checked twice a week to observe the capture of tiger and other species [3]. Cameras were active for minimum of 15 days in each grid cell. Camera trap photos were given unique identification names and sorted species wise in separate folders. A photo obtained at one hour interval was considered as independent detections.

Hyaena density estimate

Hyaena photographs in camera traps were separated in a folder and analyzed to identify individuals based on body stripes. We estimated their density using spatial capture-recapture in SPACECAP based on the Hyaena individuals identified from the camera-trap photographs. Capture history preparation, data inputs and model selection

Hyaena distribution, activity pattern and habitat use

Based on their camera photographed locations, we prepared hyaena distribution maps, temporal activity pattern and habitat characteristics. A daily activity pattern was calculated R, overlap package in hour basis. Twenty four hours activity patter has been calculated. Habitat use pattern has been analyzed based on photographed in different habitat type.

Hyaena threats

Secondary data, Field observations, conflict records have been used to analyze the threats of hyaeena. Direct observation has been used to know the status of human hyaena conflict.

Results

Hyaena density status and distribution (spatial and temporal) of striped hyaena by camera trapping

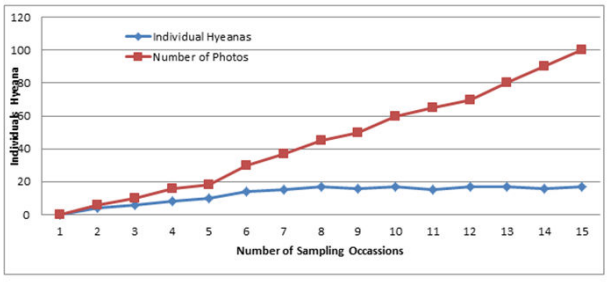

Figure 1. Number of Striped Hyena photographed and number of hyena photographs with increasing number of sampling occasions to evaluate trap shyness and sampling adequacy in intensive study area.

A total of 5,640 of camera-trap effort from 376 sampling locations resulted 57,871Photographs of 34 mammal species. We found 695

photographs and a video of striped hyaena from 37 locations in 75 independent detections in winter season (December to January) during 2013, 2016/2017. The intensive trapping resulted in a total of 695 photographs of 17 individual hyenas, based on right flank profile, as the number of individuals identified from the right flank was maximum (Figure 1). The 37 trapping stations covered an Effective Trapping Area (ETA) of 148.45 sq. km. Altogether 17 individuals of hyaena were identified in Banke-Bardia complex of Western Terai in Nepal camera trap, among them 9 from Bardia NP whereas 8 from BaNP in 2013.

National park	2013	2016/2017
Bardia NP	9	6
Banke NP	8	6
Total	17	12

Table 1. Number of individuals Hyaena recorded in BNP and BaNP during 2013, 2016 and 2017.

Hyaena distribution and habitat use

Form the following table it resulted that mixed forest is the best habitat used by hyaena.

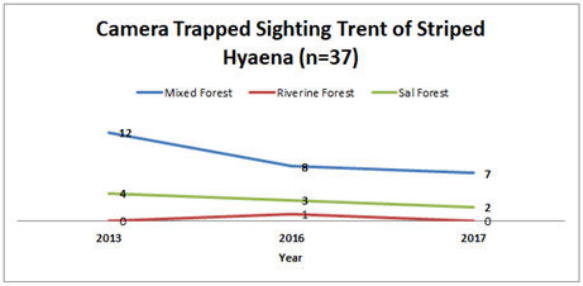

Figure 2. Camera trapped sighting trend of *Striped Hyaena*.

Similarly, we categorized the striped hyaena's habitat in four categories such as mixed Forest (composed of Sal, Saj, Botdhairo, Bans, Bhorla, Khair, Jamun), Sal Forest (composed of pure sal), Riverine Forest (composed of mainly Khair, Sisso, Jamun, Tribia nudiflora) and Grassland (composed with mainly graminee species). Among them, hyaena used mixed forest abundantly by 74% and followed by sal forest and riverine forest by 24% and 2% respectively (Figure 2).

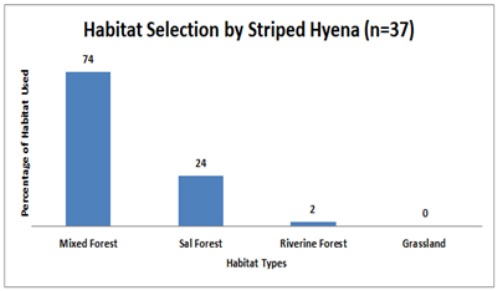

Figure 3. Habitat preference and selection by *Striped Hyena*.

Moreover, in soil terrain mostly the animal used flat land by 76% which followed by Undulating, River Bed and Hilly as 13%, 8% and 3% respectively.

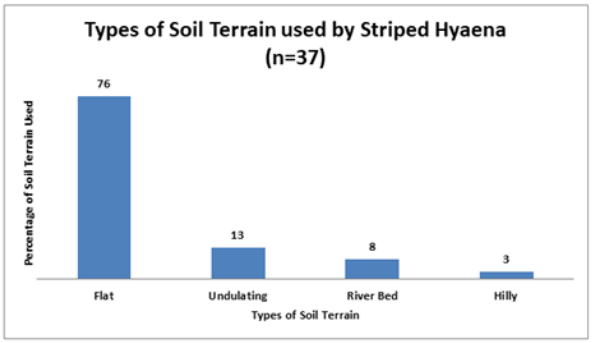

Figure 4. Soil terrain used by *Stripe Hyaena*.

Other sympatric carnivores such as Tiger (*Panthera tigris*), Common Leopard, Leopard cat, Golden Jackal etc were also recorded in some of the locations.

Co predator of *Stripe Hyaena* (sympatric carnivore or other animal)

Altogether hyaena was photographed from 37 camera location among 338. In which they were trapped in 9 locations with tiger and 11 locations with common leopard. And all three carnivores were trapped in a single location.

Activity pattern of *Striped Hyaena*

Most of the time, they were waking and roaming (67 events) around in the forest mostly in night time. Among 75 independent events, 8 events were carrying carcasses of ungulates wild animal (6 times) and livestock (2 times). Mostly the animal is active before and after mid night during 22hrs to 23 hrs and 2 hrs to 3 hrs. The activity of the animal was gradually increased form 19hrs to 23 hrs and peaked at 23 hrs and then gradually decreased after 2 AM to till 5 AM. It concluded that this animal is fully nocturnal.

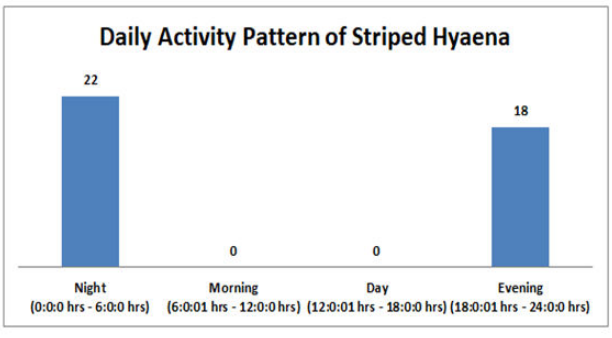

Figure 5. Daily actvity pattern.

The animal is mostly active in night and evening time rather than morning and day time.

Major causes of *Hyaena Killing*

A total of ten striped hyenas were killed in WestenTerai of Nepal between 2009 and 2018 due to Retaliatory Killings (3), Poaching (2), Road accidents (2), Natural Death (2) and Poisoning (1). Poisoning, road accident and natural death are not so much serious problem in compare to retaliation killing as this is higher in number than otters causes of death of hyaena [4].

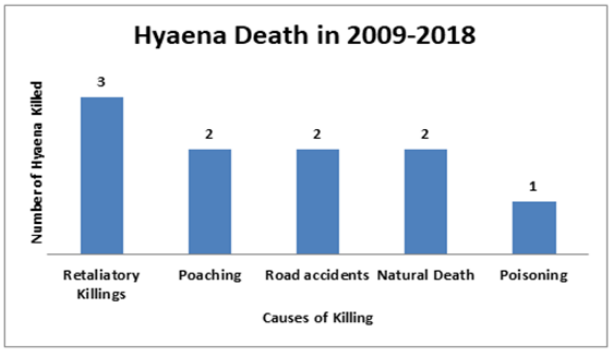

Figure 6. Death of *striped hyaena*.

Discussion

Status and distribution (spatial and temporal) of hyaena

The data shows that the number of hyaena has been decreased as the number of tiger increased from (50 to >80 in BNP) due to the animal pushed by tiger so as to disperse into fringe area nearby the settlements and human domesticated areas. Apparently, BaNP is more suitable than BNP regarding hyaena abundance as per road accident. There has been gradual decrease the number of hyaena individuals. Tiger population increase in both national parks in-between 2013 and 2016/2017 could be the reason for reduced density of hyaena. The capture-recapture technique based on camera trap photographs of Hyena provided a statistically robust estimate in estimating the population size. We had also corroborated hyena tracks and photographs at camera location for trap shyness response and did not observe any behavioral response during the study period. Effort required in terms of sampling occasions suggested that a minimum of 20 days are required to get reliable density estimates for hyena in the study area. Out of 695 captures, 2 individual Hyena were recaptured more than three times, 5 individuals were captured twice and10 individuals had single captures. Some traps showed very high capture rates (2 to 19 captures/trap location), while individual captures/trap ranged from 1 to 2 individuals/trap location. Camera traps deployed near villages showed high individual capture rates. This may be attributed to availability of carcasses (livestock) in and around these villages on which hyenas might be scavenging. The estimated Hyena population size in western terai of Nepal is lower as compared to available studies in India and Africa and this might be attributed to the availability of low wild prey base, i.e., of 92 animal/sq. km. The camera trap based capture-recapture method is proven to be good to estimate Hyena abundance and can be reliably used in various habitat types [5].

However, given the relatively lower number of hyena photo capture rates at Esrana (2.9 captures/100 trap nights) compared to Kumbhalgarh (6.8 captures/100 trap nights), if indeed there are lower hyena densities at the former site as hypothesized, the home ranges should be larger and so also the expected buffer width. Hyaena occurs historically in Terai and Churia (Himalyan foothills) but their exact distribution at present is unknown. Kumbhalgarh study site showed 85% of its terrain to be steep and suitable for hyenas in terms of breeding and protection from human disturbance, whereas in our study showed that flat land is most suitable for the species.

Human hyaena conflict and its risk to human

Striped hyaenas are the archetypal incidents of one of the strongest wild predators that roam around in the lowland of Nepal's protected areas. These animals in Nepal have been given less priority in compare to large mammals such as tiger, common leopard, snow leopard, rhino and elephant. It is one of the least studied large carnivores in Nepal and also found in community forest premises. Due to scare of food they may sometime came to settlement in search of food. In that time the animal was killed by local as they assume they may come for livestock depredation. Conflicts with wildlife are universal, and people with a near ubiquitous negative attitude toward carnivores and the conflicts are a major challenge to biodiversity conservation. Authors, Frank suggested that livestock loss by wildlife as a cause for human wildlife conflict and wildlife is accountable for the loss of 3% of livestock per year. Human-wildlife conflicts present an increasing challenge to conservation, particularly in densely populated parts of low-income countries. The conflicts are difficult to understand and manage because they are influenced by many factors including religious values, cultural and economic values of carnivores and their body parts, and the economic loss imposed by carnivore damage. Of consequence, it is important to identify the degree of influence from these factors in order to lay a foundation for designing specific conservation programs and policies.

The Hyaena, being at the apex of the food chain, influences the ecosystem structure and function despite their low densities in population. They are sensitive to habitat loss and fragmentations because of their large territories, high mortality rates and conflict with people in terms of predation of livestock, human attack and they show a differential response to human induced land-use modifications. There are few populations of Hyaena in Nepal and many tropical, wide ranging carnivorous mammals are now threatened because of the depletion of their prey reserves and anthropogenic pressures that come into conflict with their basic ecological needs. The attitudes of people toward wildlife depend on human tolerance for them. Frequent conflicts (loss of livestock and human casualties) result in decreased tolerance levels among the local communities and trigger antagonism towards conservation, and can actively encourage them to kill wildlife.

Anthropogenic pressure, human population growth coupled with expansion of agriculture resulted in habitat degradation through the loss of vegetation cover of the country. In this study, the major threats for the hyena were retaliation killing and deforestation. However, higher level of human hyena conflict recorded in outside of buffer zone area is probably due to lack of conservation awareness and mitigation program for this species. Comparing to eastern part of Ethiopia, existence of large population density of spotted hyena in

highly human populated areas wasattributed to the availability of livestock prey and domestic waste disposal. According to carnivores like Leopard Panthera pardus and Striped Hyaena hyaenahyaena inhabit a human-dominated agriculture landscape. As a result, conflicts between human and Striped Hyaena have increased. Hyaenas are under the continuous pressure of several threats throughout the world that directly or indirectly affect their occurrence and abundance and show population decline in many places. Similar situation may be prevalent in populated districts of Nepal but further study is needed to focus on the correlation of human population, livestock situation and population of striped hyena.

Due to scare of prey in degraded forest attached to village, hyaena came to human dominant landscape in night time to kill livestock. Therefore, Hyaena also killed by local people due to human-carnivore conflicts as retaliation killing. The high killing of livestock (goat) in our study sites increases human-hyena conflict. Similarly, a hyaena was camera trapped with snare in Banke National Park at two locations during 10 days among 15 sampling occasions. Moreover, in 2017, an adult Hyena was killed in a trap by the local people at Basanta Community Forest in Khata corridor of Bardia National Park Buffer Zone. In 2018, a hyena was found dead in upper Karnali River due to the monsoon flood. An adult female hyena was rescued from Machhagadh buffer zone community forest, Bardia National Park in February 10, 2014. It was suspected that a group of poachers had set the trap probably for tiger or common leopard. However an adult hyena was caught in the trap. This kind of scenario illustrates that huge problem in western terai in hyeana conservation. Therefore, human-hyena conflict is one of the major challenges to save the remaining population in Nepal. Human wildlife conflict in many parts of the world showed that the rate of tolerance among local communities toward predators mostly depends on the degree of predation on their domestic animals. This study also indicated the low awareness status of the local people about conservation of wildlife including striped hyena.

Livestock densities from the two study sites differ remarkably with Esrana having more than three times the total livestock density found in Kumbhalgarh, India. Livestock prey is an important factor in setting hyena abundance in Esrana, it may not be the most critical determinant of relative hyena densities. It was found that local people had understood various aspects of Hyaena ecology. Hyaena entered human populated areas due to an absence of food in the natural forests and habitat degradation. Similar situation occurred in buffer zone of Bardia National park. A person was bitten on neck by hyaena in 2017 at Banugaon and finally after a month the person was died due to rabies.

Why hyena found in the community? What are the reasons?

The major threats to this species include retaliatory killings and persecution, depleting prey populations and loss of habitat; it is unlikely that the species will be able to persist in large numbers outside protected areas. These threats are also highly likely to prevent intermixing between sub-populations, and a rescue effect from populations in India is unlikely, as it occurs in patchy distributions and faces deliberate persecution in most of these areas. The threats to this species are yet to be effectively addressed and therefore it is anticipated that this species will experience further population declines in the future. The Striped Hyena is distributed in the Teraiprotected region of Nepal; Bardia National Park, Chitwan National Park, Parsa National Park and Shuklaphanta National park. Hyena has also been recorded outside of protected areas namely in Bara, Kailali, Kapilbastu and Udaypur district. However, these records are likely to refer to small numbers/stray individuals. The Hyenas live in the grasslands of terai, dense forest and undulating grounds of foot hills. It also scavenges on carcasses of wild and domestic animals, such as Chital and Hog Deer. It has also been noted to feed on comparatively more vegetables than other hyena species.

Hyena and other large predators share the same habitat. Is there any sign of killing each other?

As scavenger, hyena can share the same habitat with another predator such as tiger, common leopard, wild dog, Dhole etc. Tiger and common leopard can prey itself but striped hyena can depend on other predators. Therefore, they can share the same habitat. Mostly, hyena eats residual dry part of dead body preyed by other predator and natural death of animal. We recorded more than 20 photographs of hyena with carrying dead body part of wild animals where other predators also photographed in the same camera trap locations. There is research gap in this species. Camera trap methodology has been carried out to monitor and record the number of tiger. However, the population is not estimated in hyena till date using camera trap and other methods. Therefore, a scientific research should carry out to record on distribution, population status and conservation threats of this species throughout the potential habitat range within the country. Likewise, local community conservation awareness program should perform highlighting the species ecological role as a natural scavenger, in order to prevent further killing (through poisoning prey carcasses), to implement effective grassland management systems in protected areas, including invasive alien plant species control and law enforcement and to develop and implement a conservation action plan for this species, its prey base and habitat. The spatial location of the animal has been changed every year. The animal camera trapped in 2013 in the spatial location has never been captured again in coming year in 2016 and 2017. There was an only a location where an individual captured at same location in 2013 and 2016 in Banke NP. Spatially we could recognize that they never come back again at before captured location in three successive years in two national parks (Bardia and Banke). It determines that they shift their habitat every year because of in search of food and preferable diet. Temporarily, the capture rate has been decreased in the period. It was captured from 17 locations in 2013 whereas it was followed by 12 and 9 in 2016 and 2017 respectively. We don't know the possible causes of changing the location. We can assume that it might be because of disturbance form camera traps flash and other cause. So that the result determine further behavioral study is a needful in future.

Conclusion and Recommendation

An intensive and close monitoring of the striped hyaena is required to understand their status distribution. Awareness program to local communities about hyeanais necessary to stop retaliatory killings. Although, this elusive species has scientific and conservation interest, rigorous inferences about their population dynamics are scarce because of methodological problems of sampling populations

at the required spatial and temporal scales The prevalence of positive attitudes toward Hyaena conservation holds potential for the long-term conservation of this species in and outside the protected areas of lowland, Nepal. To minimize the hyena human conflict, a suitable mitigation and outreach programs should be conducted in local areas. In most conflicting sites compensation programs should be launched that would be helpful to save striped hyena's population in Nepal. There is large gap in our knowledge on several aspects of the striped hyena behavior and its ecology such as competition with other carnivores, effect of habitat degradation and climate change. The population dynamics and ecological niche of striped hyena is urgently needed to be documented in Nepal. Moreover, the prey population should be conserved and habitat destruction should be controlled.

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