SEASONAL VARIATION OF PREY DENSITY OF LARGE PREDATORS IN SATKOSIA TIGER RESERVE, ANGUL, ODISHA, INDIA

B. K. Behera[1], R. K. Mishra[2] H.K.Sahu[3], A.K.Nayak[4]

[1, 3]Department of Zoology, North Orissa University, Baripada - 757003
[2]Department of Wildlife and Biodiversity Conservation, North Orissa University, Baripada – 757003
[4]Satkosia Tiger Reserve, Angul, - 759143

Abstract

Prey densities were estimated in Satkosia Tiger Reserve, Odisha, India from January 2015 to December 2015 by using line transect distance methods. Season wise availability of prey density was collected. The pre-monsoon and Post-monsoon seasons prey density data was analyzed separately. In total, five prey species were recorded on the transect lines studied both in the core and buffer area of the reserve having an area of $964 \ km^2$. Population density of Barking deer (Muntiacus muntjac) population densities in the study area were the highest, followed by chital (Axis axis), wild pig (Sus scrofa) and sambar (Rusa unicolor). Results of the study indicate that in Satkosia Tiger Reserve the density of the overall ungulates and each species was fewer as compared t o other landscapes. Continuous monitoring of prey population in the Tiger Reserve which may indicate subsequent rising of their populations in reserve subsequently. However, only one year data is presented here to know the preliminary prey status of this tiger reserve. Further analysis is under consideration in due course of prey population study. Therefore, the proper management plan is required for better conservation of the prey and their predator in Satkosia Tiger Reserve.

Keywords: Prey; Density; Transect; Satkosia Tiger Reserve; Odisha

Introduction

Prey species either directly or indirectly influence the population dynamics of their predators. Therefore, to conserve and manage endangered or threatened species, it is essential to understand prey densities in their natural habitat [1]. Prey selection by large carnivore is a complex phenomenon [2, 3, 4]. In forested habitat the actual estimation of prey density, is a difficult task. There are several hypothesis that have been proposed to explain prey selection by predators [5]. These hypotheses pertain to ultimate causal factors such as energetic cost-benefit involved [6, 7] as well as to proximate mechanisms of selection such as search images or prey vulnerability [8, 9, 10]. The estimation of population size and status assessment of prey density in forested habitat is important for wildlife managements. Although ungulate (prey) census may be relatively easy in open grassland or meadow areas, it is much harder in forest habitats [11]. However, in recent past, continued depletion of prey population and fragmentation of natural habitats, apart from poaching is a serious issue acknowledged by conservationists as well as managers. These two major factors led to the present dilemma of tigers in the wild and will determine its survival in future [12, 13].

In this connection we evaluated the ungulates density in Satkosia Tiger Reserve in core as well as buffer area through distance sampling method. Seasonal comparisons among available ungulate density, which is urgently required for survival of the large predators and their co-predators in terms of their available food resources.

There is a paucity of information regarding the estimate of population density of wild ungulates. The attempt was made to estimate the prey density in core as well as buffer areas of Satkosia Tiger Reserve in pre-monsoon and post-monsoon seasons. Such information would be useful for other state wildlife agencies and wildlife managers that are charged with managing prey populations.

Materials and Methods

Study Area

Satkosia Tiger Reserve comprises of two adjoining sanctuaries of central Odisha, namely Satkosia Gorge Sanctuary and Baisipalli Sanctuary. The geographical co-ordinates of 20° 25' 12" N 84° 40' 20" E to 20° 45' 36" N 85° 05' 24" E within which the core is located are. It is one of the best deciduous ecosystems which represents a diverse floral and faunal extravaganza. It is a magnificent gorge ecosystem having many rare and endangered species and also the meeting point of two bio-geographic regions of India; the Deccan Peninsula and the Eastern Ghats, contribute to its immense biodiversity. The Satkosia Tiger Reserve was notified by Govt of Odisha in 2007, and which spreads over 4 districts; Angul, Cuttack, Nayagarh and Boudh. The reserve has an area of 964 sq km with 524 sq km as core area. The northern part of the reserve along the Mahanadi river bed is under the jurisdiction of Satkosia Wildlife Division, Angul while the southern part is under Mahanadi Wildlife Division, at Nayagarh. Climate of the Tiger Reserve is variable. The bulk of precipitation occurs during the rainy season through south-west monsoon. Usually monsoon breaks in the third week of June and continues up to middle or end of September. Pre-monsoon showers are also experienced in first or second week of June, but not very common. Post monsoon showers are also experienced in month of October and November. Thunder storm usually occurs during April and May. The average number of rainy days in a year is 100 out of which, 70 are confined to the period between June to September. The annual average rainfall varies from 1250 mm to 1700 mm. It has a significant elephant population in deciduous forests. The Tiger reserve is also important for the natural habitat of two endangered species of fresh water crocodilians viz. Gharial and Mugger, and a sizeable population of Gaur, Sambar, Chowsingha, Barking deer including Tiger and Leopard. Large population of Giant squirrel is sighted on the canopy cover of the forest. Besides these species, this tiger reserve is home to many rare and endangered birds, butter flies, fishes and aquatic fauna.
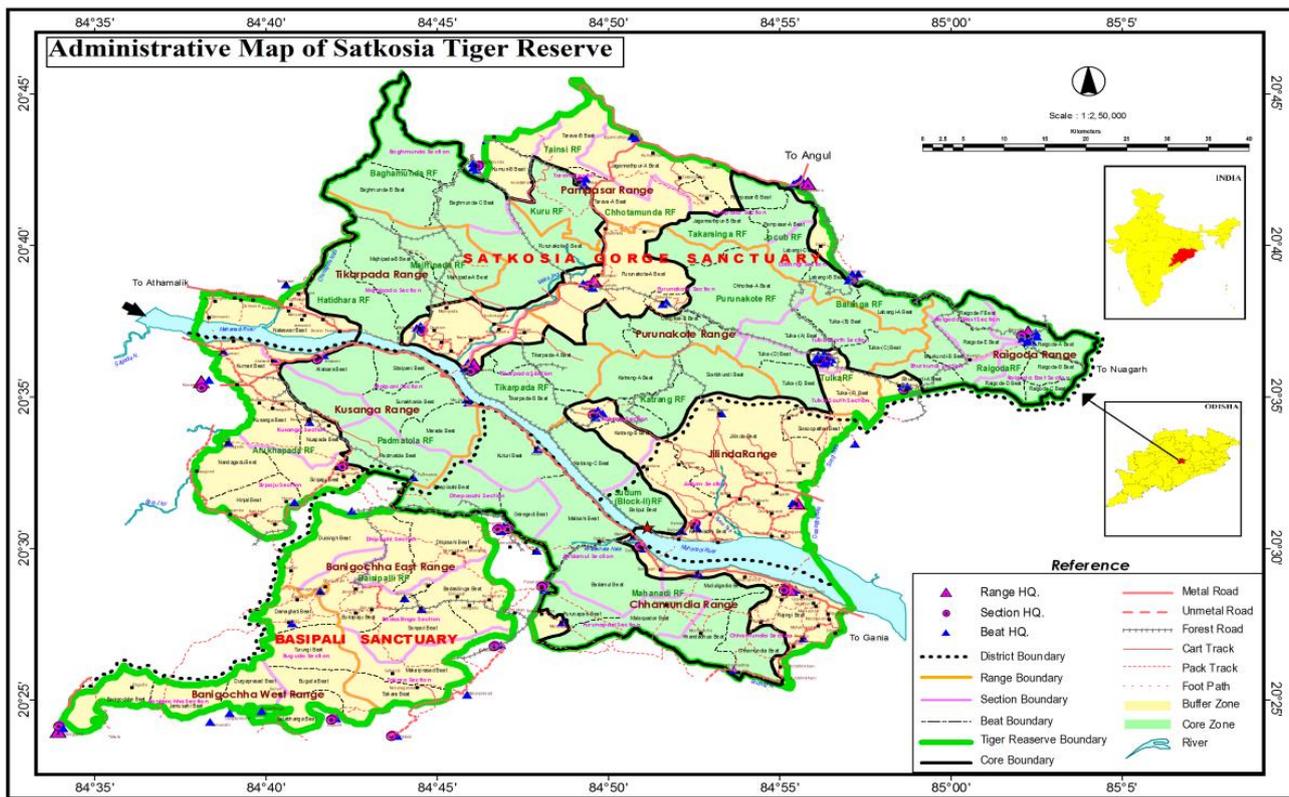
Methods

Line transect method by distance sampling [18, 19] was used to estimate densities of prey species in the study area. This method has been widely applied to estimate densities of prey species in tropical forests [20, 5, 21, 22, 23, 24, 25, 26]. We considered forest beat as sampling unit and laid transects on each beat. Eighty One line transects of 2km each (Figure 1) were walked three times (total effort = 243 km) during pre-monsoon and post- monsoon during 2015. Transects walks were carried out after two hours of sunrise.

Potential prey species of large carnivores were recorded from both sides of transect line during transect walk to collect the data on types of prey species, cluster size, animal bearing (with compass) and angular sighting distance (using laser range finder). The density of prey species was calculated using software DISTANCE *Version 6.0* [28]. Student t-test [29] showed significant difference ($p<0.05$) on visibilities of sighting distance of prey species between two seasons (pre-monsoon and post-monsoon) but not within same season of the year. Hence we pooled pre-monsoon and post-monsoon line transects data separately. The density estimated of major prey species such as common langur, *Rhesus macaque*, spotted deer, sambar, wild pig, and barking deer. Although gaur, elephant, hare and pea fowl were sighted on the line transects in both pre- monsoon and post-monsoon their densities were not estimated because of low sample size. No livestock were sighted on transects. Line transect data were analyzed using the software DISTANCE for each ungulate species. We fitted several plausible detection probability models generated under hazard-rate, half-normal and uniform detection functions to the observed distance data, to select the most appropriate models [30]. We generated estimates of detection probability, animal cluster densities, cluster size and animal densities [31].The software fits a series of functions to the distance data and the model best fitting the data was selected by the Akaike Information Criterion [30]. There are a number of important assumptions regarding the use of *Distance* sampling and key one is that all animals on the line are detected.
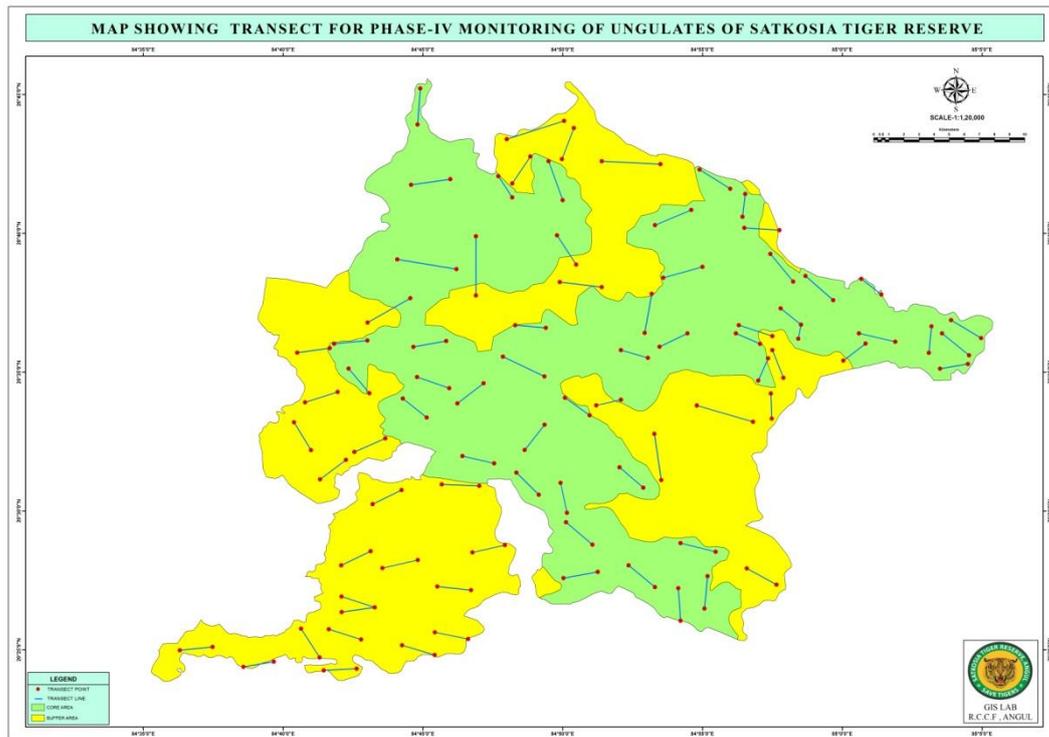
Results

The estimated density of each of the tiger reserve during pre-monsoon and post-monsoon period is presented in Table 1. Barking deer was found as the most abundant prey species during the pre - monsoon (9.86 ±0. 09SE/km^2) in pre-monsoon and post – monsoon(10.873 ± 0.64 SE/km^2) followed by chital Langur , wild pig, sambar in both the seasons (T a b l e – 1)

Half normal-Cosine was best fitted model with lowest AIC value for overall prey density during pre-monsoon and post-monsoon seasons.

The overall prey population density for the entire Tiger Reserve was 22.265 ± 2.11 / km^2 during – monsoon and19.811± 1.546 / km^2 during pre - monsoon.

Table – 1: Seasonal Prey Densities of Satkosia Tiger Reserve, 2016

Season	Density (Number/ Sq.km.)
Pre - monsoon	19.811 ± 1.546
Post - monsoon	22.265 ± 2.11

The prey of tiger & their co-predators density at all the forest ranges except Pampasar & Tikarapada of Satkosia Wildlife Division during pre – monsoon period more as compared to post -monsoon period. However, in Mahanadi WL Division, the prey density of tigers and their co-predators was reverse i.e. more in post – monsoon period and less in pre – monsoon period (Table -3).

Range wise comparative prey density of tiger in Satkosia Tiger Reserve during pre – monsoon period was maximum at Raigoda and minimum at Tikarapda while the maximum value during post – monsoon period was noticed at Raigoda and Jilinda respectively (Table – 2).

**Table – 2: Prey species Densities of Satkosia Tiger Reserve in different season**

| Name of Prey species	Observation		Density (Number/ Sq.km.)		AIC	
	Pre – monsoon	Post - monsoon	Pre - monsoon	Post - monsoon	Pre - monsoon	Post - monsoon
Langur	97	81	5.482 ± 0.580	6.413 ± 0.476	116.85	95.59
Wild boar	80	97	5.812 ± 1.400	5.549 ± 0.694	80.111	57.25
Barking deer	160	123	9.860 ± 0.918	10.873 ± 0.644	148.89	104.41
Sambar	46	74	5.460 ± 0. 765	5.916 ± 0.509	342.80	86.84
Spotted deer	66	47	6.661 ± 0.885	6. 423 ± 0.539	77.413	37.90
Over all	541	422	19.811 ±1.546	22.265± 2.113	521.69	3883.3

* Concern species data not sufficient

D - Individual Density, SE - Standard Error, DS - Group Density, AIC - Akaike Information Criteria
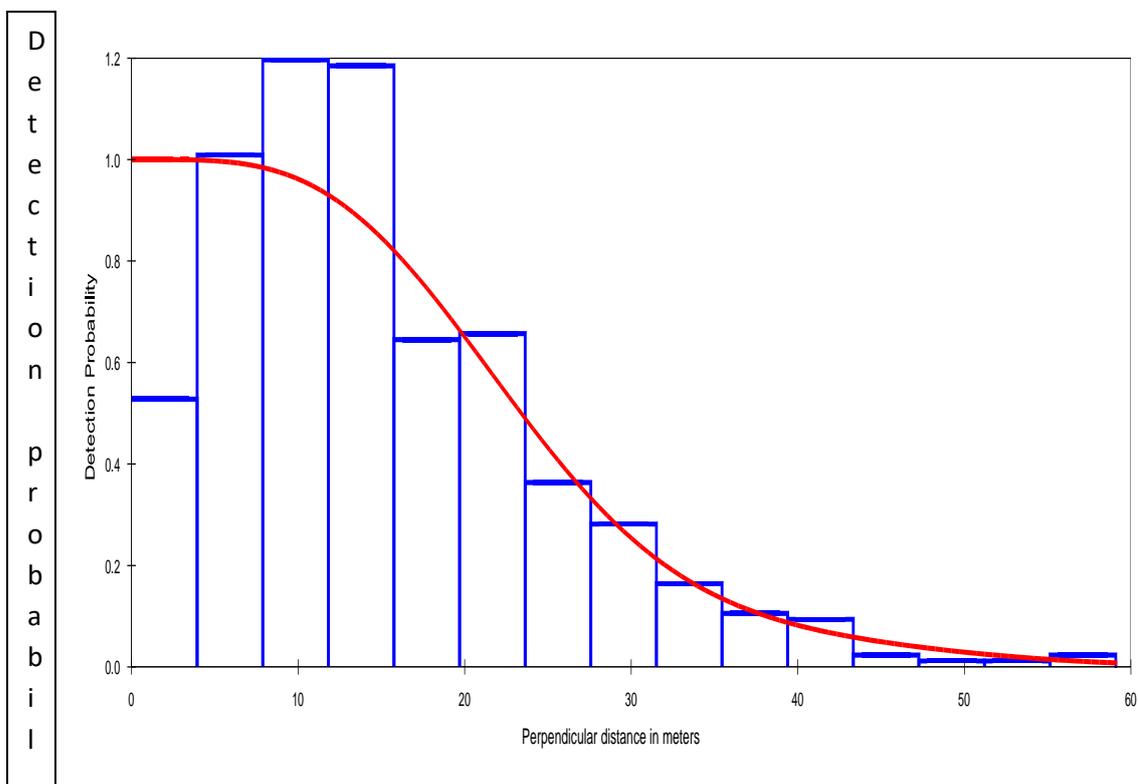
Over all Ungulate vs. Distance and fitted detection function (Half normal – Cosine, n = 537) during Pre – monsoon
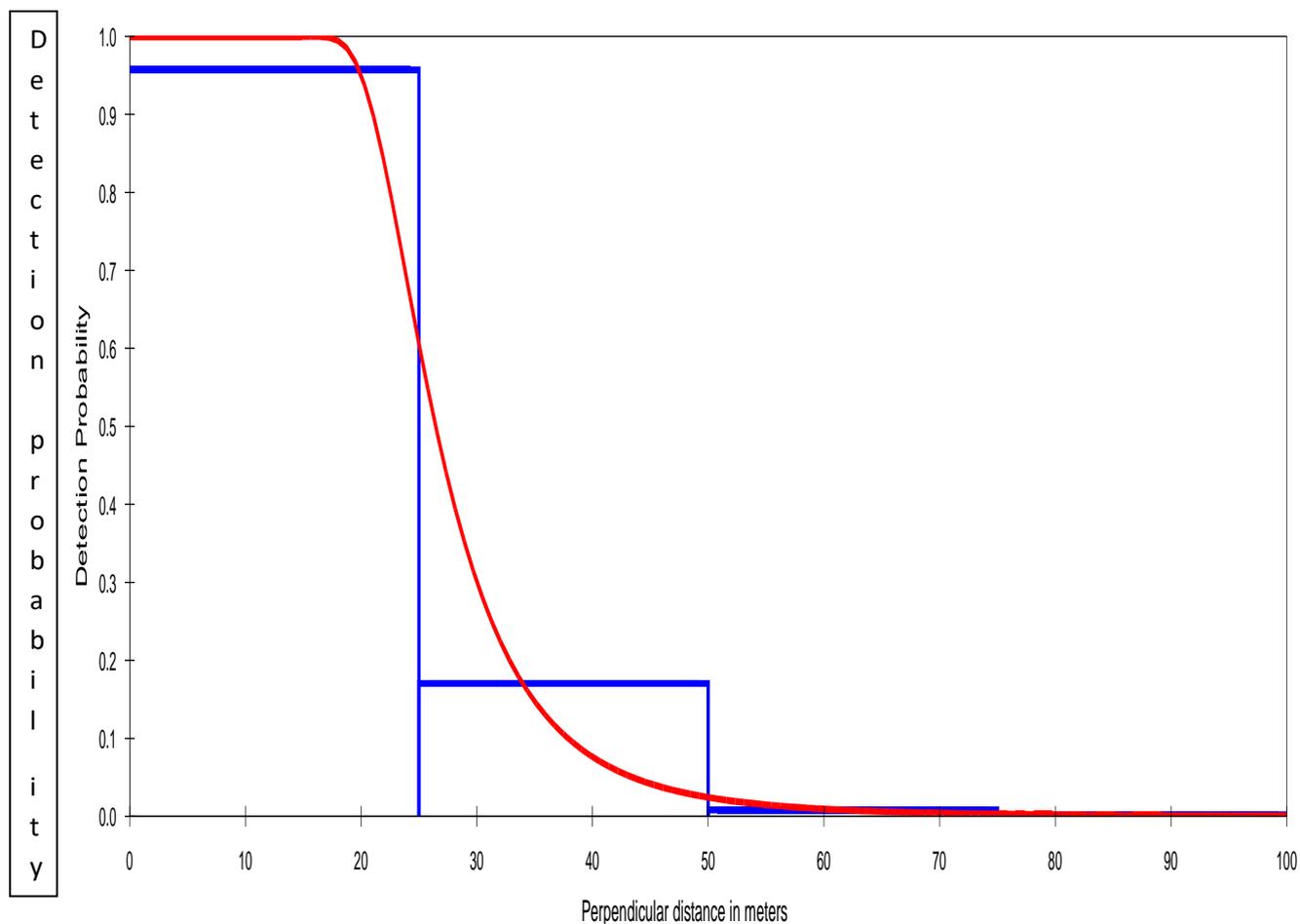
Over all Ungulate vs. Distance and fitted detection function (Half normal – Cosine, n = 541) during Pre – monsoon
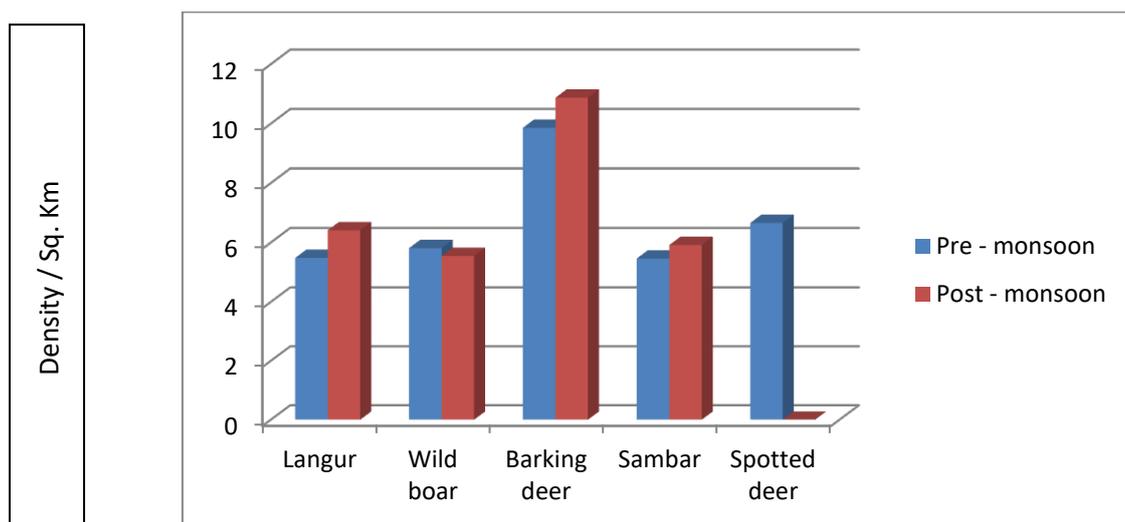
Available Prey densities in Satkosia Tiger Reserve during pre – monsoon and post – monsoon season 2015

Table – 3: Range wise prey density of Satakosia tiger reserve

Name of Division	Name of Ranges	Density (Number/ Sq.km.)	
		Pre - monsoon	Post - monsoon
Satakosia WL	Pampasar	22.415 ± 3.186	24.142 ± 4.139
	Purunakote	29.014 ± 3.412	22.417 ± 3.085
	Jilinda	33.472 ± 7.318	15.645 ± 3.329
	Tikarapada	19.787 ± 4.967	23.627 ± 6.427
	Raigoda	39.655 ± 7.931	32.410 ± 8.120
Mean of Satkosia WL		**28.868 ± 5.362**	**23.648 ± 5.02**
Mahanadi WL	Chhamundia	22.914 ± 2.127	28.956 ± 8.336
	Kusanga	15.570 ± 4.070	30.707 ± 6.669
	Banigochha W	Insufficient data	25.243 ± 4.332
	Banigochha E	Insufficient data	Insufficient data
Mean of Mahanadi WL		**9.621 ± 1.549**	**21.226 ± 4.834**
Over all Mean		**19.244 ± 3.455**	**22.437 ± 4.927**
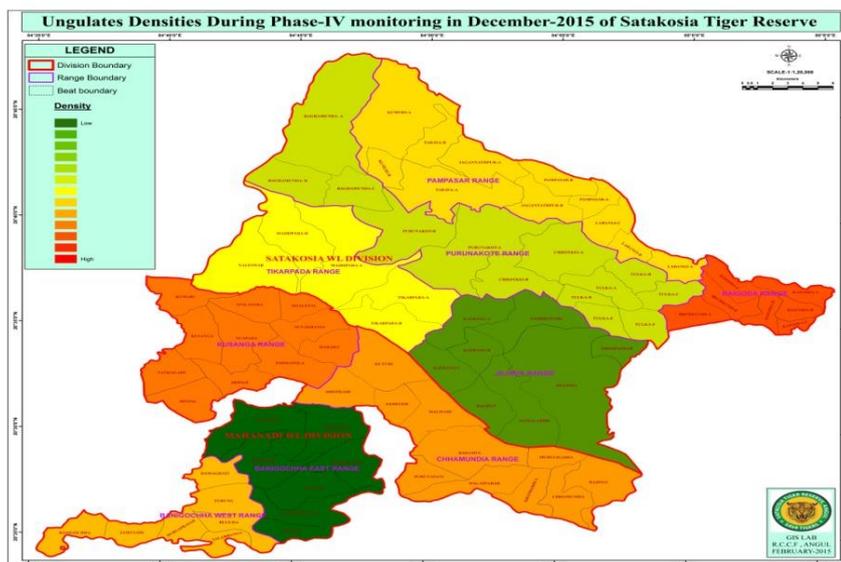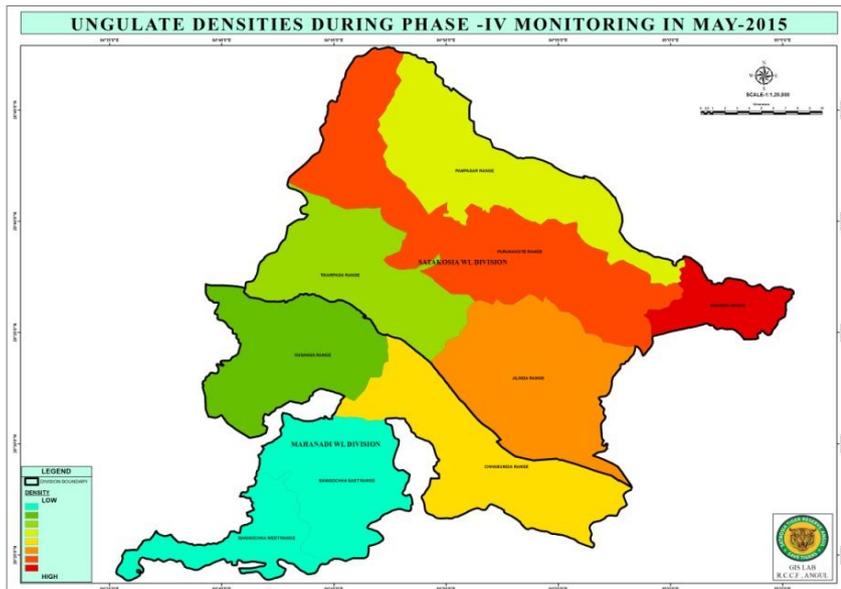
Discussion

The estimated density of barking deer in the study area was the highest followed by chital, langur, sambar and wild pig. Chital density was low in Satkosia Tiger Reserve as the species is restricted to some areas like Raigoda, Purunakote and Pampasar.

In a landscape of ever increasing fragmentation of tiger habitat, the potential for sustaining small but productive tiger populations depends primarily on maintaining high prey densities [12]. However, in Satkosia, the density of each ungulate species seems to be very low as compared to other landscapes. From another point of view the low abundance of prey species may be attributed to the unavailability of large grass meadows and suitable habitat for them. Other speculations may be attributed as the tiger reserve received from five villages present around the core areas Satkosia Tiger Reserve. Anthropogenic pressure, poaching as well as NTFP collection within the core area of the Tiger Reserve are the major factors for less number of sightings on transect lines that lead to low density of ungulates or prey species observed in Satkosia Tiger Reserve. The Satkosia area harbours three perennial rivesr (Mahanadi River, Suahagi and Nandini River) which flow throughout the year and is dominated by dense canopy cover, semi evergreen, tropical moist deciduous and with open large grassy meadows. This elevated condition of habitat heterogeneity perhaps favoured by the observed density of browsers and grazers [33]. The moist deciduous area offered favourable feeding grounds for wild pig during summer.

The ungulates or prey species play very important role in maintaining the population of predator. Thus it is essential to collect the data on the status and distribution of ungulate species and their fluctuations during adequate time intervals. Population size is an indicator by which the success of a management programe is ultimately judged. Ecologists have emphasized the important role that wild prey species play in ecosystems through their influences on the composition, productivity, nutrient cycle and succession [34] and ultimately on the population of the predator. This preliminary line transect survey gave an idea about the ungulate density available in core as well as buffer area of Satkosia Tiger Reserve. However proper management plan is required for better conservation of the ungulates whose presence is predestined for survival of tiger *Panthera tigris* and leopard *Panthera paradus* which is a high profile endangered species.

As part of our ten months rigorous field efforts (from January 2015 to December 2015) in Satkosia Tiger Reserve, Odisha, outcomes that the density of the overall prey species and each prey species seems to be very less occurrence and major in number as to other landscapes. Less abundance of prey species in this reserve may also be attributed to the unavailability of large grassy meadows and their suitable habitation. However, another reason that cannot be ignored is the large anthropogenic pressure and human interference the reserve received due to presence of human habituating around the buffer area of tiger reserve. It needs urgent attention of the line departments and local inhabitants to conserve the Satkosia Tiger Reserve before it is lost its potentiality.

Acknowledgements

References

[1] M.A. Larue, C.K. Nielsen, M.D. Grund, *Using Distance Sampling to Estimate Densities of White-Tailed Deer in South-Central Minnesota*, **The Prairie Naturalist, 39,** 2007, pp. 57-68.

[2] M. Bekoff, T.J. Daniels, J.L. Gittleman, *Life history patterns and the comparative social ecology of carnivores*, **Annual Review Ecological Systematic**, **15**, 1984, pp. 191-232.

[3] H. Kruuk, *Interactions between Felidae and their prey species: A review*, **Cats of the World: Biology, Conservation and Management** (Editors: S.D. Miller and D.D. Everett), National Wildlife Federation, Washington D.C. 1986, pp. 353-374.

[4] M.E. Sunquist, F. Sunquist, *Ecological constraints on predation by large felids*, **Carnivore Behaviour, Ecology and Evolution** (Gittleman, J. L. Ed), Cornell University Press, New York, 1989.

[5] K.U. Karanth, M.E. Sunquist, *Prey selection by tiger, leopard and dhole in tropical forests*, **Journal of Animal Ecology, 64,** 1995, pp. 439-450.

[6] D. Griffiths, *Prey availability and the food of predators*, **Ecology, 56,** 1975, pp. 1209-1214.

[7] D.W. Stephens, J.R. Krebs, **Foraging Theory,** Princeton University Press, Princeton, 1987.

[8] E. Curio, **Ethology of Predation**, Springer-Verlag, Berlin, 1976.

[9] R.J. Taylor, *Value of clumping to prey and the evolutionary response of ambush predators*, **American Naturalist, 110,** 1976, pp. 13-29.

[10] S.A. Temple, *Do predators always capture sub-standard individuals disproportionately from prey populations?*, **Ecology, 68,** 1987, pp. 669-674.

[11] V.P.W. Lowe, *Population dynamics of red deer (Cervus elaphus, L.) on Rhum*, **Journal of Animal Ecology, 38,** 1969, pp. 425-457.

[12] K.U. Karanth, B.M. Stith, *Prey depletion as a critical determinant of tiger population viability*, **Riding the Tiger: Tiger Conservation in Human Dominated Landscapes** (Editors: J. Seidensticker, S. Christie and P. Jackson), Cambridge University Press, Cambridge, 1999, pp. 100-122.

[13] M.E. Sunquist, K.U. Karanth, F. Sunquist, *Ecology, Behaviour and Resilience of the Tiger and its Conservation Needs*, **Riding the Tiger: Tiger Conservation in Human Dominated Landscapes** (Editors: J. Seidensticker, S. Christie and P. Jackson). Cambridge University Press, Cambridge, 1999, pp.5-18.

[14] H.K. Sahu, S.K. Dutta, D. Sahoo, *Study on ecological density and distribution of ungulates in Similipal Tiger Reserve, Orissa,* **Final Report,** Submitted to the Field Director, Similipal Tiger Reserve, Baripada, 2011.

[15] H.G. Champion, S.K. Seth, **The Forest Types of India**, Government of India Press, Delhi, 1968.

[16] H.O. Saxena, M. Brahmam, **The Flora of Similipal (Similipal),** Orissa, Bhubaneswar, 1989.

[17] * * *, **Similipal Now in World Net Work of Biosphere Reserves**, Information and Public Relations Department, Govt. of Odisha, Bhubaneswar, 2012.

[18] K.P. Burnham, D.R. Anderson, J.L. Laake, *Estimation of density from line transects sampling of biological populations*, **Wildlife Monograph**, **72**, 1982, pp. 1-202.

[19] S.T. Buckland, D.R. Anderson, K.P. Burnham, J.L. Laake, **Distance Sampling: Estimating Abundance of Biological Populations**, Chapman & Hall, London, 1993.

[20] K.U. Karanth, M.E. Sunquist, *Population structure, density and biomass of large herbivores in the tropical forests of Nagarahole, India*, **Journal of Tropical Ecology, 8,**

1992, pp. 21-35.

[21] J.A. Khan, R. Chellam, W.A. Rodgers, A.J.T. Johnsingh, *Ungulate densities and biomass in the tropical dry deciduous forests of Gir, Gujarat, India*, **Journal of Tropical Ecology,**

12, 1996, pp. 149-162.

[22] S. Biswas, K. Sankar, *Prey abundance and food habit of tigers (Panthera tigris tigris) in Pench National Park, Madhya Pradesh, India*, **Journal of Zoology** (London), **256**, 2002, pp. 411-420.

[23] S. Bagchi, S.P. Goyal, K. Sankar, *Prey abundance and prey selection by tiger (Panthera tigris) in a semi arid, dry deciduous forest in western India*, **Journal of Zoology** (London),

260, 2003, pp. 285-290.

[24] K.U. Karanth, J.D. Nichols, N.S. Kumar, W.A. Link, J.E. Hines, *Tigers and their prey: Predicting carnivore densities from prey abundance*, **Proceedings of National Academy of Science, USA, 101,** 2004, pp. 4854-4858.

[25] T. Ramesh, Prey selection and food habits of large carnivores (tiger, leopard and dhole) in

Mudumalai Tiger Reserve, Western Ghat, India, **PhD Thesis**, Saurastra University, 2010. [26] A. Majumder, S. Basu, K. Sankar, Q. Qureshi, Y.V. Jhala, R. Gopal, *Prey selection, food*

habits and temporal activity patterns of sympatric carnivores in Pench Tiger Reserve, Madhya Pradesh, Central India, **Journal of Scientific Transactions in Environment and Technovation, 5,** 2012, pp. 110-120.

[27] G.B. Schaller, **The Deer and the Tiger**, University of Chicago Press, Chicago, 1967.

[28] L. Thomas, S.T. Buckland, E.A. Rexstad, J.L. Laake, S. Strindberg, S.L. Hedley, J.R.B.

Bishop, T.A. Marques, *Distance software: Design and analysis of distance sampling surveys for estimating population size*, **Journal of Applied Ecology, 47,** 2010, pp. 5–14.

[29] J.H. Zar, **Biostatistical Analysis**, Englewood Cliffs, NJ, Prentice Hall, 1984.

[30] S.T. Buckland, D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers, L. Thomas,

Introduction to Distance Sampling, Oxford University Press, Oxford, 2001.

[31] L. Thomas, K.U. Karanth, *Statistical concepts: estimating absolute densities of prey*

species using line transect sampling, **Monitoring Tigers and Their Prey: A Manual for Researchers, Managers and Conservationists in Tropical Asia**, (Editors: K.U. Karanth and J.D. Nichols), Centre for Wildlife Studies, Bangalore, 2002.

[32] M. Dash, B. Behera, *Management of Similipal Biosphere Reserve Forest, Issues and*

Challenges. **Advances in Forestry Letter, 1,** 2012, pp. 7-15.

[33] J.F. Eisenberg, J. Seidensticker, *Ungulates in Southern Asia: A consideration of biomass estimates for selected habitats*, **Biological Conservation, 10,** 1976, pp. 293-307.

[34] M.J. Crawley, **Herbivore: The Dynamics of Animal-Plant Interactions**, University of

California Press, Berkeley, CA, 1983.