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PREY BASE ANALYSIS OF SRI LANKAN LEOPARD (*Panthera pardus kotiya*) IN HORTON PLAINS NATIONAL PARK AND A REVIEW TO PAST STUDIES

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ABSTRACT - The feeding ecology of the Sri Lankan Leopard (*Panthera pardus kotiya*) in three Horton Plains National Park was studied by analyzing prey remains in faeces. A total of 87 leopard scats were collected during June to October 2013 from Horton Plains National Park. Scat analysis revealed that in terms of relative biomass consumed 83.16% of leopard diet constitutes wild ungulates, 9.32% rodents, 2.89% primates and 2.63% lagomorphs. Rattus sp. were the most frequently preyed upon accounting 71.99% of relative number of individuals consumed. A review of past study data show that in some areas Sri Lankan Leopard (*Panthera pardus kotiya*) tends to switch to sub optimal prey indicating scarcity of primary prey species. Knowledge on the feeding ecology of Sri Lankan Leopard (*Panthera pardus kotiya*) is helpful when planning protected areas and an overall strategy for the conservation of this endangered species.

KEY WORDS : *Panthera pardus kotiya*. Scat analysis, Prey selection

INTRODUCTION

Sri Lankan Leopard (*Panthera pardus kotiya*) is the largest representative of family Felidae, commonly known as cat family, in Sri Lanka's wilderness. Its body size, island wide distribution and wider range of prey species qualify Sri Lankan Leopard (*Panthera pardus kotiya*) to be the top predator in Sri Lanka. Due to poaching for trade, killing in the conflict with human and continuous fragmentation and loss of preferred natural habitats, Sri Lankan Leopard (*Panthera pardus kotiya*) population is under heavy threat of decline and these have made the species to be categorized as an endangered species in red data listing (MOE 2012).

A greater percentage of the area of Sri Lankan Leopard (*Panthera pardus kotiya*) distributed is protected as wildlife and forest reserves managed by Department of Wildlife Conservation (DWC) and Forest Department (FD). The rest is comprised of the human dominated landscape fringing the protected area network aforesaid. It is observed that throughout this range Sri Lankan Leopard (*Panthera pardus kotiya*) is distributed the conflict with human, is intensifying pushing it towards extinction. Therefore DWC as the leading conservation agency has a vested responsibility to prevent poaching, mitigate conflicts with human, prevent habitat fragmentation and degradation and implement special programmes to conserve leopards.

As far as the wildlife conservation aspects are concerned, with its beauty, valor and singularity, Sri Lankan Leopard (*Panthera pardus kotiya*) is considered to be a charismatic species. It is significant as the top most predator species and as a species that perform a significantly persuasive role in the management of protected areas. When planning protected area management, such specialties are highly concerned and management prescriptions are formulated accordingly.

Understanding the prey base precisely is essential in formulation of conservation strategies for protected areas that are inhabited by Sri Lankan Leopard (*Panthera pardus kotiya*). In the management point of view, to sustain a reasonable predator population, prey base may be managed with ease through habitat manage-

ment. Such habitat management programmes are presently done based on a very crude assumption that mega herbivores such as sambhar (*Rusa uncolor*), spotted deer (*Axix axix*) and buffalo (*Babulus amee*) are the major prey species of Sri Lanka Leopard (*Panthera pardus kotiya*).

Schaller (1984) describes the prey base preference in relation to tiger and leopard in Kanha National Park in central India. According to Schaller (1984) wild ungulates contribute greater percentage of the diet of leopard in Kanha National Park. According to Hayward *et. al.* (2006), Leopards preferentially prey upon species within the range of 10 - 40 kg. of body weight whereas most preferred mass of leopard prey is 25 kg and the mean body mass of significantly preferred prey is 23 kg. Hayward *et. al.* (2006) also state that Leopards prefer prey within this body mass range, which occur in small herds, in dense habitat and afford the hunter minimal risk of injury during capture. Species outside the preferred weight range are generally avoided, as are species that are restricted to open vegetation or that have sufficient anti-predator strategies. The ratio of mean leopard body mass with that of their preferred prey is less than 1 and may be a reflection of their solitary hunting strategy.

Based on this information on the prey size preference of carnivores the ideal body weight a prey of Sri Lankan Leopard (*Panthera pardus kotiya*) is assumed falling within the range of that universal range for the purpose of this study.

Therefore, this study was carried out to refine the information on prey species preference of Sri Lankan Leopard (*Panthera pardus kotiya*) in Horton Plains National Park. However, this study is not the pioneer study within Horton Plans National Park. The study of same type conducted by Ranawana *et.al.* in 1998 at Horton Plains National Park was taken as the baseline for this study. Legally declared Horton Plains National Park is a plateau of a mosaic of montane forests, dry and wet patana grasslands and several flowing water bodies surrounded by a vast tract of montane forests managed by both Forest Department and Department of Wildlife Conservation. Records are available as proof for the presence of Sri Lankan Leopard (*Panthera pardus kotiya*) in this entire area.

In addition the available data and information from the past studies carried out for other protected areas and for some significant Sri Lankan Leopard (*Panthera pardus kotiya*) habitats were scrutinized through present study methodology.

METHODOLOGY

This study was carried out from June to October 2013. After a reconnaissance survey inside Horton Plains National Park, sampling methodology and sampling regime were decided.

Sample selection

Road and nature trail networks in Horton Plains National Park were taken together as the series of transects for sampling. Transect width for sampling was decided depending on visibility. Transect width for forested area was restricted to the width of road or nature trail. But for the grasslands 5m each side from the centerline of road or nature trail was considered as the transect width.

Sampling team walked along each transect and nearly 75% of each fresh scat encountered along transect was collected into a sealed polythene bag. Then the polythene bag was tagged with the information on date of collection and Geo coordinates of the location.

Sampling was repeated for 5 times maintaining three week gap between each collection date. Distribution of sampling locations in Horton Plains National Park is presented by figure 01. Total number of scat samples collected for the analysis was eighty seven. Hair was absent in five samples out of the total and were discarded. Therefore remaining eighty two were channeled through the analysis.

Methodology described in Amerasinghe (1983) and Amerasinghe *et. al.* (1990) to recover hair remains in scat samples and the

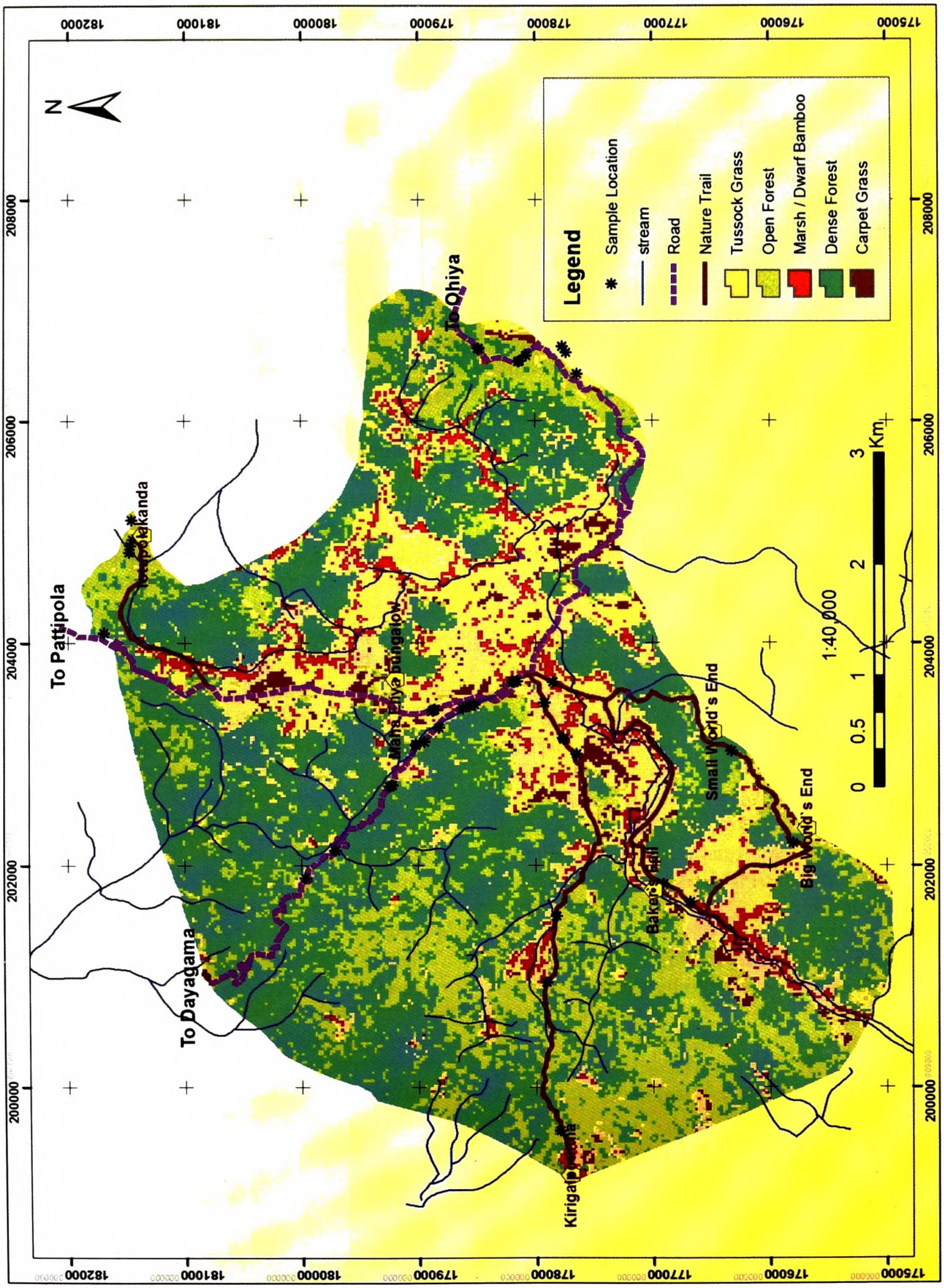

FIGURE 1: Distribution of Sampling Locations in Horton Plains National Park

preparation of these hairs for identification were followed.

Analysis

Hair identification was done based on the structure of cuticular scales, medulla and cross-sectional shape. The keys and the description in Amerasinghe (1983) were used for differentiation of each species.

Preparation for Microscopical Analysis:

Hair samples were prepared in the following manner for identification of each feature being analyzed; cuticular scales, medulla and cross sectional shape.

Cuticular Scales:

The hairs were cleaned by washing in warm water and then drying and rinsing in ether. Since the Scales are often difficult to observe on the hairs themselves, casts of the outer surface of the hairs were made. Nail polish was used to prepare the casts. Nail polish was spread on a microscopical slide in a manner similar to the making of a blood smear. The cleaned hairs were placed transversely across the slide, with their tips protruding from one side after allowing several minutes for the film to become firm (but not hard). Next, the hairs were carefully peeled off holding on their protruding tips, thus leaving a permanent impression of the cuticular scales on the nail polish film.

Medulla and Hair Profile:

The hairs were cleaned by washing in a 1:1 mixture of ether and 95% ethanol, and rinsing in pure ether to ensure complete drying. 70% ethanol was used for mounting hairs on the microscopical slide.

Cross-sections:

¾ of length of hairs to be sectioned were inserted into one end of a straw and dipped in a hot paraffin bath letting paraffin to drain into the spaces between hairs. After drying for 15-20 minutes, thin transverse sections of the straw and hairs were cut using a sharp razor blade, in a manner similar to obtaining of hand-cut botanical sections. The sections were dipped in clove oil to eliminate air bubbles, arranged on a slide and mounted in Canada balsom under a cover glass.

Data Analysis:

Each scat sample was observed under the low magnification power of a light microscope for the pre-defined features *viz.* structure of cuticular scales, medulla and cross-sectional shape. Each species was differentiated using the keys, descriptions and plates in Amerasinghe *et. al.* (1990). Frequency of occurrence of each prey species in scats was recorded.

Then the data recorded on frequency of occurrence was further analyzed to obtain percentage relative number and percentage relative biomass of each prey species consumed by Sri Lankan Leopard (*Panthera pardus kotiya*) in Horton Plains National Park.

Sidhu *et. al.* (2011) states that frequency of occurrence tends to overestimate importance of smaller prey species due to their larger surface area to volume ration compared to larger prey species. Therefore relative percent biomass consumption and relative numbers of prey consumed by Sri Lankan Leopard (*Panthera pardus kotiya*) were calculated following Ackerman *et. al.* (1984).

The equation developed for Puma, $\mathbf{C = 1.98 + 0.035W}$, was employed in this calculation assuming that the average body weight is more closer to that of Leopard than any other member of the cat family,

where C = correction factor

and W = mean prey weight.

Analyses of some pioneering past studies were further extended using Ackermann's equation.

RESULTS

Frequency of Occurrence

Eighty two scat samples were collected during the study. Out of the total no hairs were recovered from five samples. Therefore they were discarded. The rest of eighty two scat samples contained intact prey hairs as well as skeletal remains. These eighty two samples

were used for analysis. All the scat samples contained items, both hair and skeletal remains, of only single prey species.

Frequency of occurrence of hair remains in the analyzed scat samples is presented in the table 01. At the species level Sambar (*Rusa unicolor*) shows the highest percentage of occurrence (48.78 %) whereas *Rattus sp.* contribute to the prey base being the second highest percentage of occurrence (14.63 %). Identification was supplemented by the skeletal remains especially for the small mammals. Scat analysis revealed that 83.16% of leopard diet constitutes wild ungulates, 9.32% rodents, 2.89% primates and 2.63% lagomorphs.

Frequency of occurrence tends to underestimate the importance of larger prey species due to their smaller surface area to volume ration compared to smaller prey species. Therefore a correction was carried out using a formula presented by Ackermann *et.al.* (1984). This formula relates the mass of consumed prey represented by one field-collectible scat to the average body mass of the prey species.

Percent Relative biomass and relative number of prey individuals consumed by Sri Lankan Leopard (*Panthera pardus kotiya*) in Horton Plains National Park were then calculated by using Ackerman's formula and results are presented in the Table 02.

Several past studies are restricted to calculation of frequency of occurrence. Data presented by those past studies were also reviewed by employing Ackerman's equation to facilitate comparison of the situations among the focal protected areas. Summary of results obtained in relation to percent biomass and number of prey individuals consumed were tabulated against each protected area is presented in the Table 03.

DISCUSSION

Leopard (*Panthera pardus*), in general, is a solitary hunter. It prefers forest against open areas such as grasslands and it prefers much for a nocturnal life. Sri Lankan Leopard (*Panthera pardus kotiya*) shows no significant deviation from these basic features. When the feeding ecology of Sri Lankan Leopard (*Panthera pardus kotiya*) is reviewed based on the behavioral aspects aforementioned, its preference for different prey species can also be described.

According to Hayward *et. al.* (2006) preferred prey size of leopard (*Panthera pardus*) in terms of body weight range between

TABLE 1: Frequency of Occurrence of Hair Remains in Fecal Matter of Sri Lankan Leopard (*Panthera pardus kotiya*) in Horton Plains National Park.

Prey Species		Frequency of Occurrence	% Frequency of Occurrence
Scientific Name	Vernacular Name		
Trachypithecus	Langur	6	7.32
Lepus nigricollis	Ceylon Black-naped Hare	6	7.32
Ratufa macroura	Highland Grizzled Giant Squirrel	6	7.32
Rattus sp.	Meeya	12	14.63
Funambulus palmarum	Lena	2	2.44
Bandicota indica	Uru Meeya	2	2.44
Muntiacus muntjak	Barking Deer	4	4.88
Rusa unicolor	Sambhar	40	48.78
Moschiola meminna	Miminna	4	4.88
Total		82	100.00

TABLE 2: Percent Biomass and Number Contributed by different prey items to the diet of Sri Lankan Leopard (*Panthera pardus kotiya*) in Horton Plains National Park

Prey Species	% Frequency of Occurrence	Averag Body Weight (kg)	Calculated Ackerman's Correction Factor	% Relative Biomass Consumed	% Relative Number Consumed
Trachypithecus	7.32	8.39	2.27365	2.89	0.57
Lepus nigricollis	7.32	2.44	2.06523	2.63	1.77
Ratufa macroura	7.32	1.47	2.03145	2.58	2.89
Rattus sp.	14.63	0.12	1.98403	5.05	71.99
Funambulus palmarum	2.44	0.07	1.98245	0.84	19.70
Bandicota indica	2.44	0.97	2.01378	0.85	1.45
Muntiacus muntjak	4.88	20.41	2.69435	2.29	0.18
Rusa unicolor	48.78	216.59	9.56065	81.09	0.61
Mosciola meminna	4.88	3.45	2.10058	1.78	0.85

10kg and 40kg whereas the most preferred is 25kg. Average body weights of the mega herbivore species roaming in the Sri Lanka's protected area network exceed this upper limit and thereby reduce the potential of being preyed upon by Sri Lankan Leopard (*Panthera pardus kotiya*). This assumption was scrutinized by the present research.

Number of solid, field-collectable feces has been shown to be inversely related to prey size for large carnivores such as wolves (*Canis lupus*) (Floyd *et al.* 1978) and pumas (Ackerman *et al.* 1984). This situation was assumed to be applicable to Sri Lankan Leopard (*Panthera pardus kotiya*) also. Therefore relative percentage biomass consumption and relative numbers of prey consumed by Sri Lankan Leopard (*Panthera pardus kotiya*) was calculated employing the equation introduced by Ackermann *et al.* (1984).

Because of the prey species recorded in scat samples and geographic barriers that are not much economical to negotiate for finding prey species, it is assumed that collected scat samples are from the Sri Lankan Leopard (*Panthera pardus kotiya*) individuals roaming within and fringe areas of Horton Plains National Park.

Hair remains in the scat samples collected from Horton Plains National Park reveal that 48.78% samples contained those of sambar (*Rusa unicolor*) whereas the rest contributed by 8 other mammal species smaller in body size. Average weight of these recorded prey species range from 0.07kg to 216kg. Such a wide range of average prey weight indicates that Sri Lankan Leopard (*Panthera pardus kotiya*) is finding it difficult to predate on prey species in preferred weight class especially in Horton Plains National Park. At this situation it's vital to carry out a detailed study on sambhar individuals predated by Sri Lankan Leopard (*Panthera pardus kotiya*) to establish the preference of Sri Lankan Leopard (*Panthera pardus kotiya*) on Sambhar (*Rusa unicolor*) in terms of sex, age and weight.

When the negative impact of ratio of surface area to volume of prey species in prey base analysis is annihilated through Ackermman's formula, the corrected percent relative biomass consumed (Table 02) show very clearly that 81.09% of biomass predated by Sri Lankan Leopard (*Panthera pardus kotiya*) is of *Rusa unicolor*. In addition nearly 91.69% of

TABLE 3: Percent Relative Prey Biomass and Number of Prey Species in Sri Lankan Leopard (*Panthera pardus kotiya*) Diets derived from the Data Available in Past Studies from Sri Lanka.

Prey Species	% Relative Prey Biomass Consumed							% Relative Number of Individuals Consumed						
	HPNP *	Haggala*	Peak Wilderness*	Yala (1992)*	Hantana *	Agarapathana*	HPNP 2013*	HPNP *	Haggala*	Peak Wilderness*	Yala (1992)*	Hantana *	Agarapathana*	HPNP 2013*
Trachypithecus	0.99	10.10	36.05	0	0	4.52	2.89	0.30	22.61	6.46	0	0	10.96	0.57
Presbytis / Macaca	0	0	0	2.90	5.05	1.51	0	0	0	0	29.56	0.90	3.91	0
Lepus nigricollis	1.79	0	0	0.44	4.63	4.11	2.63	1.86	0	0	14.51	2.64	34.29	1.78
Ratufa macroura	0.88	0	0	0.44	0	0	2.58	1.52	0	0	23.64	0	0	2.88
Rattus sp.	4.30	0	6.99	0	0	0	5.05	94.59	0	91.41	0	0	0	71.99
Hystrix indica	0	10.84	4.30	0	43.67	1.63	0	0	15.48	0.49.	0	4.61	2.52	0
Funambulus palmarum	0	0	0	0	4.45	0	0.84	0	0	0	0	88.15	0	19.70
Bandicota indica	0	0	0	0	0	0	0.85	0	0	0	0	0	0	1.45
Canis aureus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sus Scrofa	0	0	0	7.69	13.37	0	0	0	0	0	5.38	0.16	0	0
Muntiacus muntjak	0	5.99	18.98	0	24.15	0	2.29	0	5.51	1.40	0	1.64	0	0.18
Rusa unicolor	91.14	63.73	33.68	0	0	82.45	81.09	1.06	5.52	0.23	0	0	7.74	0.61
Axis axis	0	0	0	16.09	0	0	0	0	0	0	20.56	0	0	0
Bubalus amee	0	0	0	72.44	0	0	0	0	0	0	6.37	0	0	0
Moscgiola meminna	0.91	9.33	0	0	4.71	1.40	1.78	0.67	50.87	0	0	1.90	8.28	0.85
Prionailuros vivernina	0	0	0	0	0	3.03	0	0	0	0	0	0	6.80	0
Herpestes sp.	0	0	0	0	0	1.35	0	0	0	0	0	0	25.50	0

* Source:

HPNP - Ranawana *et.al.*(1998), Haggala - Ranawana *et.al.*(1998), Peak Wilderness - Ranawana *et.al.*(1998), Yala(1992) - Amarasinghe & Ekanayake(1992)
Hantana - Kittle & Kittle (2009), HPNP 2013 – Present Study

individual preys are represented by 2 sub optimal species *viz. Rattus sp.* and *Funambulus palmarum*. In such a situation Sri Lankan Leopard (*Panthera pardus kotiya*) inhabiting Horton Plains National Park can be assumed to be toiling to predate on sub optimal preys at the most of predation attempts. These relationships should be monitored for a considerable time span and relate with habitat management practices to determine the quality of Sri Lankan Leopard (*Panthera pardus kotiya*) habitats in Horton Plains National Park. Heavy dependency over a single prey species in terms of percent relative biomass consumed by Sri Lankan Leopard (*Panthera pardus kotiya*) at Horton Plans National Park hints the need of research based approach for habitat management.

Data analysis of some pioneering studies on the prey base of Sri Lankan Leopard (*Panthera pardus kotiya*) were extended to obtain the percent relative biomass consumed and percent relative number of animals consumed. Results of this analysis show proofs to the basic behavior of leopards.

Results pertaining to percent relative number of individuals consumed at the present study indicate Sri Lankan Leopard (*Panthera pardus kotiya*) at Horton Plains National Park preyed upon suboptimal prey species at more than 71.99% of predation attempts. Majority of these individuals are *Rattus sp.* Results from analysis of data of Ranawna *et. al.*(1998) show that at Peak Wilderness Sanctuary and Horton Plains National Park 91.41% and 94.59% of successful predation attempts respectively have been made targeting *Rattus sp.* In addition analysis results for Kittle and Kittle (2009) show that 88.15% of successful attempts were made to predate on *Funambulus palmarum* which is a sub optimal prey species for Sri Lankan Leopard.

According to Hayward *et. al.* (2006) leopard (*Panther pardus*) prefers prey within this body mass range, which occur in small herds, in dense habitat and afford the hunter minimal risk of injury during capture. This behavior of leopard clearly reflected from the summary of results of the past studies presented in the Table 03. Results show that the species with much organized social behavior such as *Axis axis* does not significantly contribute to diet of Sri Lankan Leopard (*Panther pardus kotiya*). In contrary *Babulus amee* pocessing much higher mean body weight than *Axis axis* contributes much for leopard diet. The reason behind such higher predation on *Babulus amee* assumed to be the behavior where it shows very loose aggregation as a herd with no anti predator fighting strategies developed.

Leopard prefers forested habitat over the open grassland for hunting (Hayward *et. al.* 2006). As per the composite list of prey species prepared from the past studies except *Axis axis* and *Babulus amee* all the other prey species are forest dwellers. This is one among several reasons for the less representation of *Axis axis* in the fecal matter of Sri Lankan Leopard.

Abundance of principal prey species determines the prey choice of predators and carnivores are likely switched to secondary or sub optimal prey when the primary prey species is scarce (Bailey, 1993).

Results for Horton Plains, Haggala, Peak Wilderness, Agarapathana and Hantana studies show such a shift by Sri Lankan Leopard in both the directions of preferred weight class. This is a very distinctive signal of degradation of habitat quality for Sri Lankan Leopard. Arising conflict situations between human and leopard in some highland areas could be considered as a proof for this situation.

CONCLUSION

Prey base analysis of Sri Lankan Leopard (*Panthera pardus kotiya*) through scat analysis methodology can be successfully utilized to identify the prey base diversity and availability. When management prescriptions are formulated for protected areas or planning species specific overall conservation strategy such findings could be used as decision support information. Long term studies based on simple techniques such as scat analysis have the potential of generating valuable information on prey base diversity, dynamics and habitat quality.

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