

**ECOLOGICAL SPECIES SORTING
IN RELATION TO HABITAT STRUCTURE IN THE SMALL CAT GUILD OF
EAGLENEST WILDLIFE SANCTUARY, ARUNACHAL PRADESH.**



**Shomita Mukherjee, Ramana Athreya,
P.V. Karunakaran, Prafull Choudhary**

2016

**ECOLOGICAL SPECIES SORTING IN RELATION TO HABITAT STRUCTURE IN THE SMALL
CAT GUILD OF EAGLENEST WILDLIFE SANCTUARY, ARUNACHAL PRADESH.**

Technical Report No. 182

Funding Agency:

Department of Science and Technology, Govt. of India

Investigators:

Dr. Shomita Mukherjee

Dr. Ramana Athreya

Dr. P.V. Karunakaran

Program Fellow:

Prafull Choudhary

November 2016



Salim Ali Centre for Ornithology and Natural History
A Centre of Excellence under the Ministry of Environment, Forests and Climate Change,
Govt. of India
Coimbatore – 641 108, Tamil Nadu, India

© Sálim Ali Centre for Ornithology and Natural History, 2016

Recommended Citation

Mukherjee S., Athreya R., Karunakaran P.V. and Choudhary P. (2016). Ecological species sorting in relation to habitat structure in the small cat guild of Eaglenest Wildlife Sanctuary, Arunachal Pradesh. Sálim Ali Centre for Ornithology and Natural History, Coimbatore, Tamil Nadu. Technical Report No. PR-182. 52 pp.

Correspondence: Dr. Shomita Mukherjee, shomitam@gmail.com

Front cover images: Camera-trap pictures from the current study, Prafull Choudhary (Leopard Cat)

Back cover image: ©Rohan Pundit

Appendix-III: Camera-trap pictures from the current study

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	iii
SUMMARY	1
CHAPTER 1: INTRODUCTION	3
1.1 Family <i>Felidae</i> :	3
1.2 Diversity and Co-existence:.....	3
1.3 Study area:	5
1.4 Climate:	8
1.5 Vegetation:.....	8
1.6 Fauna:.....	9
1.7 The Cats:.....	9
1.8 Study period:.....	10
1.9 Base Camp:.....	11
1.10 The team:	11
1.11 Objectives:	11
CHAPTER 2: METHODS.....	12
2.1 Canopy cover estimation:	12
2.2 Camera-trapping:	13
2.3 Scat collection and assignment to species:.....	16
2.4 Diet estimation:	17
CHAPTER 3: RESULTS.....	18
3.1 Canopy Cover Estimate:	18
3.2 Camera-Trapping:	18
3.3 Scat Analysis and assignment to species:	26
3.4 Diet:.....	26
CHAPTER 4: DISCUSSION:.....	28
4.1 Felids and canopy cover:.....	28
4.2 Felids and Elevation:	30
4.3 Activity patterns:.....	31
4.4 Comparison of methods:	31
4.5 Diet:.....	32
4.6 CONCLUSION:.....	32
REFERENCES	34
APPENDIX-I: List of mammals species photo-trapped in Eaglenest Wildlife Sanctuary and Bugun Community Forests (December 2014 – April 2016).....	41
APPENDIX-II: List of mammals species photo-trapped in Eaglenest Wildlife Sanctuary and Bugun Community Forests (December 2014 – April 2016).....	42
APPENDIX-III: Camera Trap images of Felids from Eaglenest Wildlife Sanctuary.....	44

LIST OF FIGURES

FIGURE 1.1: TAIL LENGTHS OF FELIDS AS A PROPORTION OF HEAD AND BODY LENGTH.....	4
FIGURE 1.2: LOCATION OF EAGLENEST WILDLIFE SANCTUARY (EWS) AND SURROUNDING AREAS.	6
FIGURE 1.3: EAGLENEST WILDLIFE SANCTUARY WITH LOCATIONS OF CAMPING SITES AND OTHER IMPORTANT PLACES.	7
FIGURE 2.1: CAMERA-TRAP PLACEMENT CONFIGURATIONS USED IN THE STUDY.	13
FIGURE 3.1: LOCATIONS OF CAMERA TRAPS IN THE STUDY AREA.	19
FIGURE 3.2: NUMBER OF MAMMALIAN SPECIES RECORDED ON TWO BROAD CAMERA-TRAP PLACEMENT CONFIGURATIONS AND VARIED EFFORT.	20
FIGURE 3.3: SPECIES-ACCUMULATION CURVE FOR MAMMALS IN EWS.....	21
FIGURE 3.4: INDEPENDENT LOCATIONS OF THE FOUR FELID SPECIES FROM EWS AND BCF AS RECORDED ON CAMERA-TRAPS.....	22
FIGURE 3.5: ZONE OF OVERLAP FOR ALL FOUR FELIDS IN EWS.....	23
FIGURE 3.6: ASSOCIATIONS OF FELID SPECIES CAPTURED ON CAMERA-TRAPS WITH CANOPY-COVER ESTIMATES IN EWS AND BCF AREA.	25
FIGURE 3.7: ACTIVITY PATTERNS OF GOLDEN CAT, LEOPARD CAT AND MARBLED CAT AS DETERMINED FROM CAMERA-TRAP DATA.	26
FIGURE 3.8: DENTITION OF MAMMALS FOUND IN SCATS OF LEOPARD CAT FROM EWS AND BCF.....	27
FIGURE 3.9: DIET OF LEOPARD CAT IN EWS AND BCF DETERMINED THROUGH SCAT ANALYSIS.	27

LIST OF TABLES

TABLE 2.1: DETAILS OF FELID SPECIFIC PRIMERS USED FOR SPECIES ASSIGNMENT.	16
TABLE 3.1: SUMMARY OF INFORMATION FROM VARIOUS CAMERA-TRAP CONFIGURATIONS.....	20
TABLE 3.2: DETAILS OF CAMERA-TRAP CAPTURES (INDEPENDENT CAPTURES WITH AN INTERVAL OF A MINIMUM OF 30 MINUTES BETWEEN SUBSEQUENT CAPTURES OF THE SAME SPECIES ON A SINGLE LOCATION) OF FOUR SPECIES OF FELIDS FROM EWS AND BCF.	22
TABLE 3.3: SPECIES OVERLAP AT CAMERA-TRAP LOCATIONS..	24
TABLE 3.4: PROPORTION OF CAPTURES FOR EACH SPECIES OF FELID IN EWS AND BCF.	24
TABLE 4.1: SUMMARY OF CAPTURE RATES PER 100 TRAP-NIGHTS (TOTAL CAPTURES X 100/ TOTAL EFFORT) ACROSS SEVERAL REGIONS.....	29

ACKNOWLEDGEMENTS

We thank the Department of Science and Technology, Government of India for funding this project and for their support towards conducting this work. We thank the Forest Department of Arunachal Pradesh for permitting us to carry out our work. We extend our special thanks to the Divisional Forest Officer of Eaglenest Wildlife Sanctuary, Mr. Millo Tasser (IFS) for his interest in our work and for extending all assistance to us throughout the duration of the project.

We wish to thank Dr. K. Sankar (Director, SACON) and Dr. P.A. Azeez, (Former Director, SACON) for all the support extended towards the smooth operation of the project.

We are grateful to the Bugun and Sherdukpen communities for welcoming us to conduct our study, extending their support throughout the field stay and for helping us understand the nuances of biodiversity conservation in their spectacularly beautiful land.

Field work would not have been possible without the support of several people, most of all our field team consisting of Mr. Puspallal Sharma, Mr. Raju Chetri, Mr. Munna Tamang, Mr. Wangchu Phiyang, Mr. Tsamu Rai, Mr. Bikki Gindan Marphew, Mr. Bayung Marphew, Mr. Samir Bora, Mr. Sange Khandu Phyang, Mr. Sonam Lama, Mr. Baba Tamang, Mr. Dipu Chetri, Mr. Raju Sharma, Mr. Changma, Mr. Nima Tsering, Mr. Montu Kalita. They helped in various ways and for varying durations served as field assistants, daily wagers and drivers. We thank Mr. Puspallal Sharma for providing his vehicle to us throughout the duration of field work and for so efficiently managing field logistics and the base-camp.

We extend our deepest thanks to Mr. Indi Glo and Mrs. Nima Glo for offering us camping facilities at Ramaling and Lama Camps. Mr. Indi Glo's passion for forests and wildlife and his persistent encouragement of research and conservation in that region is truly heart-warming. He helped in myriad and crucial ways towards the successful completion of the project.

We are extremely grateful to Mr. Nima and Mrs. Suntali Tsering Monpa and their family for their warmth and generosity especially during rough times. They were an anchor for the field team who spent many a day at their home, celebrated festivals and occasions together, which kept their spirits high. Nima always looked out for the team and made sure they were safe and their requirements were met.

At Ramaling, Lama and Bompou Camps the staff were always warm, welcoming and endlessly entertaining. Ms. Nima Marphew, Ms. Passang Lamu Monpa, Mr. Lobsang Marphew, Mr. Gombu and Mrs. Pushpa Tsering, Mr. Mondorjee Tamang, Mr. Subhash Tamang, Mr. Tashi Phuntso Lhopa, Mr. Dinesh Subba, Mr. Dinesh Thapa, Mr. Dipender Subedi, Mr. Sang Tsering Phiyang, Mr. Swaraj Sreeni, Mr. Phurpa, Gore, Mr. Lobsang Monpa, Mr. Bijoy Rajak are among those who helped us to successfully complete this project. We apologise if we have left out any names.

Although Khellong was beyond the limits of our delineated study area, during the reconnaissance we traversed through the entire PA and at Khellong chowki we were welcomed by the Forest Guard Mr and Mrs. Wangdi Tsering. We thank them for their kindness. Several cold winter days were spent drinking piping hot tea and eating delicious pakoras at the Khellong chowki. We thank Ms. Ushma Shukla and her team for the hospitality they provided during our stay at Sisni. Mr. Rohan Pundit from Dr. Ramana Athreya's team helped us tremendously during the reconnaissance and in many ways throughout the field study. We thank him in all earnestness. We thank Ms. Satem Longchar for volunteering over one summer during the reconnaissance period. We thank Dr. Nima Manjrekar for visiting Eaglenest and helping with field work during one winter session. She introduced the inflatable camp lantern to us which was of great help! Ms. Anushka Rege and Mr. Bind Borah visited EWS during

one summer session and we thank them for their help with field work. We thank Dr. Umesh Srinivasan for offering his camp facilities at Bompou and for his inexhaustible ability to amuse and entertain!

We are very grateful to Dr. Ramana Athreya's Laboratory at IISER Pune for the help and support provided during laboratory analysis. Mr. Chintan Seth helped with vegetation and imagery analysis and we deeply appreciate his contribution. We are grateful to Ms. Mansi Mungee for assisting in numerous ways and enabling us to work efficiently in the laboratory. At IISER Pune there were many others who helped in several aspects. We are grateful to Dr. Deepak Barua for lending us his microscope for diet analysis and the staff at the Microscopy Section for help with photographing rodent dentition, the Computer Section for assistance with internet facilities and troubleshooting, Dispatch Section for help in couriering samples for sequencing, the Housekeeping staff for the smooth functioning of laboratory work and the Guest House and Canteen staff for their cordiality during the visits of the PI to IISER, Pune.

We thank Dr. Jim Sanderson for introducing us to the camera-trap analysis software that enabled us to analyse our data with ease. We thank Dr. V.B. Mathur, Director Wildlife Institute of India (WII) and Dr. G.S. Rawat, Dean WII for extending support to train Prafull Choudhury in GIS techniques. We are grateful to Mr. Qamar Qureshi and the Computer section of WII for training Prafull in GIS techniques. We thank Mr. Qamar Qureshi, Dr. Sushma HS, Dr. Devcharan Jathana and Dr. Rajah Jayapal for sparing their time over long discussions on analysis and interpretation of data, Mr. Gautam Narayan and Ms. Nandita Hazarika for their help on several occasions in Guwahati, Ms. Priya Singh, Dr. Aparajita Datta, Ms. Nandini Velho, Dr. Divya Mudappa, Dr. Kashmira Kakati for help with identification of some mammals from camera-trap pictures, Mr. Pankaj Koparde for help with analysis and Medauxin for their sequencing services. We are grateful to Dr. Shyamkant Talmale, ZSI/CZRC, Jabalpur, for his help in identifying some rodents from the teeth found in scats.

We thank the Administration and Finance Divisions and all staff members of the Library at SACON for their support and contribution in ensuring the smooth operation of the project. We thank the entire staff, faculty and students of SACON for their support during this project.

SUMMARY

The remarkable richness in felid diversity seen in India can be attributed to colonisation events facilitated by India's geographical location at the confluence of major biogeographic realms and the vast array of ecosystems and habitats to support these species. Within India the North Eastern region is among the richest in felids with nine species. Owing to their extreme similarity in morphology, physiology and behaviour, interspecies competition can be expected to be very high among felids. Most forests of North-East India harbour an assemblage of at least four species (Clouded Leopard: *Neofelis nebulosa*, Golden Cat: *Catopuma temminckii*, Marbled Cat: *Pardofelis marmorata* and Leopard Cat: *Prionailurus bengalensis*). The Ecological Species Sorting hypothesis suggests that habitats and species morphologies are tightly associated, allowing segregation over a gradient. Studies on felids elsewhere have demonstrated that segregation over space and in morphology enables species to coexist.

This study aimed to investigate this further, using tail lengths of felids to predict the kind of habitat structures that the species would occupy. We predicted that the long-tailed Marbled Cat and Clouded Leopard and the short-tailed Jungle Cat would be habitat specialists and would be restricted to closed and open canopy forests, respectively while the medium-tailed felids (Golden Cat and Marbled Cat) would be habitat generalists. We expected that a combination of spatial segregation, body size and hence diet enables high felid diversity in regions such as North-East India. We chose Eaglenest Wildlife Sanctuary (EWS) as our study area since it is part of a large Protected Area (PA) complex and harbours a wide range of altitudinal gradients and hence habitat diversity. Moreover, logistical constraints that often impede detailed studies in other regions of North-East India were absent in EWS due to the presence of a motorable road, camping sites and trained manpower.

The project was initiated in December 2013 but due to a delay in obtaining permits from the Forest Department, we could begin field work only in September 2014. We concluded field work in April 2016. Due to the reduction of time allotted we were unable to analyse the LISS IV imagery data that we had planned at the onset. However, we collected information on canopy cover as part of the ground-truthing exercise for the GIS analysis. We deployed 30 infra-red camera traps in various configurations to obtain information on the diversity and presence of felids in EWS and the surrounding Bugun Community Forests (BCF). We collected scats and preserved them in alcohol for further analysis to assign them to felids using molecular techniques and to estimate diet of each species of felid.

Results of canopy cover estimates showed that the area under EWS has higher canopy cover on average than the BCF land (2-tailed Student's t-Test: $n=767$, $df=632$, $t\text{ Stat}=9.68$, $P=0.00$). A total

of 27 mammalian species were recorded of which there were 13 species of carnivores including four species of felids. The species-accumulation plot showed that most species were recorded by the 45th day. Four species of felids (Leopard Cat, Golden Cat, Marbled Cat and Clouded Leopard) were recorded from EWS and the surrounding community forests. Jungle Cat was not recorded on any of our camera traps. There were 71 independent locations of felids in EWS and BCF of which 70% were from within the PA. Three felid species were found in BCF (Leopard Cat: 10 of 32 locations, Golden Cat: 8 of 22 locations, Clouded Leopard: 1 of 5 locations and the House Cat: 2 locations). The Marbled Cat (11 locations) was found only inside EWS. Using the Minimum Convex Polygon method and independent records of felids we found that Leopard Cat encompassed an area of 49.08 km², Golden Cat: 33.49 km², Marbled Cat: 10.12 km² and Clouded Leopard: 9.12 km². The area of overlap of the four wild felid species was estimated at 5.94 km² and was between Sundarview and Bompou Camp within EWS. A plot of the presence of each felid species with the associated canopy cover showed that the Marbled Cat and Clouded Leopard occur in very dense/closed canopy habitats as expected, while the Leopard Cat and Golden Cat occur in moderate canopy cover. The Marbled Cat and Leopard Cat, with similar body mass differed the most in habitat use and activity patterns. The Marbled Cat was largely diurnal while the Leopard Cat was nocturnal. Four morphs of Golden Cat were recorded from a small area of 34 km².

A total of 427 scats were collected. All scats were analysed for predator identity and 248 (66%) of these were felid scats. Of the 248 assigned to felid species, 239 scats were of Leopard Cat, five of Golden Cat, one of Clouded Leopard, one of House Cat and two were not identifiable because of poor quality sequences. No Marbled Cat or Jungle Cat scat was detected. The diet of the Leopard cat consisted chiefly of rodents (Bootstrap means of 6000 iterations: 73.6% and 95% CI: 66.3% - 81.1%, n = 122 scats). We were able to differentiate four species of rodents in Leopard Cat scats from dental patterns. A *Rattus sp.* suspected to be *R. andamanensis* was the most commonly eaten rodent (Bootstrap means of 6000 iterations = 56.3% scats; 95% CI: 47.5% - 64.7%), followed by a vole (suspected *Eothenomys melanogaster*) (Bootstrap means of 6000 iterations = 18%; 95% CI: 11.5% - 25.4%) and unidentified rodents found in less than 5% of the scats. An insectivore (species not identified) was also eaten (Bootstrap means of 6000 iterations = 5.8%, 95% CI = 2.5% - 9.8%). A comparison of diets inside and outside the PA showed that a higher proportion of voles were consumed inside EWS than outside. Bird remains were found only in scats from within EWS. Though we expected to locate scats of all felids, 96% of scats collected were of Leopard Cat. Our results showed that camera-trapping is a more efficient method to determine felid presence and habitat use but scats could be used to support the information obtained through camera-traps as well as provide information on diet which cannot be obtained in any other way.