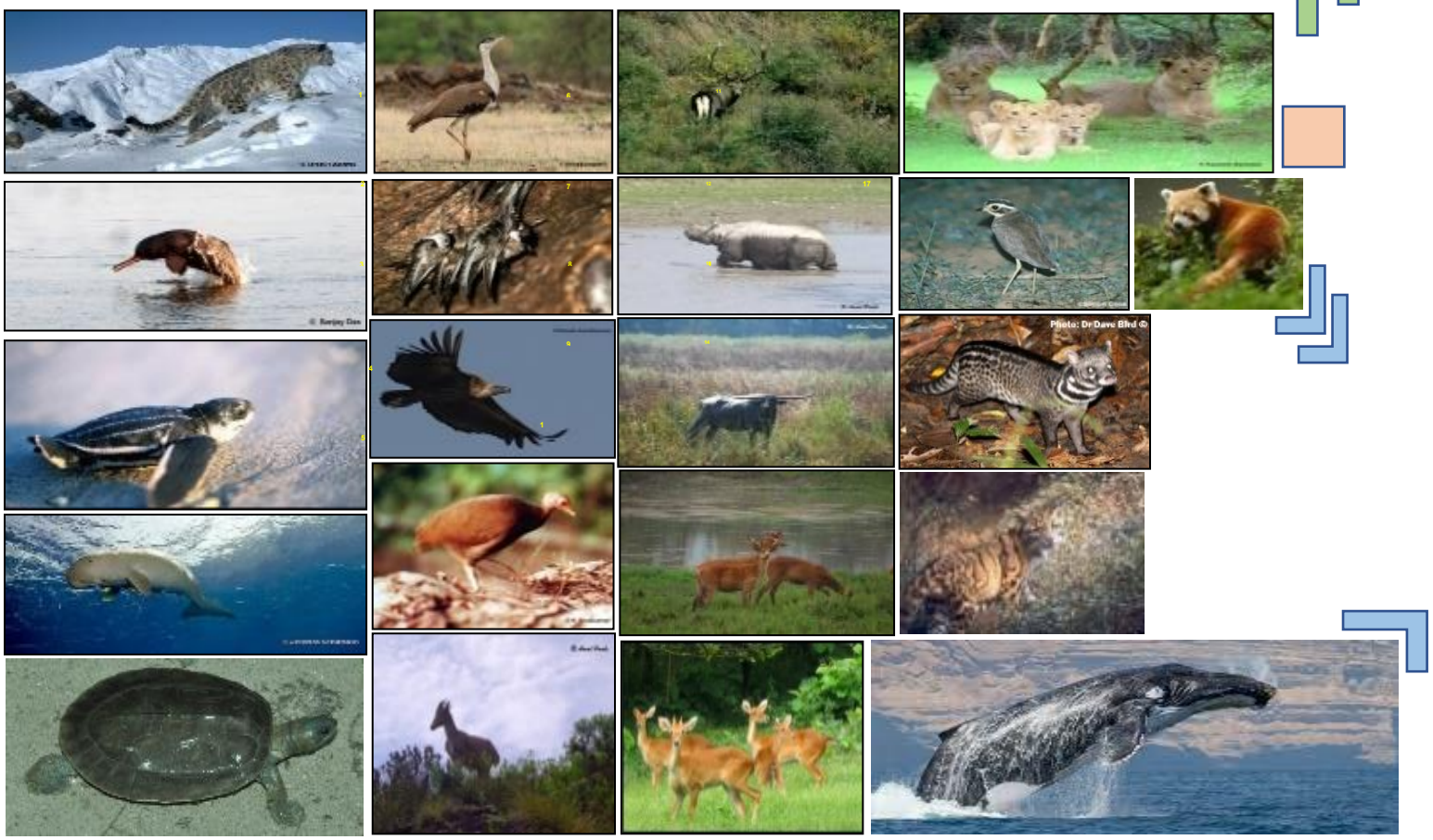
PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC

Project Progress Report (September 2023)



भारतीय वन्यजीव संस्थान
Wildlife Institute of India

PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC

List of Progress Reports

S.No.	Project Name	Page No
1	Snow Leopard	1
2	Hangul	10
3	Nilgiri Thar	15
4	Marine Turtles	24
5	Andaman Edible Swiftlet	27
6	Wild Buffalo	34
7	Nicobar Megapode	43
8	Vultures	51
9	Malabar Civet	55
10	Great Indian Onehorned Rhinocores	61
11	Asiatic Lions	67
12	Swamp Deer	71
13	Jerdon's Courser	78
14	River Terrapin *Batagur Baska*	85
15	Clouded Leopard	95
16	Asiatic Sea Humpbacked Whale	109
17	Red Panda	116
18	Caracal	128
19	Habitat Monitoring	131

PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Snow Leopard (*Panthera uncia)*

2. SUPERVISOR: Dr. S. Sathyakumar

3. BRIEF BACKGROUND:

The Snow Leopard is the apex predator of the trans-Himalayan and the high altitude (>3,000m) of the Himalaya and has been recognized as a flagship species for conservation of high-altitude regions of India (PSL 2006). Accurate population estimation and monitoring is a crucial ecological indicator, reflecting high-altitude ecosystems' broader health and resilience (Alexander et al., 2016). Besides its ecological significance, the Snow Leopard holds cultural and economic importance, embodying a symbolic representation of local communities (Chetri et al., 2017).

Keeping this in mind, the MoEFCC had launched the Project Snow Leopard (PSL) in 2006, a centrally sponsored project to plan and implement conservation and management programmes at the landscape level involving local communities (PSL, 2006).. Under the PAN India Endangered Species Monitoring under the Integrated Development of Wildlife Habitat (IDWH) Program, the Snow Leopard has been identified as one species for population estimation and monitoring. Prior to this in 2019, the MoEFCC in consultation with all the CWLWs and senior officials of the SL range states, and biologists developed the Snow Leopard Population Assessment in India (SPAI). The nodal institute for SPAI is WII including technical support for two states/UTs viz., Uttarakhand and Ladakh. While, the Nature Conservation Foundation (NCF), World Wide Fund- India (WWF-India) provided technical support for J&K

& Himachal Pradesh, the WWF-India provided technical support to Arunachal Pradesh and Sikkim. Moving forward, IDWH and SPAI lay a strong groundwork for continuous monitoring, conservation plans, and cooperative projects necessary for safeguarding snow leopards and associated species in the Indian Himalayas.

4. OBJECTIVES

- Occupancy-based assessment of Snow Leopard distribution
- Long-term monitoring protocols for the population Status and habitat of Snow Leopard

5. APPROACH /METHODOLOGY

a) **Occupancy-based assessment of Snow Leopard distribution:** The primary objective of STEP I was to understand Snow Leopard distribution in India thoroughly. Snow Leopard potential distribution ranges were divided into uniform grids (15x15 km), and the actual presence of snow leopards was assessed by sampling through the occupancy method framework (Mackenzie et al. 2006). Information on Snow Leopard occurrence was compiled from 448 questionnaires from 42 (15x15 km) grids. Key informants (tour guides, porters, headers, paramilitary personnel and local people) were questioned about the occurrence of Snow Leopard and their prey species in their area of knowledge. Interviews focus on direct or indirect detections made by the person being interviewed. Respondents who failed to identify the species from the images and could not provide reliable information on the location of species detection were excluded from the analyses. Information received for 15x15 grids from each division was compiled into Excel sheets. The occurrence information from questionnaire surveys was arranged in a detection/non-detection (1/0) framework. Each interviewee's report from a particular site was assigned as a replicate survey within the site. Site covariates (terrain

complexity, elevation, vegetation index) that could influence the snow leopard's probability of site use were modelled using logistic insertions in the occupancy framework using the unmarked package in R software. Survey covariates that could have influenced the probability of detecting and reporting a species to the surveyor were also used to model detection probability. These included respondents' age, profession, duration (in years) of familiarity with their area of knowledge, and time spent in that area annually (Ghoshal et al., 2019), the top model predicted the probability of sites used in unsampled areas.

b) **Long-term monitoring protocols for the population status and habitat Snow leopard:** Camera Trapping efforts Step II entails estimating the population through intensive camera trap sampling in areas within each stratum (identified in Step I), capturing spatial variation in Snow Leopard density. Step I assessment provides the basis for the camera trap site level sampling approach- ensuring that camera trap surveys occur in each stratum. Areas for step II sampling within different strata were delineated. Camera trap sampling across identified grids was carried out using the spatial capture-recapture method (SCR) framework (Royle & Young, 2008). Forest department officials, collaborating NGOs and researchers from the Wildlife Institute of India deployed cameras based on Snow Leopard signs such as scat, spray or scrape marks and suitable habitats such as cliffs or animal trails to maximize the capture of snow leopards. Major valleys in various high-altitude regions were approached by trekking trails, herder's routes, or walking along rivers and tributaries to their sources (glaciers). The method requires snow leopards to be sampled long enough to be encountered at multiple locations within the sampling area. Both side and single-side camera traps were used to optimize the area coverage and identification of individuals.

Spatial capture-recapture

The resulting spatial encounter history data were analyzed using SCR methods (Royle & Young, 2008) implemented in R using the package oSCR (Sutherland et al., 2019). Individual snow leopards were identified using their unique coat patterns from camera trap pictures. Individuals who could not be identified because of poor picture quality (e.g., blurry, overexposed) were excluded from the analyses. Sex was determined using cues such as the presence of visible genitals or the presence of accompanying cubs. Cubs were excluded from the analysis. For the analysis, individuals captured on both sides, right and left flank and individuals with one side flank for whom maximum captures were recorded were used (Augustine et al., 2018). To accurately identify the Snow Leopard individuals, the photographs from each sampling block were independently reviewed and compared by 2 to 3experienced researchers. Based on the individual identification, a capture history of Snow Leopard individuals was generated for each camera site. A matrix of individual capture histories, camera trap operation (effort) and camera trap locations were prepared for the SCR analysis. Cubs captured with their mother were not included in the analysis.

To account for the fact that snow leopards are unlikely to have circular space-use patterns, the ecological distance SCR model was used, that allows for non-Euclidean distance estimation (Sutherland et al., 2015). Using this least-cost path approach enables the estimation of one or more resistance parameters ($\alpha 2$) that quantitate how movement is influenced by local landscape structure (Sutherland et al., 2019). Because sex is a partially observed individual attribute, the data was analyzed using the class-structured likelihood that allows for missing sex information (Royle et al., 2015). The state space was defined (the area within which detectable Snow Leopard activity centers are expected to occur) as a regular grid of points using a 40-km buffer around the camera trap locations (large enough to include activity centres of all individuals

exposed to detection on the cameras, (Royle et al., 2015) and a resolution of 2 km (fine enough to approximate continuous space but coarse enough for computational tractability). Points that were deemed unsuitable (glaciers, >5300 m), that is, that have a negligible probability of containing Snow Leopard activity centers were excluded from the state space.

The data was analyzed in a multi-session framework, which allows combining data from several sessions and enables the fitting of models with parameter values that apply across sessions. The camera trapping data from all the areas was arranged in three sessions based on the sampling period. To understand the influence of terrain on Snow Leopard movement, layers of mean slope and ruggedness were generated. The effect of both Euclidean and ecological distance models on Snow Leopard movement was tested, and the best model was used to fit the rest of the parameters: density (D), detection (p) and space use (σ). Negligible temporal variation in detectability within each session was assumed, and all encounters were collapsed into a single count. Density was modelled and tested as a function of three topographical (elevation, ruggedness, slope), one vegetation (Normalized Difference Vegetation Index) and two anthropogenic activity-related (distance to human settlements and protection status) variables. Detection probability was also examined for the effect of sex and camera trapping effort. Space use was modelled for sex and session. Models were selected based on the Akaike Information Criterion (AIC) (Burnham, K. P., & Anderson, 2004). Pearson correlation tests were performed to examine any multi-collinearity between covariates. The best model was used to predict realized density (number of individual activity centers per state space pixel, (Morin et al., 2017).

6. PROGRESS TILL DATE:

The sampling exercises involved 1554 camera trap locations, identifying 242 unique Snow Leopard individuals. These comprehensive findings allow for estimating a total Snow Leopard

population of 709 individuals in India, underscoring the significance of the research in enhancing the understanding of Snow Leopard populations in these critical areas (Table 1).

Session	No. of Camera traps	No. of Unique Individuals	Density Estimates (#/100 sq. km)	Estimated Number of Snow Leopards
Ladakh	956	126	0.34	477
Jammu and Kashmir	278	9	0.75	-
Himachal Pradesh	284	44	0.08-0.37	51
Uttarakhand	20	41	0.7 to 1.04	124
Sikkim	99	14	0.4	21
Arunachal Pradesh	16	8	0.26	36
Total	1554	242	-	709

Table: Snow Leopard population estimates in two Union Territories (Ladakh and J&K) and four states (Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh and Sikkim) of India.

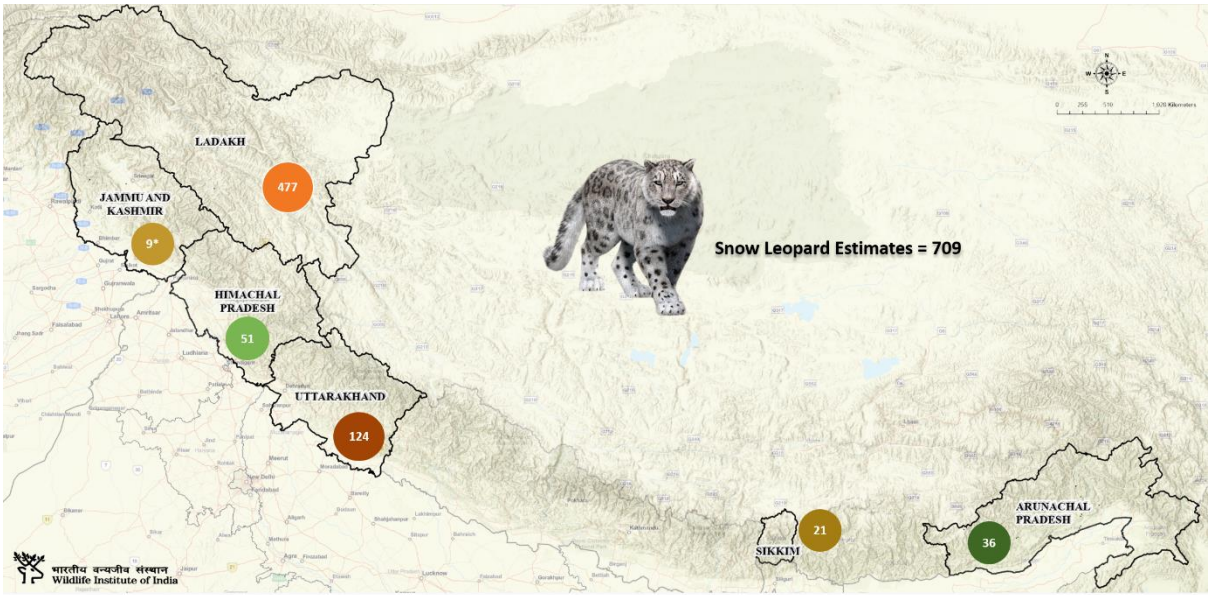


Figure:1 Individual Snow Leopard counts in India indicated each state and union territory. The results show the highest estimates from Ladakh (126), followed by Himachal Pradesh (44) and Uttarakhand (41)

7. PROPOSED PLAN OF WORK (FOR 2023-24)**:**

We will conduct intensive camera trapping in gap areas and assess the population status of the snow leopard's main prey species, camera trapping should be done at the finest scale. To track the changes and trends in the Snow Leopard population and habitats over time, we will analyze the field data to estimate the population density of the Snow Leopard and its prey, movement ecology of the Snow Leopard with respect to seasonal changes, connectivity among the habitats and increasing human pressure due to various activities in the distribution range.

8. BUDGET RECEIVED & AMOUNT SPENT:

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower (Salary & Field Assistants)	30,85,000.00	**18,51,000.00**	12,12,925.50	0.00	**12,12,925.50**	**6,38,074.50**
2	Vehicle Hiring	43,20,000.00	**25,92,000.00**	0.00	0.00	**0.00**	**25,92,000.00**
3	Travel & Field Accommodation	10,00,000.00	**6,00,000.00**	87,780.00	0.00	**87,780.00**	**5,12,220.00**
4	Equipment (Field & Laptops)	24,50,000.00	**14,70,000.00**	4,70,712.00	18,31,950.00	**23,02,662.00**	**-8,32,662.00**
5	Consumables	25,00,000.00	**15,00,000.00**	0.00	0.00	**0.00**	**15,00,000.00**
6	Workshops	15,00,000.00	**9,00,000.00**	0.00	0.00	**0.00**	**9,00,000.00**
7	Contingency (Insurance & Publications)	1,45,000.00	**87,000.00**	16,986.00	0.00	**16,986.00**	**70,014.00**
Total		**1,50,00,000.00**	**90,00,000.00**	**17,88,403.50**	**18,31,950.00**	**36,20,353.50**	**53,79,646.50**
						Less : Forest Advance	3,55,000.00
						Less : Tour Advance	45,000.00
Balance							**49,79,646.50**

REFERECE:

1. Alexander, J. S., Zhang, C., Shi, K., & Riordan, P. (2016). A granular view of a Snow

Leopardpopulation using camera traps in Central China. *Biological Conservation*, *197*, 27–31. https://doi.org/10.1016/j.biocon.2016.02.023

2. Augustine, B. C., Royle, J. A., Kelly, M. J., Satter, C. B., Alonso, R. S., Boydston, E. E., & Crooks, K. R. (2018). Spatial capture–recapture with partial identity: An application to camera traps. *The Annals of Applied Statistics*, *12*(1). https://doi.org/10.1214/17-AOAS1091
3. Burnham, K. P., & Anderson, D. R. (2004). *Model Selection and Multimodel Inference* (K. P. Burnham & D. R. Anderson (eds.)). Springer New York. https://doi.org/10.1007/b97636
4. Chetri, M., Odden, M., & Wegge, P. (2017). Snow Leopardand Himalayan Wolf: Food Habits and Prey Selection in the Central Himalayas, Nepal. *PLOS ONE*, *12*(2), e0170549. https://doi.org/10.1371/journal.pone.0170549
5. Ghoshal, A., Bhatnagar, Y. V., Pandav, B., Sharma, K., Mishra, C., Raghunath, R., & Suryawanshi, K. R. (2019). Assessing changes in distribution of the Endangered Snow LeopardPanthera uncia and its wild prey over 2 decades in the Indian Himalaya through interview-based occupancy surveys. *Oryx*, *53*(4), 620–632. https://doi.org/10.1017/S0030605317001107
6. Kachel, S. M., McCarthy, K. P., McCarthy, T. M., & Oshurmamadov, N. (2017). Investigating the potential impact of trophy hunting of wild ungulates on Snow LeopardPanthera uncia conservation in Tajikistan. *Oryx*, *51*(4), 597–604. https://doi.org/10.1017/S0030605316000193
7. Mackenzie, D.I. Nichols, J.D. Royle, J.A. Pollock K.H., Bailey, I.I. & Hines, J. E. (2006). *Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence*. Academic press, San Deigo, USA.
8. Ministry of Environment, F. and W. W. I. of I. N. C. F.-S. L. T. and G. S. L. and E. P. P.-P. A. P. (2019). *SNOW LEOPARDPOPULATION ASSESSMENT IN INDIA. Population Assessment of World's Snow Leopards*.
9. Morin, D. J., Fuller, A. K., Royle, J. A., & Sutherland, C. (2017). Model-based estimators of density and connectivity to inform conservation of spatially structured populations. *Ecosphere*, *8*(1). https://doi.org/10.1002/ecs2.1623
10. PSL 2006. Project Snow Leopard. Ministry of Environment, Forest and Climate change, Government of India.
11. Royle, J. A., Sutherland, C., Fuller, A. K., & Sun, C. C. (2015). Likelihood analysis of spatial capture-recapture models for stratified or class structured populations.

Ecosphere, *6*(2), art22. https://doi.org/10.1890/ES14-00148.1

12. Royle, J. A., & Young, K. V. (2008). A hierarchical model for spatial capture recapture data. *Ecology*, *89*(8), 2281–2289. https://doi.org/10.1890/07-0601.1
13. Sutherland, C., Fuller, A. K., & Royle, J. A. (2015). Modelling non-Euclidean movement and landscape connectivity in highly structured ecological networks. *Methods in Ecology and Evolution*, *6*(2), 169–177. https://doi.org/10.1111/2041-210X.12316
14. Sutherland, C., Royle, J. A., & Linden, D. W. (2019). oSCR: a spatial capture–recapture R package for inference about spatial ecological processes. *Ecography*, *42*(9), 1459–1469. https://doi.org/10.1111/ecog.04551
15. Zakharenka, A., Sharma, K., Kochorov, C., Rutherford, B., Varma, K., Seth, A., Kushlin, A., Lumpkin, S., Seidensticker, J., Laporte, B., Tichomirow, B., Jackson, R. M., Mishra, C., Abdiev, B., Modaqiq, A. W., Wangchuk, S., Zhongtian, Z., Khanduri, S. K., Duisekeyev, B., … Yunusov, N. (2016). The Global Snow Leopardand Ecosystem Protection Program. In *Snow Leopards* (pp. 559–573). Elsevier. https://doi.org/10.1016/B978-0-12-802213-9.00045-6

PAN India Assessment and Monitoring of endangered species covered under theDevelopment of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Hangul (*Cervus hanglu hanglu*)

2. SUPERVISORS: Qamar Qureshi, Parag Nigam, Vishnupriya Kolipakam, Lallianpuii Kawlni

3. BRIEF BACKGROUND:

The hangul, scientifically known as Cervus hanglu hanglu, once believed to be an easternmost subspecies of the red deer (Cervus elaphus), has been reclassified as a subspecies of the Tarim red deer (Cervus hanglu). This reclassification includes the Yarkand or Tarim deer (Cervus hanglu yarkandensis) from northwestern China and the Bactrian or Bukhara deer (Cervus hanglu bactrianus) from western Central Asia (Ahmad et al., 2023).

At the species level, C. hanglu is currently categorized as "Least Concern" on the IUCN Red List (Brook et al., 2017a). However, the Kashmir subspecies, C. hanglu hanglu, is critically endangered (Brook et al., 2017b). It holds the status of a Schedule I species under the Indian Wildlife (Protection) Act, 1972, and is a conservation priority species in the National Wildlife Action Plan (2017–2031) of India (Ahmad et al., 2021).

The hangul is endemic to the mountains of the Kashmir Valley (Prater, 1980; Grzimek, 1990; Geist, 1998; Nowak, 1999). While it was once distributed widely along the Greater Himalayan mountain range in Kashmir (Gee, 1966; Holloway & Wani, 1970), the hangul population is now restricted to Dachigam National Park, with only a few remaining herds in nearby areas (Ahmad et al., 2009, 2013, 2015, 2021; Qureshi et al., 2009).

The hangul population exhibits a female-biased structure and a low calf-to-hind ratio, attributed to predation by leopards (Panthera pardus), meso-carnivores (foxes, Vulpes vulpes, jackals, Canis aureus), and domestic dogs associated with local security forces and nomadic livestock grazers (Ahmad et al., 2009, 2015, 2021; Qureshi et al., 2009). Poaching has been a significant limiting factor and has been further exacerbated by challenges in patrolling due to the presence of insurgents and armed forces (Ahmad et al., 2009; Qureshi et al., 2009). Consequently, genetic heterozygosity has decreased (Ahmad et al., 2009; Mukesh et al., 2013; Ahmad & Nigam, 2014; Lorenzini & Garofalo, 2015; Kumar et al., 2016).

While precise estimates are lacking, historical records suggest a substantial decline in the hangul population. In the first half of the 20th century, their numbers decreased from an estimated 5,000 in 1900 to 2,000 by 1947 (Gee, 1966; Schaller, 1969). This decline persisted into more recent times (Ahmad et al., 2009, 2013, 2015; Qureshi et al., 2009). The latest estimates indicate a population ranging from 175 to 190 individuals (Ahmad et al., 2021; Charoo et al., 2021), underscoring the critical status of this subspecies. These trends suggest that the hangul population may be facing an extinction vortex due to its small size, limited genetic diversity, and fragmented range.

This study presents the findings from 19 years of hangul monitoring, offering updated demographic parameters. To assess the likelihood of the current population declining to extinction, a population viability analysis was conducted (Lacy et al., 2017). The primary objective was to generate realistic demographic projections that reflect hangul population dynamics and growth. In addressing uncertainties associated with demographic processes in small populations, both deterministic and stochastic formulations were employed (Lacy et al., 2017). Multiple scenarios were developed to evaluate the probability of extinction, providing valuable insights for conservation planning. These insights are crucial for the development of science-based management policies, the prioritization of conservation actions, and ensuring the long-term survival of this highly endangered subspecies endemic to the Kashmir Himalayas.

The presence of livestock in the upper reaches of Dachigam National Park and its adjacent unprotected areas poses a significant threat to the long-term survival of the hangul, an endangered species. Livestock have displaced wildlife species like elk and red deer, leading to reduced habitat quality and negatively affecting the hangul population. Addressing this issue is critical to prevent further population declines. Due to the small population size and demographic fluctuations, it is essential to restock the hangul in suitable habitats within its historical range. The Shikargah Conservation Reserve, which houses the only conservation breeding center for the hangul, is a suitable location for restocking. The Overa-Aru Wildlife Sanctuary also offers potential for establishing a second hangul population.

To initiate this restocking program, it is necessary to transfer young hangul individuals from the

wild population in Dachigam National Park. The involvement of stakeholders, administrative bodies, and support from the scientific and conservation community is vital to implement these recommendations effectively.

4. OBJECTIVES:

a) Development of long-term monitoring protocols for hangul population and their habitats.
b) Develop conservation action plan

5. APPROACH /METHODOLOGY:

a) Population Assessment: The status of the population of hangul will be assessed through line transect and camera trap distance sampling,
b) Mapping of potential hangul habitat.

6. PROGRESS TILL DATE:

a) Literature Review of current status of hangul in India is completed
b) Monitoring method will be tested and implemented in winter.
c) Proposed conservation action plan for hangul is under progress.

7. PLAN OF WORK (FOR 2023-24)**:**

a) Workshop with stakeholders will be conducted
b) In March, action plan will be submitted

8. BUDGET RECEIVED & AMOUNT SPENT:

Total Funds Approved	Funds Received (60% of Total Amount) FY 2021-22	Committed Indents	Total Expenditure Including Committed	Balance
10,00,000.00	6,00,000.00		-	6,00,000.00

REFERENCE:

1. AHMAD, K. & NIGAM, P. (2014) Kashmir red deer or hangul Cervus elaphus hanglu at the brink of extinction – conservation action, the need of an hour. IUCN-DSG Newsletter, 26, 37-47.

2. AHMAD, K., NIGAM, P., NAQASH, R.Y. & QURESHI, Q. (2021) Final Field Technical Report: Long Term Conservation Plan for Hangul Part II: Hangul Movement Pattern Study Using GPS-Satellite Telemetry. SKUAST-Kashmir, Srinagar, India, and Ministry of Environment, Forests and Climate Change, Government of India, New Delhi, India.

3. AHMAD, K., PERELADOVA O., NIGAM, P. QURESHI, Q. & NAQASH, R.Y. (2023) Hangul/Tarim deer Cervus hanglu. In Deer of the World (eds M.M. Melleti & S. Focardi). Springer, Cham, Switzerland.

4. AHMAD, K., QURESHI, Q., AGORAMOORTHY, G. & NIGAM, P. (2015) Habitat use patterns and food habits of the Kashmir red deer or hangul (Cervus elaphus hanglu) in Dachigam National Park, Kashmir, India. Ethology Ecology & Evolution, 28,85-101.

5. AHMAD, K., QURESHI, Q., NIGAM, P. & SUHAIL, I. (2013) Status and conservation of hangul (Cervus elaphus hanglu) in its relic range areas outside Dachigam National Park, Kashmir. Indian Forester, 139, 883-887.

6. AHMAD, K, SATHYAKUMAR, S. & QURESHI, Q. (2009) Conservation status of the last surviving wild population of hangul or Kashmir deer Cervus elaphus hanglu in Kashmir, India. Journal of the Bombay Natural History Society 106,245-255.

7. BROOK, S.M., THAKUR, M., RANJ ITSINH, M.K., DONNITHORNE-TAIT,D. & AHMAD, K. (2017b) Cervus hanglu ssp. hangul. In The IUCN Red List of Threatened Species
8. .

9. BUCKLAND, S.T., REXSTAD, E.A.,MARQUES, T.A. & OEDEKOVEN, C.S.(2015) Distance Sampling: Methods and Applications. Springer, New York, USA.

10. CHAROO, S, DENTOO, M.A. & NAQASH, R.Y. (2021) The Annual Hangul Census 2020. Internal Report. Department of Wildlife Protection, Jammu and Kashmir Government, Srinagar, India.

11. CLUTTON-BROCK, T.H., GUINNESS, F.E. & ALBON, S.D. (1982) Red Deer: Behavior and Ecology of Two Sexes. University of Chicago Press, Chicago, USA.

12. CLUTTON-BROCK, T. H. & IASON, G. R. (1986) Sex ratio variation in mammals. The Quarterly Review of Biology, 61,339-374.

13. CLUTTON-BROCK, T.H., MAJOR, M. & GUINNESS, F.E. (1985) Population regulation in male and female red deer. Journal of Animal Ecology, 51,831-846.

14. FLINT, A.P.F., ALBON, S.D. & JAFAR, S.I. (1997) Blastocystm development and conceptus sex selection in red deer Cervus elaphus: studies of a free-living population

on the isle of Rum. General and Comparative Endocrinology, 106,374-383.

15. FRANKLIN, W.L. (1979) The social organization of a sedentary population of North American elk: a model for understanding other populations. In North American Elk: Ecology, Behavior, and Management. Proceedings of a Symposium on Elk ecology and Management (eds M.S. Boyce & L.D. Hayden-Wing), pp.85–198. University of Wyoming, Laramie, USA.

16. GEE, E.P. (1966) Report on the status of the Kashmir stag;October 1965. Journal of the Bombay Natural History Society,62,379-393.

17. GEIST, V. (1998) Deer of the World: Their Evolution, Behaviour and Ecology. Stakepole Books, Mechanicsburg, USA.

18. GRZIMEK, B. (1990) Grzimek's Encyclopedia of Mammals, volume 5. McGraw Hill Publishing Company, New York, USA.

19. HOLLOWAY, C.W. (1970) The hangul in Dachigam: a census. Oryx, 10,373-382.

20. HOLLOWAY, C.W. & WANI , A.R. (1970) Management plan for Dachigam Sanctuary, 1971-1975. Cyclostyled. Department of Wildlife Protection, Jammu & Kashmir Government, Srinagar, India.

21. INAYATULLAH, M. (1987) The project 'hangul' (Cervus elaphus hanglu), deer, conservation, India. In Wildlife in India (ed. V.B. Saharia), pp. 164–173. Department of Agriculture and
22. Cooperation, Ministry of Agriculture, Government of India, New Delhi, India.

23. JHALA, Y.V., QURESHI, Q. & GOPAL, R. (2005) Monitoring Tigers, Co-predators, Prey and Their Habitat, 2nd edition,
24. QURESHI, Q., IQBAL, S., AHMAD, K., LONE, I., MANSOOR, M., ZARGAR, R. et al. (2009) Status and distribution of hangul Cervus elaphus hanglu Wagner in Kashmir, India. Journal of the Bombay Natural History Society, 106,63-71.
25. ROUTLEDGE, R.D. (1982) The method of bounded counts: when does it work? Journal of Wildlife Management, 46,757-761.
26. SCHALLER, G.B. (1969) Observations on the hangul or Kashmir stag, (Cervus elaphus hanglu. Wagner). Journal of the Bombay Natural History Society, 66,1-7.

3

PAN India Assessment and Monitoring of endangered species covered under theDevelopment of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Nilgiri tahr (*Hemitragus hylocrius*)

2. SUPERVISORS: Dr. S. Sathyakumar & Dr. K. Ramesh

3. BRIEF BACKGROUND:

The Nilgiri tahr (*Hemitragus hylocrius*) is endemic to the Western Ghats mountains of Kerala and Tamil Nadu with distribution limited to a narrow stretch of 400km between 11^0 30' N – 8^0 20' N bordered by Nilgiris in the North and the Kanyakumari hills in the south (Mishra et al., 1998). They are group-living animals and inhabit montane grasslands with rocky cliffs at elevations of around 300m to 2600m above mean sea level (Rice 1984; Predit et al., 2015). Nilgiri tahr has been listed as an endangered species and is protected under Schedule-I of Wildlife Protection of India (IUCN). E.R.C Davidar conducted the first Nilgiri tahr population estimation in 1963 (Davidar 1975). Most previous surveys have estimated the Nilgiri tahr population using the bounded count technique which have some limitations that need to be addressed (Rice 1984; Mishra et al., 1998; Abraham et al., 2006; Predit et al., 2015). Under the PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC, we aim to standardize a robust monitoring protocol for the population estimation of Nilgiri tahr.

4. OBJECTIVES:

- Assessing the population status of Nilgiri tahr
- Developing long term monitoring protocols for population and the habitat of the species.

5. APPROACH /METHODOLOGY

Along with the traditional bounded count technique that has some limitations, we propose to use two alternate methods for estimation and monitoring of Nilgiri tahr populations. A brief description of these methods are given below.

Bounded count technique: In this method, the study area is divided into smaller blocks or plots and trained observers systematically survey each block, counting the number of individuals of the target species. Bounded count method is typically used for relatively small and easily observable populations (Abraham et al., 2006). This method has high potential for double counts of individuals or groups if they move between blocks during the survey (Suryawanshi et al., 2021). Nilgiri tahr is a group living mountain ungulate that inhabits the rugged and steep rocky cliffs of the Western Ghats in South India. Due to the challenging terrain in which the Nilgiri tahr are found, traditional population estimation methods are

often difficult to implement, hence bounded count technique is applied.

Double Observer method: This method is based on the principle of Capture Mark Recapture method, applying to groups rather than individuals. The Nilgiri tahr cannot be identified individually but identification of groups is possible based on age sex composition and location of their sighting. It involves two observers surveying the same area/block simultaneously or being separated in time and space; independently ensuring they have the same visual coverage of the area and recording the number of Nilgiri tahr and their age sex classification. After completing the survey, the data from the 2 observers are compared based on the group structure (age class and sex) for identifying captured and recaptured groups, which are further used in estimating the population and detection probability (Suryawanshi et al., 2021).

Distance Sampling using Camera traps:
Distance sampling with camera traps is a non-invasive method used to systematically collect data in large field areas. Camera traps are programmed to trigger immediately and capture an image followed by a 30 second video when movement is detected. To estimate the distance of the photo-captured animal from the camera trap we made field calibration using pole and markers spaced at 1m interval up to 10m from the center of camera along both sides of the camera's field of view. The data was analyzed using Distance package in R 4.2.3.It involves calculating the distance of animals from the camera trap to estimate population density of target species (Howe et al., 2017; Pal et al., 2021).

In this study we propose to address the issues of bounded count method and standardize double observer method and pilot alternate methods like camera trap-based distance sampling and Unmanned Aerial Vehicle (UAV) based counts for population estimation of Nilgiri tahr.

6.PROGRESS TILL DATE

Researchers joined the project "Pan India Assessment and Monitoring of Endangered Species under the Integrated Development of Wildlife Habitats (IDWH) Nilgiri tahr" during December 2022. Literature Review on Nilgiri tahr particularly population estimation methods have been completed. Permission to carryout field work have been obtained from the Forest Departments of Kerala and Tamil Nadu.

The Eravikulam National Park (NP) hosting the most viable population of Nilgiri tahr was selected as pilot study area. In March 2023, a meeting was held in Munnar where the objectives and methods of IDWH- Nilgiri tahr project were discussed with the Wildlife Warden of Munnar Wildlife Division, Kerala. The briefing included details about the techniques to be used, namely double observer method and camera trap-based distance sampling, for the population estimation of Nilgiri tahr. Accommodation at an outpost in Chattamunnar was provided and we were advised to carry out fieldwork in the Lakkomkudy block of Eravikulam National Park.

In the initial days of fieldwork in March 2023, we visited Rajamala to closely observe Nilgiri tahr. This involved differentiating between age/sex categories and capturing high quality images to train the survey team in Nilgiri tahr classification. We engaged with the members of the Mudhuvan tribal community and gathered valuable insights about Nilgiri tahr and identified individuals with strong local knowledge of the landscape and expertise in spotting Nilgiri tahr.

Figure:1 Nilgiri tahr- Young one

Figure:2 Nilgiri tahr-Yearling

Figure:3 Nilgiri tahr-Saddleback

Figure:4 Nilgiri tahr- Adult Female

In April 2023, we started by explaining the classification of Nilgiri tahr using pictures to the field assistants. Subsequently, we demonstrated the data collection method, survey technique, data entry and operating of GPS for double observer method. Practical demonstrations were conducted on arming and deployment of camera traps and calibration using markers for camera trap based distance sampling at Chattamunnar base camp.

Figure:5 CTDS method demonstration to field staff

Following the suggestion of the Munnar Wildlife Warden, trials were conducted in

Lakkomkudy block of Eravikulam National Park using the double observer method. Minor modifications to the data collection sheets were done and sheet was converted to a bilingual format, as field assistants faced challenges in understanding English.

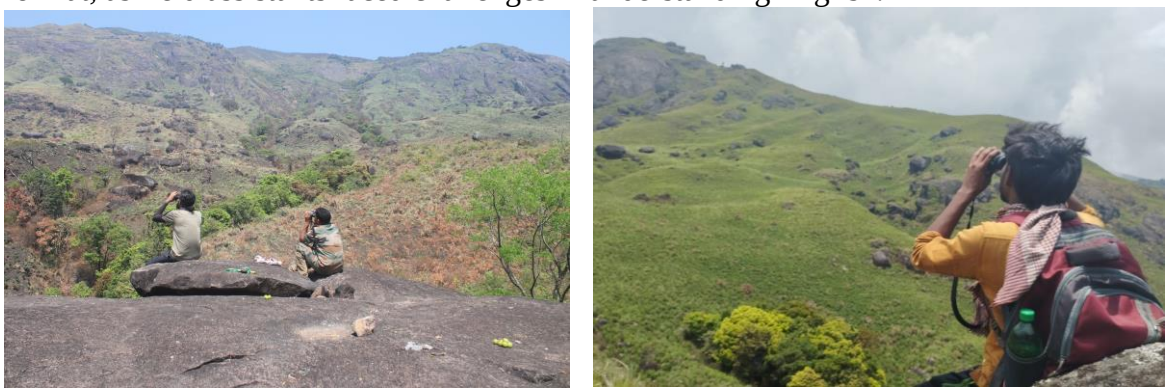


Figure:6 Conducting N.tahr survey using Double Observer Method in Lakkomkudy Block, Eravikulam N.P.

We deployed five camera traps on a trial basis in the Lakkomkudy block for a duration of 15 days. These traps were placed in locations with dense pellet evidence of Nilgiri tahr to assess potential false triggering caused by vegetation movement in the montane grassland and to assess the effectiveness of Nilgiri tahr detection. Out of the five camera traps, four successfully captured photos of Nilgiri tahr.

Figure:7 Deployment of camera trap using CTDS method

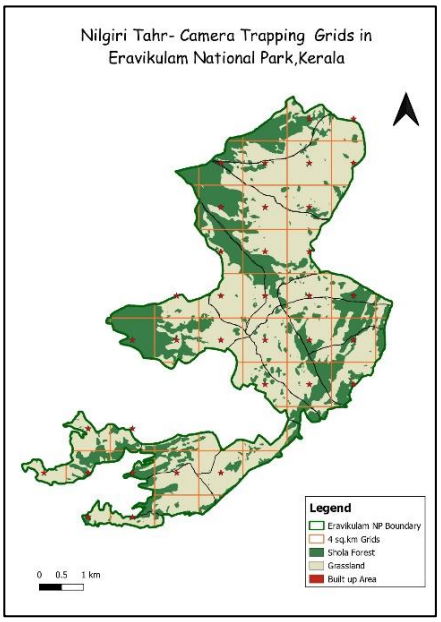
The annual Nilgiri tahr population estimation exercise was held from 25th April to 28th April 2023 by Munnar Wildlife Division using Bounded count method. Based on previous studies on the distribution of Nilgiri tahr in the division, the Munnar Wildlife Division was subdivided into 21 blocks, spread across four protected areas: Eravikulam National Park, Anamudi Shola National Park, Chinnar Wildlife Sanctuary and Kurinjimala Wildlife Sanctuary. Eravikulam National Park was divided into 13 blocks based on the home ranges of Nilgiri tahr suggested by Rice (1984).

Our team participated in the exercise alongside volunteers from the College of Forestry. The methodology for conducting surveys and gathering data was explained during an orientation program on Nilgiri tahr population estimation held in Munnar. We provided instructions on how to collect GPS data using the 'Locus Map' smartphone application.

Figure:8 Nilgiri tahr population estimation orientation program at Munnar

The participants were divided into teams and on April 24, 2023, each team was deployed to their respective base camps. The population estimating exercise took place from April 25 to April 28, 2023. During this period, each team systematically surveyed their assigned blocks. As a result of this exercise, the total estimated population of Nilgiri tahr at Eravikulam National Park was determined to be 803 individuals.

After the initial learnings from the trial CTDS conducted in the Lakkomkudy Block of Eravikulam National Park, in May 2023, the National Park was subdivided into grid cells of 4km^2. The centroids of these grid cells were extrapolated using QGIS to eliminate sampling bias and camera traps (Cuddeback) were deployed at the centroids of the 20 grids.



Camera traps were programmed to trigger immediately and capture an image followed by a 30 second video when movement was detected. To estimate the distance of the photo-captured animal from the camera trap, we made field calibration using pole and markers

spaced at 1m interval up to 10m from the center of camera along both sides of the camera's field of view.

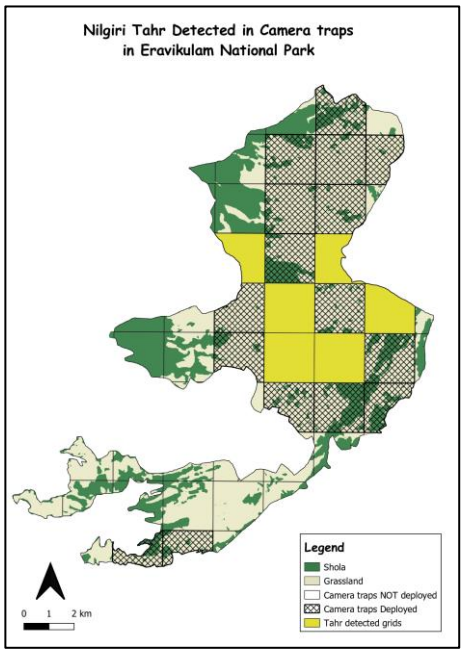


Figure:9 Camera trap image of Nilgiri tahr

The Nilgiri tahr was photo-captured by 6 out of the 20 camera traps deployed resulting in 3023 snapshots from the videos. Distances of the animals from the camera traps were calculated using a field-calibrated reference image and data was analysed using the 'Distance' package in R software version 4.2.3. The best-fit model, identified as the Half-normal model with cosine adjustment, yielded an estimated density of 6.58 SE ±3.94 individuals/km^2 (CV = 0.37), for Eravikulam National Park.

7. PLAN OF WORK (FOR 2023-24):

November 2023	• Discussion with Annamalai Tiger Reserve and planning field work • Demonstration of Camera trap-based distance sampling (CTDS) and double observer method for field staff. • Population estimation exercise using Double Observer method and CTDS in Annamalai Tiger Reserve, Tamil Nadu
December	• Planning for survey in isolated Nilgiri tahr habitats in Tamil Nadu. • Workshop on Methods of Population estimation of Nilgiri tahr in Tamil Nadu • Drone survey with Tamil Nadu Forest Department • Population estimation exercise using CTDS and Double Observer method in other parts of Tamil Nadu.

January 2024	• Meeting with Kerala Forest Department for planning a synchronized Nilgiri tahr population estimation in Kerala. • Demonstration of Camera trap-based distance sampling (CTDS) and double observer method. • Workshop on Methods of Population estimation of Nilgiri tahr in Kerala. • Population estimation exercise using CTDS and Double Observer method in Kerala.
February March April May	• Population estimation exercise using using Double Observer method and CTDS in Kerala & Tamil Nadu
June	• Data Compiling and Analysis at WII, Dehradun.

8. BUDGET RECEIVED & AMOUNT SPENT

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower (Salary & Field Assistants)	11,70,000.00	**7,02,000.00**	4,03,926.00	0.00	**4,03,926.00**	**2,98,074.00**
2	Vehicle Hiring	3,00,000.00	**1,80,000.00**	0.00	0.00	**0.00**	**1,80,000.00**
3	Travel & Field Accommodation	4,00,000.00	**2,40,000.00**	7,373.00	0.00	**7,373.00**	**2,32,627.00**
4	Equipment (Field & Laptops)	8,50,000.00	**5,10,000.00**	1,68,394.00	0.00	**1,68,394.00**	**3,41,606.00**
5	Consumables	8,50,000.00	**5,10,000.00**	0.00	0.00	**0.00**	**5,10,000.00**
6	Workshops	3,50,000.00	**2,10,000.00**	0.00	0.00	**0.00**	**2,10,000.00**
7	Contingency (Insurance & Publications)	80,000.00	**48,000.00**	11,260.00	0.00	**11,260.00**	**36,740.00**
Total		**40,00,000.00**	**24,00,000.00**	**5,90,953.00**	**0.00**	**5,90,953.00**	**18,09,047.00**
						Less : Forest Advance	1,20,000.00
						Less : Tour Advance	15,664.00
Balance							**16,73,383.00**

REFERENCE:

1. Abraham SK, Easa PS, Sivaram M. Status and distribution of Nilgiri tahr Hemitragus hylocrius in Kerala part of the Western Ghats. Zoos' Print Journal. 2006;21(9):2379-85.

2. Alempath M, Rice C. Nilgiritragus hylocrius. The IUCN Red List of Threatened Species 2008:e.T9917A13026736. https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T9917A13026736.en. Accessed on 14 October 2023

3. Davidar ER. The Nilgiri tahr. Oryx. 1975 Oct;13(2):205-11.

4. Howe EJ, Buckland ST, Després-Einspenner ML, Kühl HS. Distance sampling with camera traps. Methods in Ecology and Evolution. 2017 Nov;8(11):1558-65.

5. Mishra C, Johnsingh AJ. Population and conservation status of the Nilgiri tahr Hemitragus hylocrius in Anamalai Hills, South India. Biological Conservation. 1998 Nov 1;86(2):199-206.

6. Pal R, Bhattacharya TA, Qureshi Q, Buckland ST, Sathyakumar S. Using distance sampling with camera traps to estimate the density of group-living and solitary mountain ungulates. Oryx. 2021 Sep;55(5):668-76.

7. Predit PP, Prasath V, Raj M, Dasai A, Zacharia J, Johnsing AJT, Ghose D, Ghose PS, Sharma RK. Status and distribution of the Nilgiri tahr (Nilgiritragus hylocrius) in the Western Ghats, India: Technical report. WWF-India; 2015

8. Rice, C G. 1984. The behaviour and ecology of the Nilgiri tahr (HemitragushylocriusOgliy 1838). Unpublished PhD Thesis, Texas, A & M University.

9. Suryawanshi KR, Mudappa D, Khanyari M, Raman TS, Rathore D, Kumar MA, Patel J. Population assessment of the Endangered Nilgiri tahr Nilgiritragus hylocrius in the Anamalai Tiger Reserve, using the double-observer survey method. Oryx. 2021 Jan;55(1):66-72.

PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Marine Turtle

2. SUPERVISOR: Dr. R Suresh Kumar & Dr. Nehru Prabakaran

3. BRIEF BACKGROUND:

Four of the five sea turtle species found in Indian waters nests along the Indian coast. All the sea turtles are threatened due to incidental capture in fishing gears, nesting habitat loss and climate change. India being a signatory member of IOSEA MoU of CMS, conservation of the sea turtles is a priority. The Government of India recently launched a National Marine Turtle Action Plan (2021-2026) to mitigate and reduce the threats to sea turtles. This assignment of MoEF&CC, under the IDWH programme aims to assess and monitor the sea turtle population and their habitats, and provide real-time information accessible through an online database to all stakeholders at both the local nesting beach site and to Pan-India level.

3. OBJECTIVE:

- To assess the population of nesting turtles along the east coast, west coast and islands of India.
- To characterize the beach, stretch to determine the suitable nesting sites.
- To understand current hatchery management practices and assess the hatching success.
- To create a national sea turtle database for long-term assessment of sea turtle populations of India.

5. APPROACH/METHODOLOGY:

A systematic assessment of nesting along the whole coast is being undertaken to identify important sea turtle nesting areas and the number of nesting taking place along the different coastal states. A dedicated project assistant for each state is assigned to undertake the population and habitat monitoring for sea turtles and assist the local forest department in compilation of state level data.

6. PROGRESS TILL DATE:

- The Project associates for the project were appointed in December 2022 who undertook the systematic assessment of sea turtle nesting and nesting habitats along the whole of west coast and partial stretches of West Bengal, Andhra Pradesh, Tamil Nadu and Puducherry in East Coast.
- Permission requests for undertaking the surveys were sent to the 12 coastal states and union territories in March 2023 of which, permissions are granted by 6 states.
- More than 4000 km of the coast and approximately 150 beaches in the mainland India has been assessed during the surveys conducted in 2023.
- A network with local forest departments and NGOs was established which undertake sea turtle monitoring and conservation activities along these coasts, and dedicated project assistants for each state has been appointed in October 2023.
- The equipment procurement was initiated by the end of 2022, which were received by May 2023.
- A national sea turtle database is established with nesting and management information compiled for the whole of west coast of India, where nesting and habitat information from 66 nesting beaches has been compiled. Here, 1412 sea turtle nests have been recorded based on the Forest Department data and nest conservation methods for each beach has been collated.

7. PLAN OF WORK (for 2023-24):

- The systematic assessment of the east coast and islands will continue to identify important nesting beaches for the focused monitoring of nesting numbers, habitat and hatchery management practice.
- Project staff appointed for each state will be carrying out monitoring activities for the 2023-2024 nesting season.
- Basecamps for each state will be setup for the monitoring in 2023-2024 nesting season and field vehicles will be hired.
- Capacity building workshops are planned for the frontline forest department staff in coastal states to standardise the data collected along Indian coast.
- Off-shore monitoring of the arribada nesting olive ridley sea turtles will be undertaken in mass nesting areas of Odisha.

- A web portal and website will be created for sea turtle database along with showcasing the activities relating to sea turtle conservation and the pan India monitoring of populations.

8. BUDGET RECEIVED & AMOUNT SPENT

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower (Salary & Field Assistants, Intern)	82,77,120.00		14,50,671.50	0.00	**14,50,671.50**	
2	Travel (Tours & Vehicle Hiring, POL, Two Wheeler hiring, Boat Hiring)	54,20,000.00		1,91,798.00	0.00	**1,91,798.00**	
3	Accommodation	19,20,000.00		1,26,057.00	0.00	**1,26,057.00**	
4	Equipment (Tagging Equipments, Mobile Application, Workstations, Desktop, Laptops, Binoculars, Camera, GPS, projector)	23,70,000.00	**1,20,00,000.00**	2,48,700.00	3,95,000.00	**6,43,700.00**	**95,78,547.50**
5	Miscellaneous (Consumables, Publication, Workshop, Insurance)	16,00,000.00		9,226.00	0.00	**9,226.00**	
6	Contingency	4,12,880.00		0.00	0.00	**0.00**	
Total		**2,00,00,000.00**	**1,20,00,000.00**	**20,26,452.50**	**3,95,000.00**	**24,21,452.50**	**95,78,547.50**
						Less : Forest Advance	2,03,108.00
						Less : Tour Advance	65,000.00

5

PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. **SPECIES:** Andaman Edible-nest Swiftlet

2. SUPERVISOR(s): Dr. Suresh Kumar, Dr. Shirish Manchi. S and Dr. Nehru Prabakaran

3. BREIF BACKGROUND:

Andaman Edible-nest Swiftlet (AENS) *Aerodramus fuciphagus inexpectatus* is an endemic subspecies of Edible-nest Swiftlet in Andaman and Nicobar Islands. Their nest which is made of their saliva is a delicacy in Southeast Asian countries, especially China. This sub-species witnessed a decline in 80% of its population over the 1990s due to extensive nest collection (Sankaran, 2001). The minimum breeding population of the sub-species was estimated to be 13,260 birds, in 2001 and later in the years 2000-2008 swiftlet population in protected caves hiked by 39% compared to a 74% decline in unprotected caves (Manchi, 2014). However, no detailed survey was conducted on this species in the Andaman Islands post 2014. More importantly, the population in the Nicobar archipelago remain unassessed since the 1998 survey by Sankaran (1998). Conservation and Management efforts to secure these cave-nesting birds are currently underway in the Andaman group of islands by the Forest Department, though the overall population status is unknown. In this context, the current study supported by the IDWH scheme is envisaged to assess the population Edible nest swiftlets in the Andaman and Nicobar group of Islands. Estimating all the possible and potential breeding population of Edible-nest swiftlets in the Andaman archipelago and Nicobar archipelago will provide a status of Andaman edible-nest swiftlets in specific islands. This will also fill the current knowledge gap of site-specific information on population in caves and Islands that were not assessed in the recent time (eg. Nicobar archipelago).

4. OBJECTIVE:

- Population estimation of Andaman edible-nest swiftlets in major nesting sites in Andaman and Nicobar Islands.

5. APPROCH/METHODOLOGY:

Study Area: Andaman and Nicobar Islands are located between 06° 45'9 N and 13° 41'9 N. and 92° 12'9 E and 93° 57'9 E, extending from the Arakan-Yoma ranges of Western Myanmar (Burma) in the north to Sumatra in the south. The Andaman Sea flanks the archipelago in the east and the Bay of Bengal in the west. The dense tropical forest dominates the region (Champion & Seth 2005). The Andaman and Nicobar groups comprise 572 Islands. Presently, of the 394 limestone caves known from the Andaman and Nicobar Islands, 314 are in the Andaman group (Manchi & Sankaran 2014).

Approach:

a) Nest count method of manually counting nests (Sankaran, 1995) or by photographic documentation is done to estimate the number of Andaman Edible-nest Swiftlets present in caves by considering one breeding pair per nest.
b) Swiftlet populations other than cave populations like urban populations are also estimated.
c) Nesting sites other than the known ones are explored.

6. PROGRESS TILL DATE:

- **December 2022:**
  Project personnel joined.

- **January 2023:**
  Literature review on the species biology and previous data is done. Permission request is sent to Forest Department.

- **March 2023:**
  Project personnel reached A&N Islands and a base camp was setup in South Andaman. Preliminary survey was conducted in Baratang (Naya Dera Limestone Caves).

- **April 2023:**
  Letter was submitted to Forest Department, A&N Islands for permitting the field surveys. The project team interacted with the Forest Department and deliberated on the projects. Reconnaissance surveys were conducted at multiple sites including urban areas to understand

the population and habitat use of Swiftlet. The survey sites were identified through previous literature. Fieldwork permission for the project team was issued by the Forest department.

- **May 2023:**
  Fieldwork was initiated in Middle Andaman (Baratang) and North Andaman (Interview Island, Pathilevel). The project team deliberated on the project to the concerned DFO and forest department staff in Middle Andaman and North Andaman.
  Fieldwork in remote islands of North Andaman could not be conducted due to the cyclonic conditions. Hence, the project team went back to Bartang (Naya Dera Limestone Caves) where number of caves can be accessible even during monsoon.

- **June 2023:**
  Field survey in Baratang (Naya Dera Limestone Caves) was completed. The project team has visited Kadamtala camp office and collected the previous year data from the register maintained by the Forest department.

- **July 2023:**
  Field survey was conducted at Chota tikrey, North Andaman, which is a non-monitored nesting site.

- **August 2023:**
  The research team has returned to WII due to the heavy monsoon in the Islands that hampered the field surveys. Sorted all the Photographic and manual data collected. The field data was entered in MS-EXCEL.

- **September 2023:**
  Data analysis and preparation of project progress report.

Summary of Results and Observations:

According to the previous literature, Sankaran (1998) has identified and visited 384 caves in the Andaman and Nicobar Islands, of which 325 caves are in the Andaman Islands. In which the Nest Count of 205 caves in Interview Island, Pathilevel, Naya Dera, and Chota Tikrey together were done

manually and by photographic documentation during the period of May 2023 - July 2023. The presence and number of other co-existing species like Plume-toed Swiftlets and Bats were also observed.

During the current field season (May – July 2023), all the caves which were monitored by the Forest Department along with one non–monitored site (Chota Tikrey) in the Andaman Islands were surveyed (Fig. 1). In total, 205 caves were surveyed, of which 56 caves were fully accessed and the remaining were either partly accessed or inaccessible. A total of 2324 nests were found in the current survey. This suggests that the total number of birds to be 2324 breeding pair or 4648 adult birds. Interview Island having 75 nests (150 individuals) in just one cave. Pathilevel consists of 28 caves with 960 nests in total, meaning 1920 adult birds. Whereas Naya Dera had 2538 individuals that is 1269 nests in whole total of 174 caves. Chota Tikrey is the non-monitored site which had 20 nests in the total of 4 caves surveyed where the number of birds is found to be 40.

Nest numbers per cave differ drastically and ranged between 0 - 149. Cave Number 17 of Pathilevel (PTLVLCN17) had the maximum number of nests, that is149 nests. Whereas many caves had minimum number of nests 0 or 1. An average of 11.33 number of nests are found in the caves surveyed.

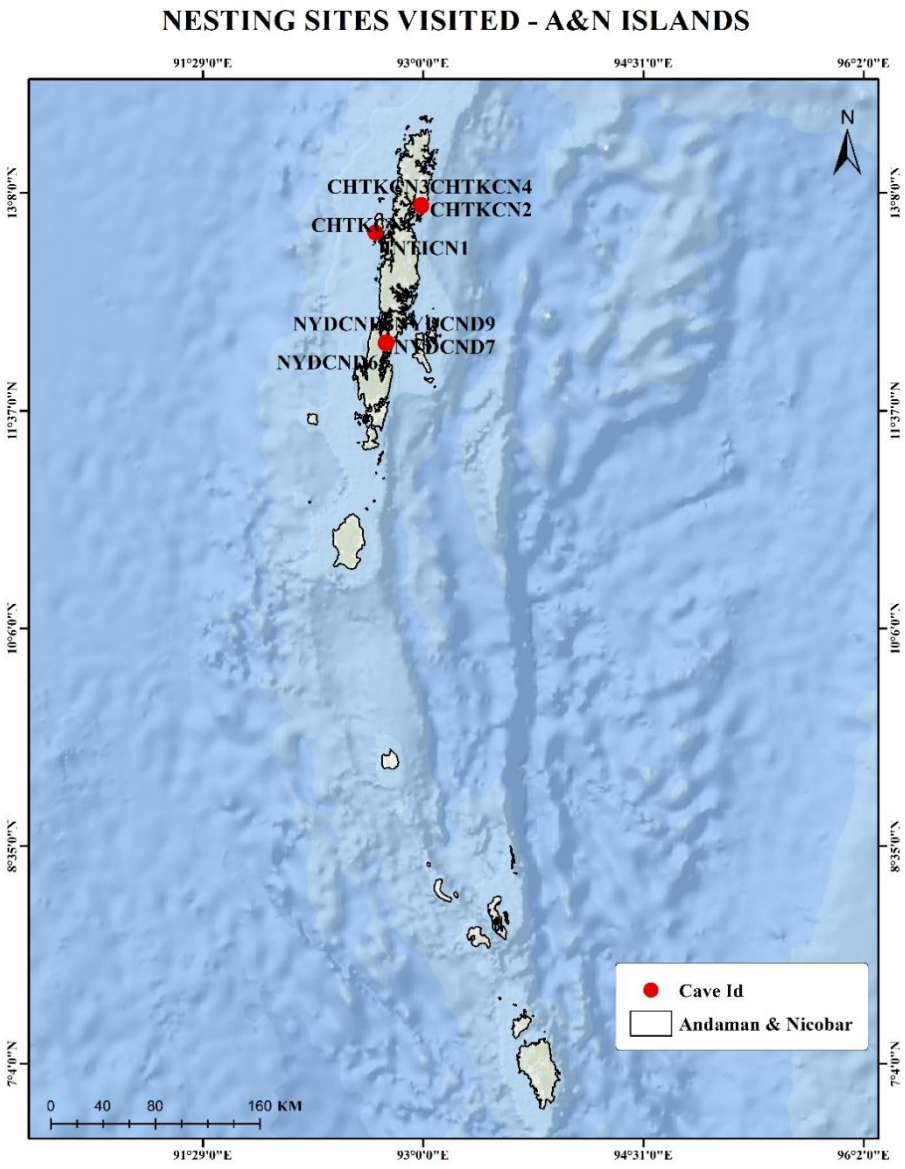


Figure:1 A map of Caves / Nesting sites surveyed during the field season (May – July 2023)

7. PLAN OF WORK (for 2023-24)**:**

Sl. No.	Work To Be Done
1.	Visit all the remaining known nesting sites of the Swiftlet and collect data.
2.	Field survey in Nicobar archipelago. Permission for this is still pending with the Andaman and Nicobar Forest department.
3.	Explore new nesting sites (natural habitats and urban areas) of the species.

4.	Data entry and analysis.
5.	Report preparation and submission.

8. BUDGET RECEIVED & AMOUNT SPENT

S. No	Budget Head	Total Budget Approved	Total Funds Received	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower (Salary & Field Assistants)	6,11,520.00	12,00,000.00	3,41,863.00	0.00	3,41,863.00	7,26,709.00
2	Travel (Tours & Vehicle Hiring, Boat Hiring)	7,50,000.00		824.00	0.00	824.00	
3	Accommodation	2,00,000.00		0.00	0.00	0.00	
4	Equipment	2,35,000.00		1,02,490.00	0.00	1,02,490.00	
5	Consumables (Base Camp, Medical Insurance, Stationery)	1,00,000.00		28,114.00	0.00	28,114.00	
6	Reports and Documentation	50,000.00		0.00	0.00	0.00	
7	Contingency	53,480.00		0.00	0.00	0.00	
Total		**20,00,000.00**	**12,00,000.00**	**4,73,291.00**	**0.00**	**4,73,291.00**	**7,26,709.00**
				Less : Forest Advance			70,000.00
				Less : Tour Advance			30,000.00
	Balance as on 10 Mar 2023						**6,26,709.00**

RERERNCE:

1. Bandopadhyay, P. C., & Carter, A. (2017). About this title - The Andaman–Nicobar Accretionary Ridge: Geology, Tectonics and Hazards. *Geological Society, London, Memoirs*, *47*(1).

2. Champion, H. G & Seth, S. K. (2005). A revised Survey of the forest types of India. Government of India. Natraj Publisher, New Delhi.

3. Manchi, S., & Sankaran, R. (2014). Protection of the white-nest swiftlet aerodramus fuciphagus in the Andaman Islands, India: An assessment. *Oryx*, *48*(2), 213–217pp.

4. Sankaran, R. (1995). Impact assessment of nest collection on the Edible-nest Swiftlet in the Nicobar Islands. (Technical Report), SACON, 35pp.

5. Sankaran, R. (1998). The impact of nest collection on the Edible-nest swiftlet *Collacalia fuciphaga* in the Andaman and Nicobar Islands (Techincal Report), SACON, 53pp.

6. Sankaran, R. (2001). The status and conservation of the Edible-nest Swiftlet (Collocalia fuciphaga) in the Andaman and Nicobar Islands. *Biological Conservation*, *97*(3).

6

PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Wild water buffalo (*Bubalus arnee*)

2. SUPERVISORS: Qamar Qureshi, Samrat Mondal, Vishnupriya Kolipakam, Lallian Kawlni, Bilal Habib, Bivash Pandav

3. BRIEF BACKGROUND:

The wild water buffalo, Bubalus arnee (Kerr, 1792) (wild buffalo, hereafter), an endangered megaherbivore, has undergone a steep decline in recent decades due to human activities, making it one of the mammalian species most impacted by anthropogenic pressures (Choudhury, 2014; Kaul et al., 2019). It is the ancestor of the modern-day domestic buffalo and is listed in Schedule I of the Wildlife Protection Act, 1972, which offers the utmost protection to a species in India. In addition, it has been classified as endangered by the IUCN Red List of Threatened and Endangered Species. It is also included in Appendix III of the Convention on International Trade for Endangered Species of Wild Flora and Fauna (CITES) to prevent illegal trade of the species. Worldwide, three subspecies of wild buffalo have been recognized: B. a. arnee (Nepal and peninsular India), B. a. fulvus (northeast India), and B. a. theerapati (Southeast Asia) (Kaul et al., 2019). Within India, it is found in the northeastern states of Assam, Arunachal Pradesh, and Meghalaya, along with a handful of individuals located in the central states of Chhattisgarh and Maharashtra (Choudhury, 2014; Jhala et al., 2021; Qureshi et al., 2023). It has been eradicated from Laos, Bangladesh, Indonesia, Malaysia, Sri Lanka, and Vietnam, while its status in Myanmar and Cambodia remains uncertain (Kaul et al., 2019). Wild buffalo's global population has been believed to be between 3000 and 4000 individuals (~2500 adults), of which more than 90% live in India and mostly in the state of Assam (Choudhury, 2014; Kaul et al., 2019). According to some reports, the wild buffalo population in Nepal and Assam is increasing, reaching up to 4690 (Table 1). However, there is a dearth of scientific population estimates across its range.

Table 1. Population estimates of wild buffalo according to (Choudhury, 2022, 2014)).

Country	State/Province	Choudhury (2010)	Choudhury (2022)
India	Assam	2800	3800
	Arunachal Pradesh	200	150
	Meghalaya	50	<40
	Chhattisgarh, Maharashtra	<50	>70
	India Total	3100	4070
Nepal		200	510
Bhutan		<30	<40
Thailand		50	50
Cambodia		<20	<20
	Rest of the world total	300	620
Total		**3400**	**4690**

4. OBJECTIVES:

a) Assess the current status of wild buffalo.
b) Development of long-term monitoring protocols for populations and their habitats of wild buffalo.

5. APPROACH /METHODOLOGY:

a) Population Assessment: We used line transect based distance sampling and Camera trap-based distance sampling both the approaches to estimate densities of Wild Buffalo, Barasingha (Swamp Deer) and Rhinoceros. We are also considering the possibility to modify the total count survey with statistical robustness.

I) Line transect surveys is the preferred formal population estimation method based on visual detection of animals (Buckland et al. 1993). Population estimation of the Ungulates can be carried out by using line transects of length 2.0 km. Each transect were walked between 6:30 am and 8:30am. GPS locations for beginning points and end points of transect were recorded. Broad forest type and terrain type for each transect line were recorded. For each cluster of prey animals encountered on transects, the following variables have been recorded: (1) species (2) cluster size (3) angular sighting distance and (4) bearing. The computer Program DISTANCE Version 6.0 (Laake et al., 2004) is used for analyses of line transects data to yield density estimates of the different tiger prey species. Distance is a Windows-based computer package that allows us to design and analyze distance sampling surveys of wildlife populations. It gives us best fit model to calculate cluster density (DS), population density (D), estimated population (N), Detection probability (*p*)

II) Camera trap distance sampling (Howe et al 2017) is mostly used to estimate density of ungulates or animals which are not individually identifiable and difficult to study in the wild due to hostility of the terrain and elusiveness of the species. However, to estimate the density, this sampling method requires accurate camera to animal distance. This distances can be acquired by performing calibration process before conducting the survey. This calibration process involves taking images of objects of known dimensions at know distances from the camera. CTDS is also effective at areas where animal density is very low. It minimizes the risk of hostile landscape and chance of observer fatigue.

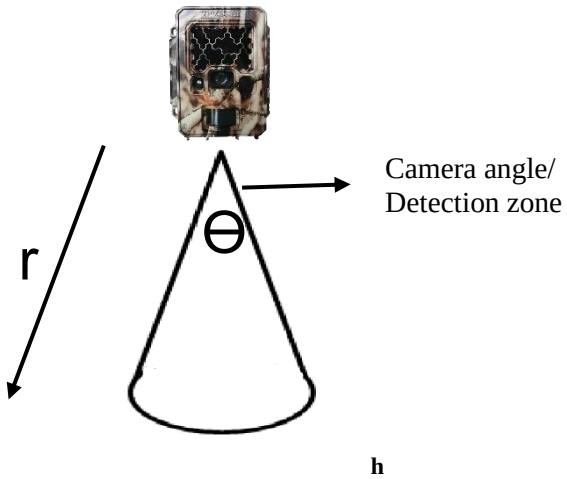


Figure:1 Schematic diagram of Camera trap-based distance sampling approach

a) Assessment of potential habitats: Current status of the swamp and grassland habitats across its historic range will be delineated using LULC maps, species distribution modelling will be used to identify potential sites for planning reintroduction of the species.

6. PROGRESS TILL DATE:

a) We used line transect based distance sampling in Manas Tiger reserve on Elephant Back with the support of Forest department Manas Tiger reserve. We also did survey through Camera trap-based distance sampling. Habitat specific cameras were deployed randomly in the Manas National park. We calibrated each camera trap station with known distances up to the detection zone. Data Analysis is in progress.

b) We have modelled suitable habitat for Wild Buffalo across the India through Maxent model.

c) We have collated information of Central Indian sub-species of Wild Buffalo from Chhattisgarh and Maharashtra from Indravati basin and currently data analysis is in progress.

d) Conservation action plan for wild buffalo is under progress.

Figure:2 Capacity Building Workshop on sampling to Manas Tiger Reserve staff

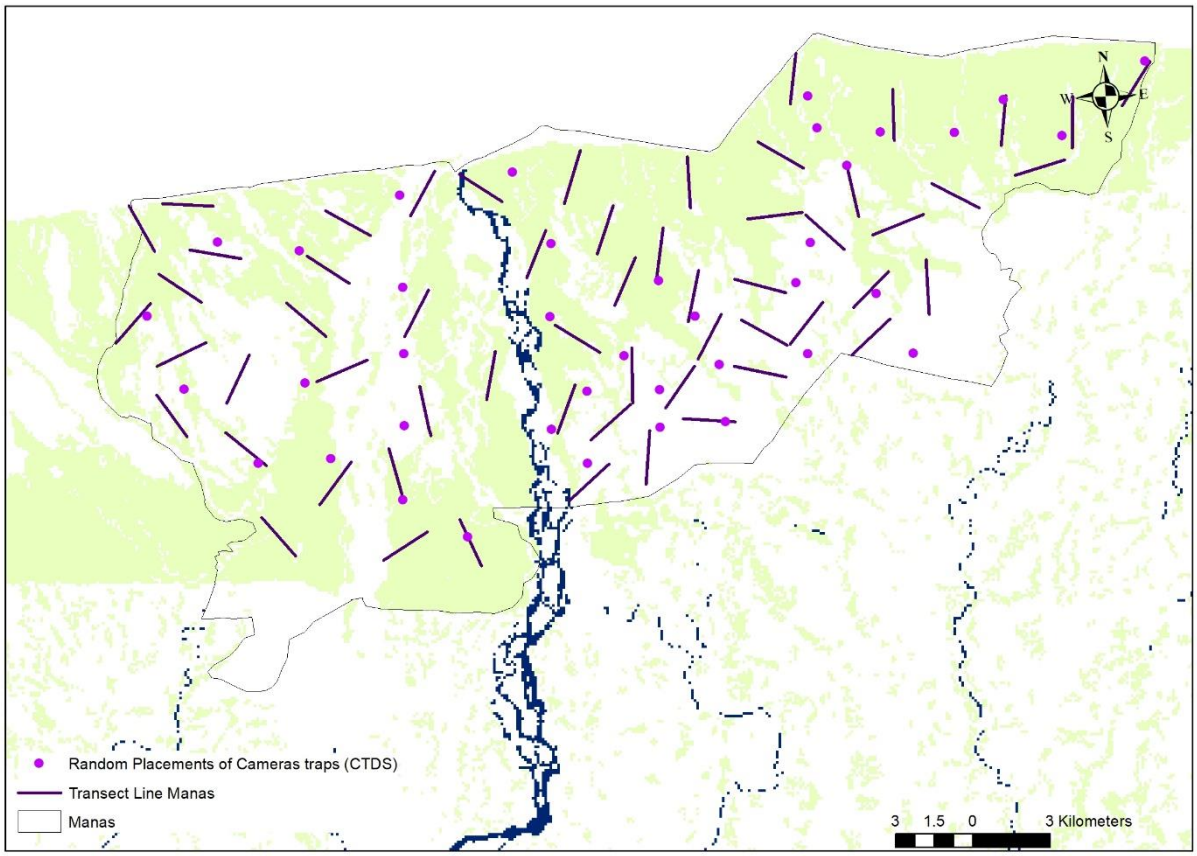


Figure:3 Line transect and Random camera placement at Manas Tiger reserve

Figure:4 Transect walk on Elephant back

7. **PLAN OF WORK** (FOR 2023-24)**:**

a) We intend to sample Kaziranga Tiger reserve for Wild Buffalo population estimation.
b) Workshop with stakeholders and officials of current and historic range states of wild buffalo will be conducted.
c) Development and testing of monitoring method for wild buffalo populations and their habitat through workshop consultation.
d) Final action plan report will be submitted in March, 2024.

Figure:5 Camera trap placement for CTDS in Manas Tiger reserve

Figure:6 Wild Buffalo observation through Line transect on Elephant back

8. BUDGET RECEIVED & AMOUNT SPENT

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower (Researchers)	4,31,520.00	**2,58,912.00**	0.00	0.00	**0.00**	**2,58,912.00**
2	Technical Researchers/ Intern	1,80,000.00	**1,08,000.00**	0.00	0.00	**0.00**	**1,08,000.00**
3	Daily Labour	1,90,000.00	**1,14,000.00**	0.00	0.00	**0.00**	**1,14,000.00**
4	Vehicle Hiring	7,00,000.00	**4,20,000.00**	0.00	0.00	**0.00**	**4,20,000.00**
5	Genetic lab chemicals, consumables, glassware	12,00,000.00	**7,20,000.00**	0.00	0.00	**0.00**	**7,20,000.00**
6	Field supplies and equipments	1,70,000.00	**1,02,000.00**	0.00	88,500.00	**88,500.00**	**13,500.00**
7	Insurance	1,00,000.00	**60,000.00**	0.00	0.00	**0.00**	**60,000.00**
8	Publications	28,480.00	**17,088.00**	0.00	0.00	**0.00**	**17,088.00**
Total		**30,00,000.00**	**18,00,000.00**	**0.00**	**88,500.00**	**88,500.00**	**17,11,500.00**
				Less : Forest Advance			0.00
				Less : Tour Advance			0.00
Balance							**17,11,500.00**

REFERENCE:

1. Buckland, S.T., Anderson, D.R., Burnham, K.P. & Laake, J.L. (1993) Distance Sampling: Estimating Abundance of Biological Populations. Chapman & Hall, London.

2. Choudhury, A., 2022. Upward ternd in numbers of the wild water buffalo (Bubalus arnee). BULLetin.

3. Choudhury, A., 2014. Wild water buffalo Bubalus arnee (Kerr, 1792), in: Melletti, M., Burton, J. (Eds.), Ecology, Evolution and Behaviour of Wild Cattle. Cambridge University Press, Cambridge, United Kingdom, pp. 255–301. https://doi.org/10.1017/CBO9781139568098.018

4. Howe, E.J., Buckland, S.T., Despres-Einspenner, M.-L., Kühl, H.S., 2017. Distance
5. sampling with camera traps. Methods Ecol. Evol. 8 (11), 1558–1565

6. Jhala, Y.V., Qureshi, Q., Yadav, S.P., 2021. Status of leopards, co-predators, and megaherbivores in India, 2018 (No. ISBN-81-85496-56-0). National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun.

7. Kaul, R., Williams, A.C., rithe, K., Steinmetz, R., Mishra, R., 2019. Bubalus arnee, Wild Water Buffalo. https://doi.org/10.2305/IUCN.UK.2019-1.RLTS.T3129A46364616.en

8. Qureshi, Q., Jhala, Y.V., Yadav, S.P., Mallick, A., 2023. Status of tigers, co-predators and prey in India, 2022. National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun, Dehradun.

7

PAN India assessment and monitoring of endangered species covered under the Integrated Development of Wildlife Habitats Scheme of MoEF&CC

Progress report, September 2023

1. SPECIES: Nicobar Megapode *Megapodius nicobariensis*

2. SUPERVISOR: Dr. R. Suresh Kumar & Dr. Nehru Prabakaran

3. BACKGROUND:

The Nicobar megapode, an endemic bird of the Nicobar archipelago that lives in coastal forests and has an intriguing evolutionary history, was well-known for its breeding behaviour. By adding and removing the soil and vegetation that make up the mound, they construct mounds to incubate eggs and maintain the mound's temperature (Sivakumar, 2003). The populations of these birds have declined severely over the past two decades, primarily due to the impacts of the devastating 2004 Indian Ocean tsunami and the subsequent habitat loss due to land drowning. The bird population has experienced a 70 % decline after the 2004 tsunami. Reports have suggested that the species' population remained more or less stable after the initial loss. Further disturbance would severely impact the species' natural recovery and drive them to extinction. So, the bird's current population status needs to be assessed, and the stability of the population needs to be ensured. In this background, MoEF&CC has recognized this species' conservation need, included it in the list of top-priority species for conservation and management, and added it to the Integrated Development of Wildlife Habitats (IDWH) program. As an initial step, assessing the Nicobar megapode population and understanding the current status will help the species' conservation action and management plan. This assessment includes objectives that will help understand the current population status of Nicobar Megapode, which can contribute to the design of Island/site-specific management interventions that will be critical for the species long-term survival.

4. OBJECTIVES:

- To assess the current population status of Nicobar Megapode in the Nicobar archipelago.

5. METHODOLOGY:

Study Area: The Nicobar Archipelago comprises a group of 22 Islands (Fig. 1), covering a total area of 1930 km^2. These islands form three spatially discrete clusters, North (Car Nicobar and Battimalv Islands), Central (Chowra, Tarasa, Bompoka, Tillanchong, Praire rock, Isle of Man, Katchall, Trinkat, Camorta, Nancowry Islands) and South Nicobars (Meroe, Trax, Treis, Little Nicobar, Pilo Milo, Menchal, Kondul, Cabra, Pigeon, Great Nicobar). The Islands are located in the Bay of Bengal, east of peninsular India. The Nicobar Archipelago is separated from the Andaman Islands, a group of 572 Islands and islets on the North, by the Ten-degree Channel. The Nicobar megapode distributed in 15 islands (Shankaran, 1995a) (Camorta, Trinket, Nancowry, Katchall, Teressa, Bompoka, and Tillanchong, Great Nicobar, Little Nicobar, Kondul, Menchal, Treis, Meroe, Cubra, and Pilo Milo).

Approach:

As nest mounds are predominantly placed in a narrow strip of forest along the seashore in a clumped manner (Sankaran, 1995a), the survey will concentrate on forests adjoining the beach in 15 Islands. For small Islands, three observers will walk abreast parallel to the seashore, with one observer closest to the high tide line (HTL). As mounds within 20m of the observer are easily located, most mounds within a belt of forest about 60m wide were thus counted. The entire width of 140m will be covered by parallel walking to the initial trail. The length of this modified belt trail will be about 2 km. Small islands will be covered fully. Seven observers walk at 20m intervals parallel to the shore for larger islands. The interior forests of Great Nicobar, Little Nicobar, Camorta, Katchal and Teressa islands will be surveyed, with 2 km trails of 140 m width. The total number of active and abandoned mounds, mound size, canopy cover over the mound (Using a densiometer), and the distance between the HTL and mounds will be recorded by the survey protocol of Sankaran (1995b).

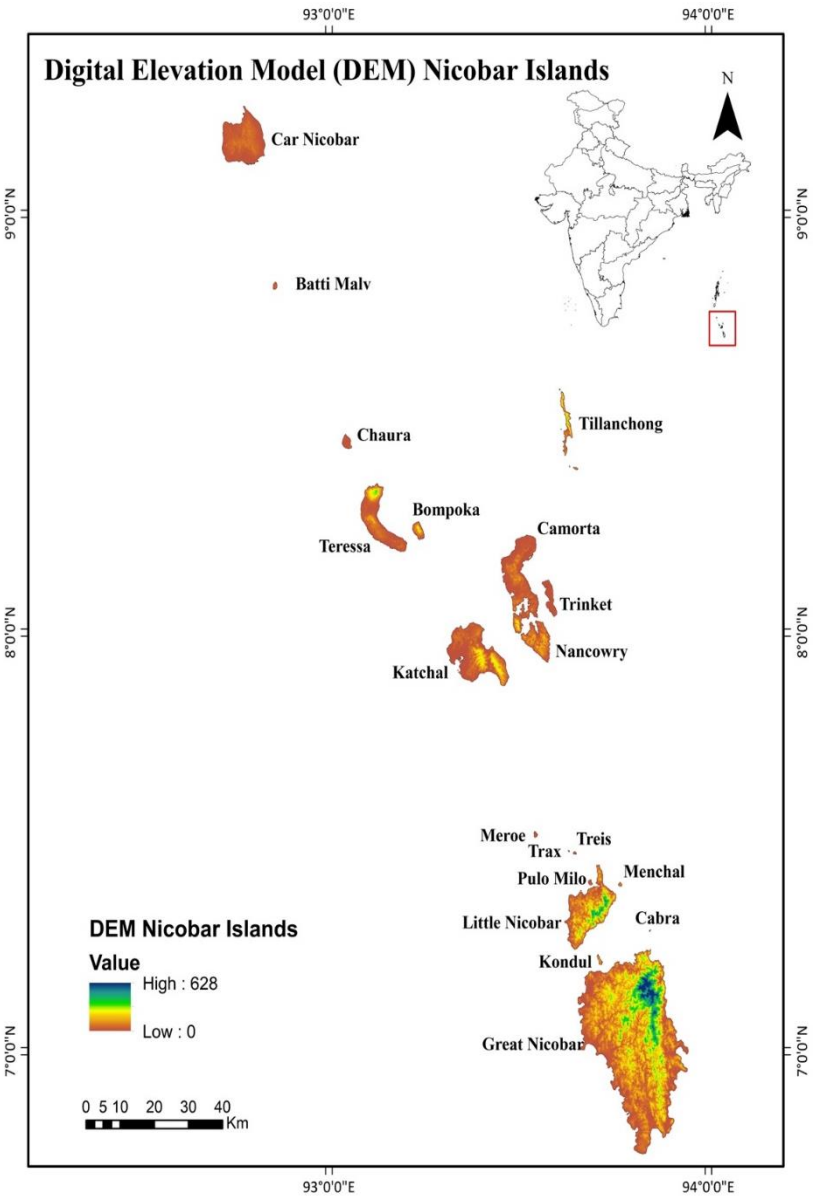


Figure:1 Map of Nicobar archipelago with details of the distribution of Islands

6. PROJECT PROGRESS (December 2022 – September 2023)

The following are the highlights of the progress made so far in the project:

• Recruitment of Project Personnel. Vishnu T joined as a Project Associate-I on 12/12/2022.
• Literature Review, mapping of study area, previous data collation, procurement of equipment and proposal preparation for the forest department.

• A research team, including Arathi J (IDWH-Edible Nest swiftlet) and Vishnu T (IDWH-Nicobar megapode), reached the Andaman and Nicobar Islands. A reconnaissance survey was conducted in important birding sites to acclimatize the island ecosystem. The researcher assisted in a reconnaissance survey conducted for population estimation of Edible-nest Swiftlet in South Andaman and Middle Andaman.
• The research team established a base camp in Garacharma, Portblair, South Andaman.
• Request for permission letter to conduct field survey in Andaman and Nicobar Islands submitted (For IDWH- Nicobar Megapode, Edible-nest swiftlet, Marine turtles). The project team has deliberated the Forest officials in Andaman Islands about the project and its importance.
• The Forest Department provided necessary permission to conduct the study in the Andaman Islands; however, permission for Nicobar Islands is still awaited.
• After a discussion with the Principal Chief Conservator of Forests (PCCF) Andaman and Nicobar Islands, a permission letter for the Nicobar Islands has been resubmitted.
• The researcher assisted the IDWH-Edible nest swiftlet team (18 Days) with their intensive fieldwork.
• In the absence of necessary entry permission for Nicobar Islands, the research personnel have visited turtle nesting beaches of North Andaman and collected data for the IDWH-Marine turtle team (20 days of fieldwork). Beach characteristics were recorded, and nesting data were gathered where there is monitoring happening from the forest department.
• The Project proposal is forwarded to place it in the upcoming Research Advisory Committee (RAC) by the Andaman and Nicobar Forest Department.
• As the research permission was delayed and the onset of monsoon has limited the possibility of fieldwork. The research team returned to the WII, HQ.

- No further communication was received from the Andaman and Nicobar Forest Department regarding RAC. A reminder letter has been submitted to expedite the permission.

An extensive literature review was conducted to understand the available information on the population status of Nicobar Megapode. The first population assessment conducted by Dekker in 1992 at Great Nicobar Island estimated 780 breeding pairs (Jones et al., 1995). The first-ever survey across all the islands estimated the species' overall population by monitoring 16 islands done by Sankaran (1995a). Estimated Population: (1161 mounds) 4644 - 8127 adult birds. Sivakumar (2010) surveyed 15 islands and to estimate the total number of active mounds, the coastline of each island was divided into two segments such as 'Potential Coastal Habitat for Megapode (PCHM) and 'Non-conducive Coastal Habitat for Megapode (NCHM), Potential coastal habitat of megapode was identified based on habitat preference (Sivakumar, 2000). The Tsunami shattered the coastal forests, and 70% of the population decline of Nicobar megapode was reported from its range (Sivakumar, 2007). From the study, 394 active mounds are estimated from 15 islands surveyed in its range. The total population estimated is 1576 and 394-788 breeding pairs. A following study on 15 islands in Nicobar, estimated 376 total active mounds (Balasubramanian et al., 2012). Estimated Total Population: 752 - 1504, and 376-752 breeding pairs. This estimate implies that the population become stable after the Tsunami (Fig. 2).

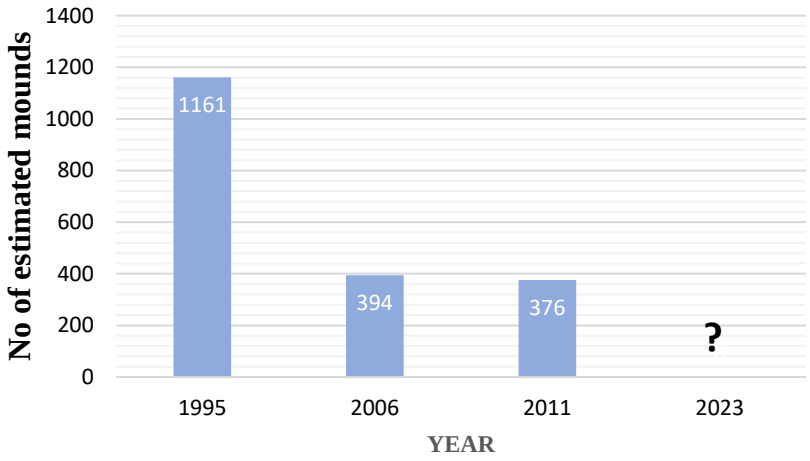
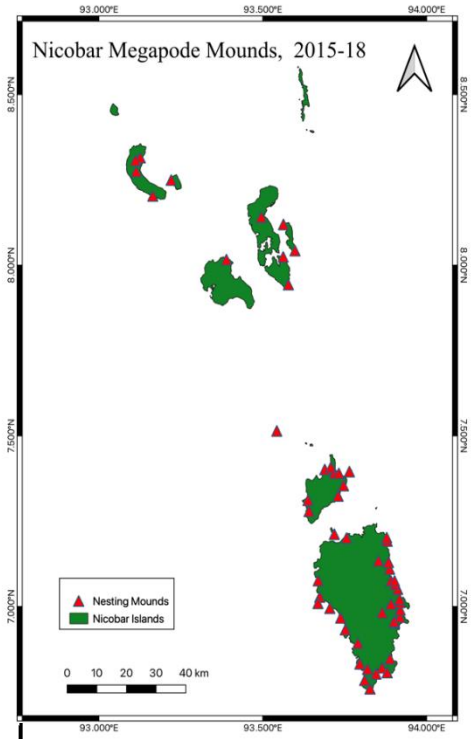


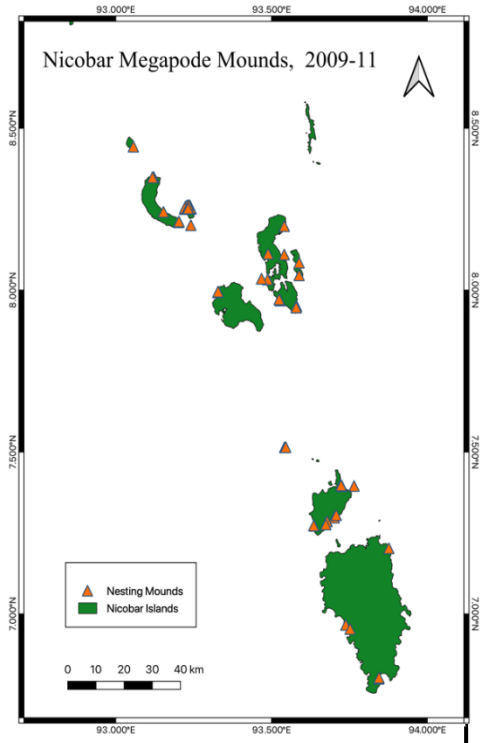
Figure:2 Population assessment of Nicobar Megapode by previous studies (Sankaran (1995); Sivakumar (2007); Balasubramanian et al. (2012).

7. Plan of work (2023-24):

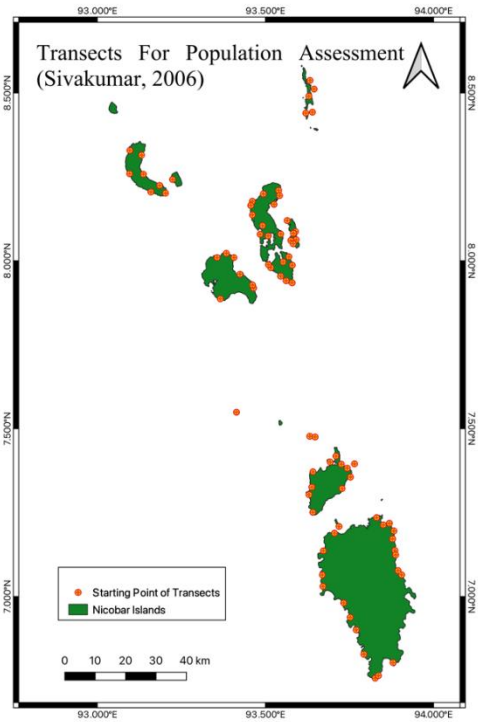
- Upon receiving the necessary permission to conduct fieldwork from the forest department, the team will initiate a field survey in the Nicobar Islands
- Field data processing, analysis, and population estimation in the study area
- Report preparation and submission



Mound locations from 2015-18 population assessment study (Sivaperuman et al, 2022)



Mound locations from 2009-11 population assessment study (Balasubramanian et al, 2012)



8. BUDGET RECEIVED & AMOUNT SPENT:

Total Funds Approved	Funds Received (60% of Total Amount) FY 2021-22	Committed Indents	Total Expenditure Including Committed	Balance
30,00,000.00	18,00,000.00	2,65,000.00	9,69,710.00	8,30,290.00

REFERENCE:

1. Balasubramnian, P., Vijayan, L., & Shankaran, R. (2012). *Monitoring Post-Tsunami Coastal Ecosystem Recovery in the Nicobar Group of Islands and Developing site-specific Restoration Measures*.
2. Jones, D. N., Dekker, R. W. R. J., and Roselaar, C. S., 1995, The Megapodes, Oxford
3. Sankaran, R. 1995a. The distribution, status and conservation of the Nicobar Megapode *Megapodius nicobariensis. Bioi. Conser*.
4. Sankaran, R. 1995b. The Nicobar Megapode and other endemic Avifauna of the Nicobar Islands (Status and conservation). Technical Report 2, Salim Ali Centre for Ornithology and Natural History, Coimbatore
5. Sivakumar, K. (2010). Impact of Tsunami on certain species of Nicobar Group of Islands with Special reference to the Nicobar Megapode Megapodius Nicobariensis. In *Recent Trends in Biodiversity of Andaman and Nicobar Islands* (pp. 435–441). Zoological Survey of India.
6. Sivakumar. K. (2007). *The Nicobar Megapode Status, Ecology and Conservation: Aftermath tsunami*.
7. Sivakumar, K., & Sankaran, R. (2003). The Incubation Mound and Hatching Success of the Nicobar Megapode Megapodius Nicobariensis. *Journal of the Bombay Natural History Society*, *100*(1), 375–387.

8. Sivakumar. K., (2000) *A Study on the Breeding Biology of the Nicobar Megapode Megapodius Nicobariensis*. Salim Ali Institute of Ornithology and Natural History, Coimbatore.
9. Sivaperuman, C., Gokulakrishnan, G., & Sivakumar, K. (2022). Present Status and Distribution of Nicobar Megapode Megapodius nicobariensis in Nicobar Islands. In *Faunal Ecology and Conservation of the Great Nicobar Biosphere Reserve* (pp. 319–333).

8

PAN India Assessment and Monitoring of endangered species covered under the Integrated Development of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. **SPECIES:** Vultures
2. **SUPERVISOR(s):** Dr. Suresh Kumar & Dr. Gautam Talukdar
3. **BACKGRROUND:**

India is home to nine species of vultures, which have wide distribution across the country. However, vulture populations in India have declined drastically by 97% since the 1990s, primarily due to the use of the veterinary drug Diclofenac (Shultz et al., 2004; Murn, Khan, and Farid, 2008; Prakash et al., 2012; Saini et al., 2012). Other factors that have also contributed to the decline of vultures in India include habitat loss and electrocution (Prakash et al., 2003). The Government of India has taken several measures to conserve vultures, Post Diclofenac ban in 2006 the population of vultures is said to have stabilized though is still critical. To understand the current status, The Ministry of Environment, Forest and Climate Change (MoEF&CC) under the Integrated Development of Wildlife Habitats (IDWH) scheme through WII initiated a nationwide population assessment. This is also one of the actions listed in the Action Plan for Vulture Conservation in India (2020-25).

4. Objectives:

To assess the nesting population of the vultures across the Indian region and to develop a Centralised Database for the same with a special focus on the three species of Critically Endangered Gyps Vultures: *Gyps bengalensis*, *Gyps indicus*, *Gyps tenuirostris*, and *Sarcogyps calvus*

5. Methodology:

Study Area: The study area for this project encompasses the vast and diverse Indian region, across the states of Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Uttar Pradesh, West Bengal, Assam, Sikkim, Chhattisgarh, Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Andra Pradesh, Telangana, Karnataka, Kerala and Tamil Nadu.

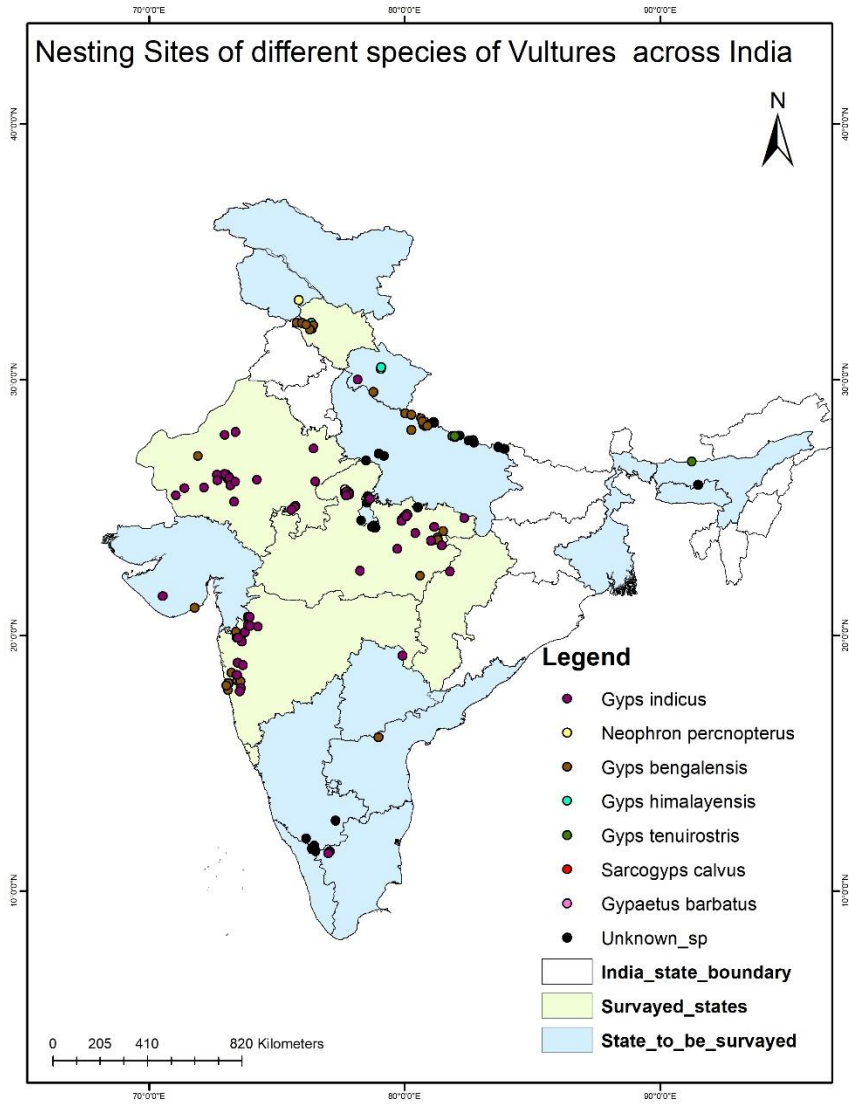


Figure:1 Map showing Nesting sites of different species of Vultures recorded from Literature Survey

Approach:

Given that the vulture populations are widely distributed across the Indian region, and in the case of the highly threatened species having small populations and that they are confined to only a few sites, a systematic approach through counts at nesting or roosting sites and counts at carcass dumping sites were undertaken. All known vulture nesting sites across the Indian region have been mapped. Information on other sites that may not be recorded in the literature review were collected from the forest department in the respective region. Information on the species of vulture nesting, the number of nests, and site characteristics were recorded during the nesting site survey. Apart from this information, data on the carcass dumping sites and threats were also recorded.

6. PROJECT PROGRESS:

The permission requests were communicated to all 18 states of which permission has been granted by seven states: Chhattisgarh, Gujarat, Himachal Pradesh, Kerala, Madhya Pradesh, Rajasthan, and Uttarakhand. Accordingly, surveys in these states were carried out. The field visits were carried out from May 2023 in five states: Maharashtra, Madhya Pradesh, Rajasthan, Chhattisgarh, and Himachal Pradesh.

A total of 100 out of the 114 nesting locations that were recorded have been found to be active. *Gyps bengalensis* had 241 active nests spread over 29 locations, whereas *Gyps indicus* had 732 active nests spread across 60 sites. With just 3 active nests at 3 locations, the *Sarcogyps calvus* had the fewest number of nests. While for *Neophron percnopterus*, 11 nests at 7 locations were recorded. The highest number of vulture nesting sites was recorded in the state of Madhya Pradesh (58), followed by Maharashtra (19), Rajasthan (12), Himachal Pradesh (8) and Chhattisgarh (3). Out of the total recorded sites, only 44% of the sites were reported to be inside the Protected area. This shows that the majority of the sites are located outside of the PAs and are more prone to threats in the region.

The biggest nesting colony of G. indicus was discovered at the Garadia Mahadev site in Rajasthan's Chambal Wildlife Sanctuary, where 150–200 nests were recorded during the breeding season while only 49 nests with adults and juveniles were observed during the visit in non-breeding season. The state of Madhya Pradesh (39) had the highest record of Gyps Indicus nesting sites followed by Maharashtra (12), Rajasthan (6), and Chhattisgarh (3). No nesting site of *G. indicus* was recorded in Himachal Pradesh. The biggest colony of *G. bengalensis* was discovered in the Lalpur location in the Kangra District of Himachal Pradesh, with 40 individuals making it the largest colony of *G. bengalensis* nesting on the Chir Pine trees. Another population of *G. bengalensis* was recorded in Shrivardhan, Maharashtra, where the population is observed to be nesting on the Coconut Trees. Based on vulture nesting data collected from five States, the minimum number of individuals nesting in the case of G. indicus is 1464. While the minimum number of *G. bengalensis* individuals nesting is 482.

7. PLAN OF WORK (2023-24):

Fieldwork is to be carried out in the remaining states of Uttarakhand, Uttar Pradesh, West Bengal, Assam, Sikkim, Ladakh, Gujarat, Andra Pradesh, Telangana, Karnataka, Kerala and Tamil Nadu. Once the Data collection from the field is completed the data will be analysed to determine the population of the vultures across the Indian region. The data collected will be maintained in a National Vulture Database that will be developed, which information will be accessible to all the stakeholders involved in vulture population monitoring. The data collected will form the baseline for all future population trend analysis.

8. BUDGET RECEIVED & AMOUNT SPENT:

Total Funds Approved	Funds Received (60% of Total Amount) FY 2021-22	Committed Indents	Total Expenditure Including Committed	Balance
25,00,000.00	15,00,000.00	1,35,000.00	7,63,081.00	7,36,919.00

REFERENCE:

1. Murn, C., Khan, U. and Farid, F., 2008. Vulture populations in Pakistan and the Gyps vulture restoration project. Vulture News, 58: 35-43.
2. Prakash, V., Bishwakarma, M.C., Chaudhary, A., Cuthbert, R., Dave, R., Kulkarni, M., Kumar, S., Paudel, K., Ranade, S., Shringarpure, R. and Green, R.E., 2012. The population decline of Gyps vultures in India and Nepal has slowed since veterinary use of Diclofenac was banned. PloS one, 7(11), p.e49118.
3. Prakash, V., Pain, D.J., Cunningham, A.A., Donald, P.F., Prakash, N., Verma, A., Gargi, R., Sivakumar, S. and Rahmani, A.R., 2003. Catastrophic collapse of Indian whitebacked Gyps bengalensis and long-billed Gyps indicus vulture populations. Biological conservation, 109(3): 381-390.
4. Saini, M., Taggart, M.A., Knopp, D., Upreti, S., Swarup, D., Das, A., Gupta, P.K., Niessner, R., Prakash, V., Mateo, R. and Cuthbert, R.J., 2012. Detecting Diclofenac in livestock carcasses in India with an ELISA: A tool to prevent widespread vulture poisoning. Environmental Pollution, 160: 11-16
5. Shultz, S., Baral, H.S., Charman, S., Cunningham, A.A., Das, D., Ghalsasi, G.R., Goudar, M.S., Green, R.E., Jones, A., Nighot, P. and Pain, D.J., 2004. Diclofenac poisoning is widespread in declining vulture populations across the Indian subcontinent. Proceedings of the Royal Society of London. Series B: Biological Sciences, 271(suppl_6): S458-S460.

Pan India Assessment and Monitoring of endangered species covered under the Integrated Development of Wildlife Habitats (IDWH) Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Malabar Civet (*Viverra Civitena)*

2. SUPERVISORS: Dr. Vishnupriya Kolipakam & Dr. Samrat Mondal

3. BRIEF BACKGROUND:

Integrated Development of Wildlife Habitats (IDWH) is a Centrally Sponsored Scheme, made operational during 11th Plan Period by augmenting the existing *Assistance for the Development of National Parks and Sanctuaries* with additional components. The third component of IDWH is focused on conservation of 22 endangered and critically endangered species by understanding their current population status and distribution. The species was listed as "Endangered" in 1986, 1988, 1990, and 1994; starting in 1996, it is listed as "Critically Endangered." The Indian Wildlife (Protection) Act, 1972 lists the Malabar civet in Schedule I, part I. The current population status is unknown. It was thought to be possibly extinct and then rediscovered (Kurup, 1989; Ashraf et al., 1993; Rai & Kumar, 1993), but there is no further recent information and no recent sightings of live Malabar civets (Rao et., 2007).

4. OBJECTIVES:

1) Analyse the severely Critically endangered Malabar civet species current status; 2) Identify potential field sites for long-term ecological study of Malabar civets in the Western Ghats; 3) Develop protocols for long-term population and habitat monitoring.

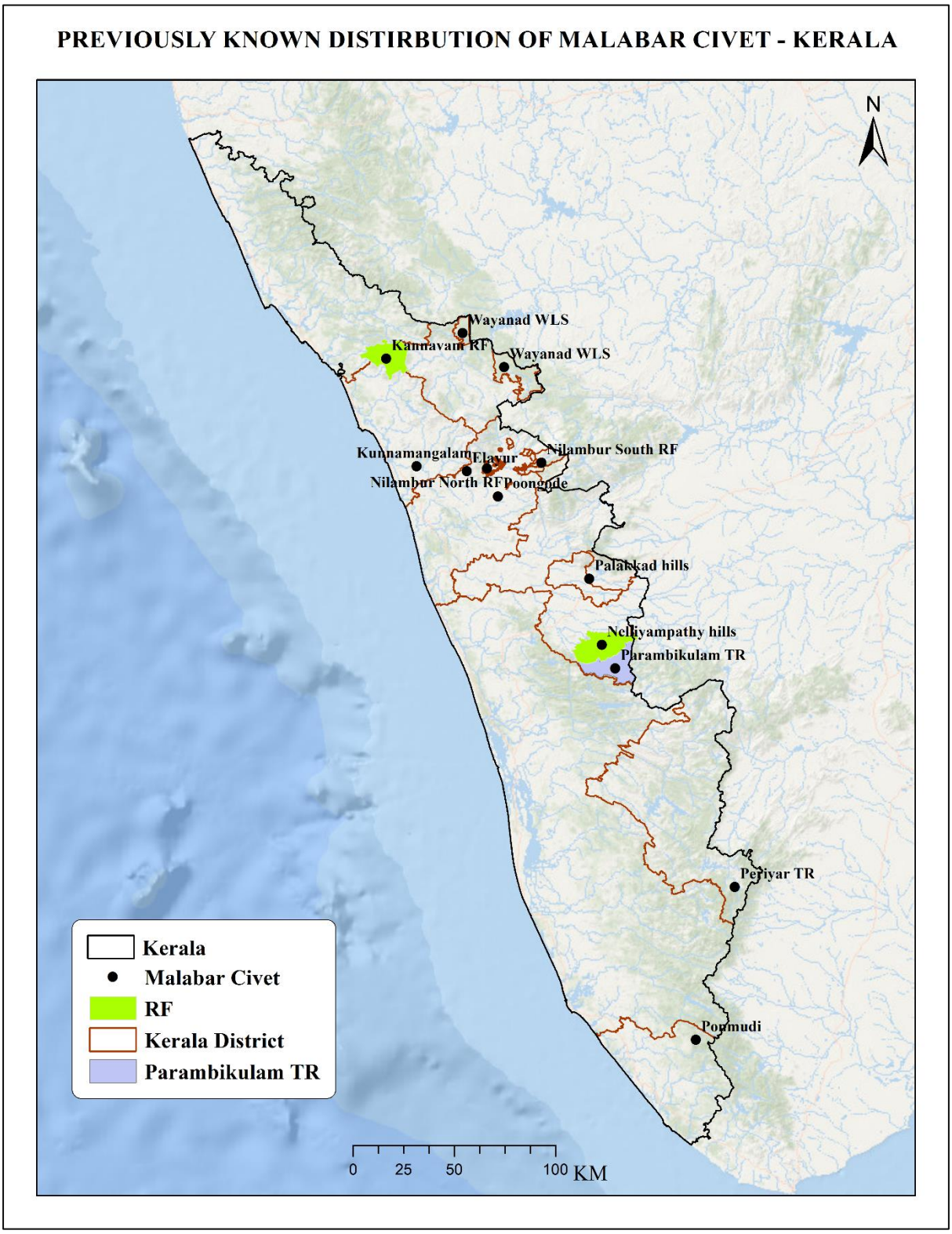
5. METHODS:

Extensive camera trapping across the Western Ghats has not yielded any photographic evidence of Malabar Civet. It would be wise first to determine the phylogeny of the Malabar Civet using putative museum specimens using modern genetic methods. Before declaring a species extinct, once it has been established as a separate species, all targeted camera trapping efforts employing lures and baits in arboreal camera trap setups should be made to identify Malabar Civet.

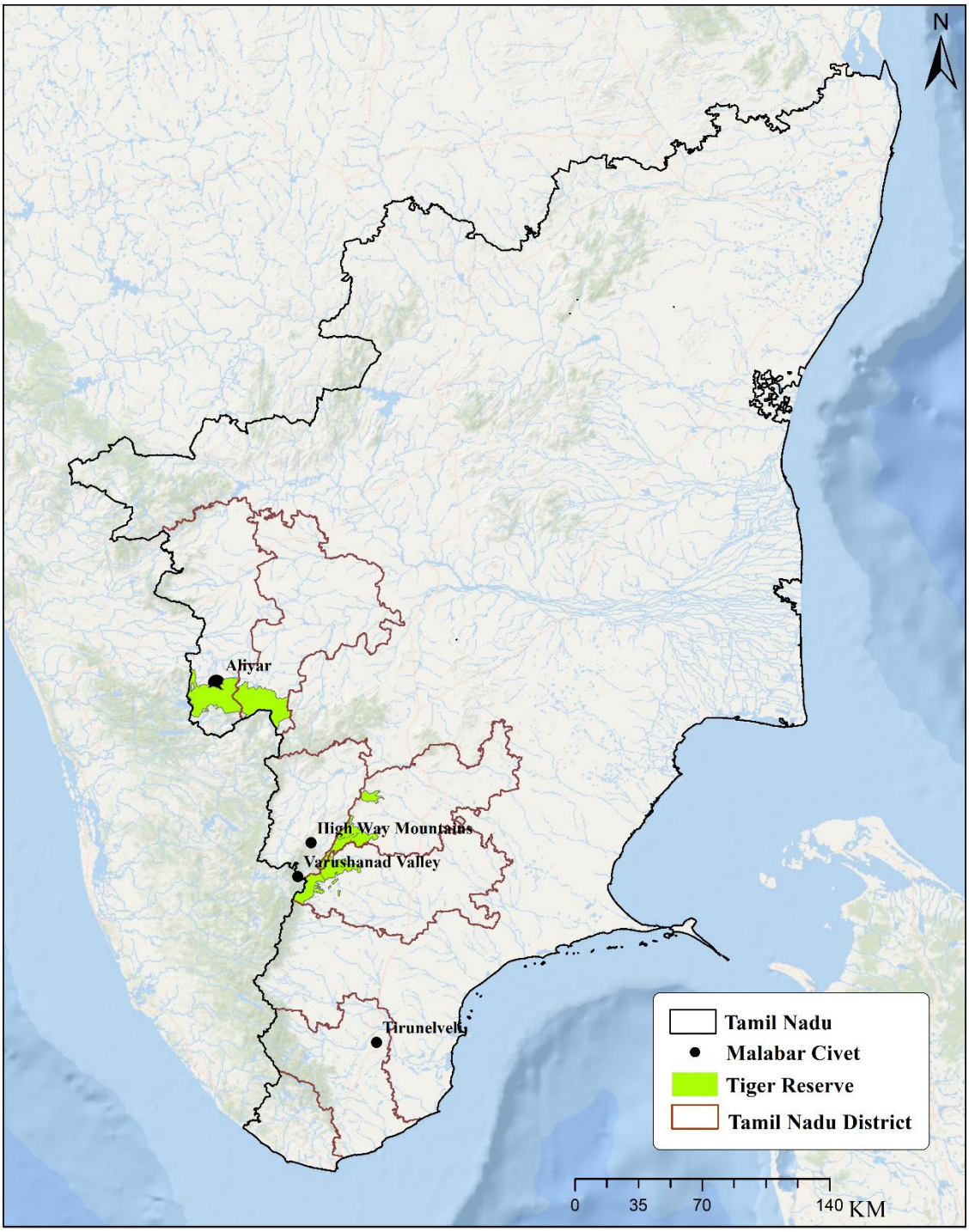
6. PROGRESS TILL DATE:

There is no fieldwork started to identify Malabar Civet in the Western Ghats.

However, distribution mapping based on previous records and publications has been undertaken.



PREVIOUSLY KNOWN DISTIRBUTION OF MALABAR CIVET - TAMIL NADU



PREVIOUSLY KNOWN DISTIRBUTION OF MALABAR CIVET - KARNATAKA

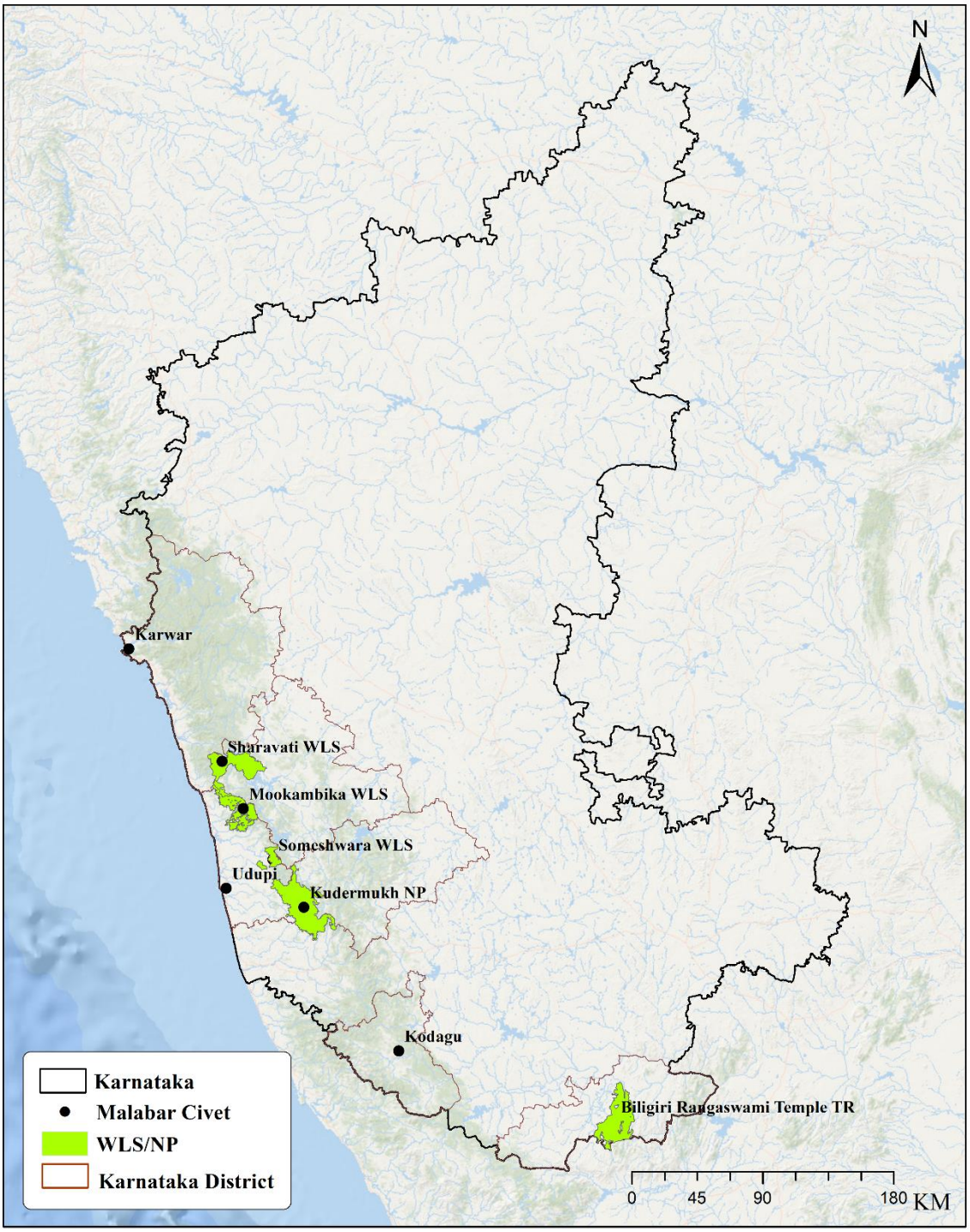


Table 1: Review of different museums and universities where putative Malabar Civet skins are present

Sl. NO	Museum	Collection Number	Skin	Skull	Sex	Collection Location	Source of Skin	Date of Collection	Collector	Complete Tag Details
1	ZSI, Kolkata	10394	Yes	No			Unknown	Unknown (19th century)	Unlnown	Tag 1: Indian Museum Calcutta, *Viverra civettina*, Purchased Tag 2: ZSI, *Viverra megaspila* subsp. *civettina* Blyth, Purchased, det. Robinson and Kloss 7.1.20
2	ZSI, Kolkata	20834	Yes	No			Purchased	Unknown (19th century)	Unlnown	Tag 1: Indian Museum Calcutta, *Viverra civettina*, South Indian variety, *V. civettina* Blyth, Purchased Tag 2: ZSI, *Viverra megaspila civettina* Blyth Tag 3: Indian Museum, *Viverra civettina*, Purchased
3	Natural History Museum, London	ZD 1884.6.3.11	Yes	Yes	M	Sumatra on earliest tag - later changed to South India	Unknown, deposited at Zoological Society, London, then sold to Dr. Crisp, then sold to NHM, purchased	Donated to Zool. Soc. before 1838, bought from Dr Crisp 1860	Sir T. S. Raffles	Tag 1: *V. megaspila*, Sumatra, Collector: Sir T. S. Raffles, Crisp Sale Tag 2: *V. civettina*, Probably S. India, Collector: Sir T. S. Raffles, Crisp Sale Tag 3: *Moschothera civettina*, India (no doubt), Collector: Sir T.S. Raffles, Crisp Sale
4	Natural History Museum, London	ZD 1920.1.17.3	Yes	Yes	M	Trivandrum Zoo	Obtained from Trivandrum Zoo	1907 - Govt. Zoo/ Museum - Tvdm, 1918 - BNHS, 1920 - NHM	W. S. Millard	Tag 1: *Viverra civettina*, Trivandrum Zoo, Bombay Natural Historv Society Tag 2: Moschothera civettina, Travancore, Trivandrum Zoo
5	Bombay Natural History Society, Mumbai	5599	Yes	Yes	M	Trivandrum Zoo Obtained from	Obtained from Trivandrum Zoo	1907 - Govt. Museum - Tvdm, 1918 - BNHS	W. S. Millard	*Viverra civettina*, Trivandrum Zoo, patch of skin missing from neck, possibly due to a skin infection.
6	Zoological Survey of India, Kozhikode	3847	Yes	No		Elayur, Kerala	Recovered from a hunter	1987	G.U Kurup	Viverridae, Malappuram district, Ernad Taluk, Karvzannur, Elavur, Collection date: 9.3.1987 (sic), date of entry: 17.3.1987 (sic).
7	Calicut University Museum, Kozhikode	no details	Yes	No		Elayur, Kerala	Recovered from a hunter	1987	N. G. George and ZSI team	Malabar Civet cat
8	Chennai Government Museum	no details	Yes	No		Unknown	Unknown	Presumably before 1923	Unknown	Unknown
9	Wildlife Institute of India, Dehra Dun	2 skins, destroyed	No	No		Elayur, Kerala	Recovered from a hunter	1990	N. V. K. Ashraf	Unknown
10	Wildlife Institute of India, Dehra Dun	2 skins, destroyed	No	No		Elayur, Kerala	Recovered from a hunter	1990	N. V. K. Ashraf	Unknown
11	Zoological Survey of India, Kolkata	10393 (=A.S.B No. 140A, =I.M, No.b)	Yes	Yes		South Malabar, Kerala		1845	Lord Arthur Hay	not seen
12	NCB Naturalis, Netherlands (RMNH)	3748	Yes	Yes	F	India	Unknown	14-Jun-38	Gebr. Blazer	Civettictis civetta, India
13	Zoological Survey of India, Kolkata	?	Yes	Yes		?	Unknown	Unknown (19th century)	Unknown (19th century)	[not seen]. According to Sclater (1891) the skeleton corresponding to this skin is at the museum

- Progress has also been made to compare all the possible civet photos from All India tiger monitoring data to understand if there is any possibility of Malabar civet capture. However, after screening more than 1000 pictures of civet, no Positive Malabar civet photo has been found.

- We are designing a primer to identify the Malabar civet as a separate species from the other species.

7. PLAN OF WORK:

After designing the primer, collect the putative skins of Malabar Civet samples from the different institutes and conduct the genetic analysis to confirm their distinctiveness from the other Viverrid species. If we confirm, fieldwork will start in the previous distribution regions of Malabar Civet in the Western Ghats as soon as possible.

8. BUDGET RECEIVED & AMOUNT SPENT:

Total Funds Approved	Funds Received (60% of Total Amount) FY 2021-22	Committed Indents	Total Expenditure Including Committed	Balance
5,00,000.00	3,00,000.00	-	2,93,143.00	6,857.00

REFERENCE:

1. R. Nandini and Divya Mudappa. Mystery or myth: a review of history and conservation status of the Malabar Civet *Viverra civettina* Blyth, 1862. Small Carnivore Conservation, Vol. 43: 47–59, December 2010.
2. Ashraf, N.V.K, Kumar, A. and Jhonsingh, A.J.T. Two endemic viverrids of the Western Ghats. Oryx, 27 (2): 109-114.
3. R. Nandini. An Investigation into The Taxonomy of The Malabar Civet, *Viverra civettina*. National Institute of Advanced Studies, Bangalore.
4. Rao, S., Ashraf, N. V. K. & Nixon, A. M. A. 2007. Search for the Malabar Civet Viverra civettina in Karnataka and Kerala, India, 2006–2007. Small Carnivore Conservation 37: 6–10.

PAN India Assessment and Monitoring of endangered species covered under theDevelopment of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: One horned rhinoceros (*Rhinoceros unicornis*)

2. SUPERVISORS: Qamar Qureshi

3. BRIEF BACKGROUND:

Greater one horned rhinoceros (*Rhinoceros unicornis*) (rhinoceros, hereafter) are among four megaherbivores that are found in Indian sub-continent. Once widespread across the alluvial floodplains of Indus, Ganges and Brahmaputra, rhinoceros population is now restricted to few protected areas of India and Nepal (Jhala et al 2021a). In the Indian side, rhinoceros are present in Dudhwa national park of Uttar Pradesh, Gorumara and Jaldapara national park in West Bengal, Kazirang, Manas, and Orang tiger reserve and Pobitora wildlife sanctuary in Assam with occasional presence from Valmiki tiger reserve of Bihar and Laokhowa-Burachhapori wildlife sanctuary of Assam. Drastic decline of distribution range and population of rhinoceros is mostly due to demand driven poaching of rhinoceros for illegal trade of horns, conversion of natural habitats for agriculture, thatch collection, cattle grazing, burning of grassland for fodders, and invasion of exotic plant species like *Mikania micrantha, Leea crispa* etc. in grassland habitats (Jhala et al 2021b). After the local extinction, rhinoceros were reintroduced in Dudwa national park (1984) and Manas tiger reserve (2006) (Kumar, R. and Ashokkumar, M. 2023). At present Kaziranga tiger reserve holds the largest population of one horned rhinoceros in the India with a population of 2613 followed by Jaldapara national park (287) in West Bengal (News report, Deccan Herald 2022).

4. OBJECTIVES:

- Assess the current population status of one horned rhinoceros.
- Development of long-term monitoring protocols for populations and their habitats of one horned rhinoceros.
- Identifying suitable habitat for reintroduction of one horned rhinoceros.

5. APPROACH /METHODOLOGY:

a) Population Assessment: We used line transect based distance sampling and Camera trap-based distance sampling both the approaches to estimate densities of Wild Buffalo, Barasingha (Swamp Deer) and Rhinoceros. We are also considering the possibility to modify the total count survey with statistical robustness.

Line transect surveys is the preferred formal population estimation method based on visual detection of animals (Buckland et al. 1993). Population estimation of the Ungulates can be carried out by using line transects of length 2.0 km. Each transect were walked between 6:30 am and 8:30am. GPS locations for beginning points and end points of transect were recorded. Broad forest type and terrain type for each transect line were recorded. For each cluster of prey animals encountered on transects, the following variables have been

recorded: (1) species (2) cluster size (3) angular sighting distance and (4) bearing. The computer Program DISTANCE Version 6.0 (Laake et al., 2004) is used for analyses of line transects data to yield density estimates of the different tiger prey species. Distance is a Windows-based computer package that allows us to design and analyze distance sampling surveys of wildlife populations. It gives us best fit model to calculate cluster density (DS), population density (D), estimated population (N), Detection probability (*p*)

Camera trap distance sampling (Howe et al., 2017) is mostly used to estimate density of ungulates or animals which are not individually identifiable and difficult to study in the wild due to hostility of the terrain and elusiveness of the species. However, to estimate the density, this sampling method requires accurate camera to animal distance. This distance can be acquired by performing calibration process before conducting the survey. This calibration process involves taking images of objects of known dimensions at know distances from the camera. CTDS is also effective at areas where animal density is very low. It minimizes the risk of hostile landscape and chance of observer fatigue.

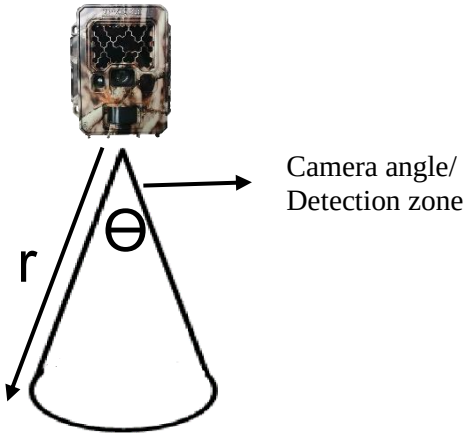


Figure:1 Schematic diagram of Camera trap-based distance sampling approach

a) **Assessment of potential habitats**: Status of grassland habitats across alluvial floodplains of Ganges- Brahmaputra basin will be assessed through LULC maps, species distribution modelling along with population habitat viability analysis will be used to identify potential sites to reintroduce the species.

1. PROGRESS TILL DATE:

a) Review of different methodologies are completed.
b) Line transect based distance sampling and CT based distance sampling data obtained from Orang TR. Data analysis and comparison of results are ongoing for Orang TR.
c) We used line transect based distance sampling in Manas Tiger reserve on Elephant Back with the support of Forest department Manas Tiger reserve. We also did survey through Camera trap-based distance sampling. Habitat specific cameras were deployed randomly in the Manas National park. We calibrated each camera trap station with known distances up to the detection zone. Data Analysis is in progress.
d) Comparison of RAIs obtained from SECR camera trap data and CTDS data has been done.
e) Analysis of CTDS data of Manas tiger reserve and Jaldapara national park are ongoing.

f) Mapping of grassland habitats are ongoing.

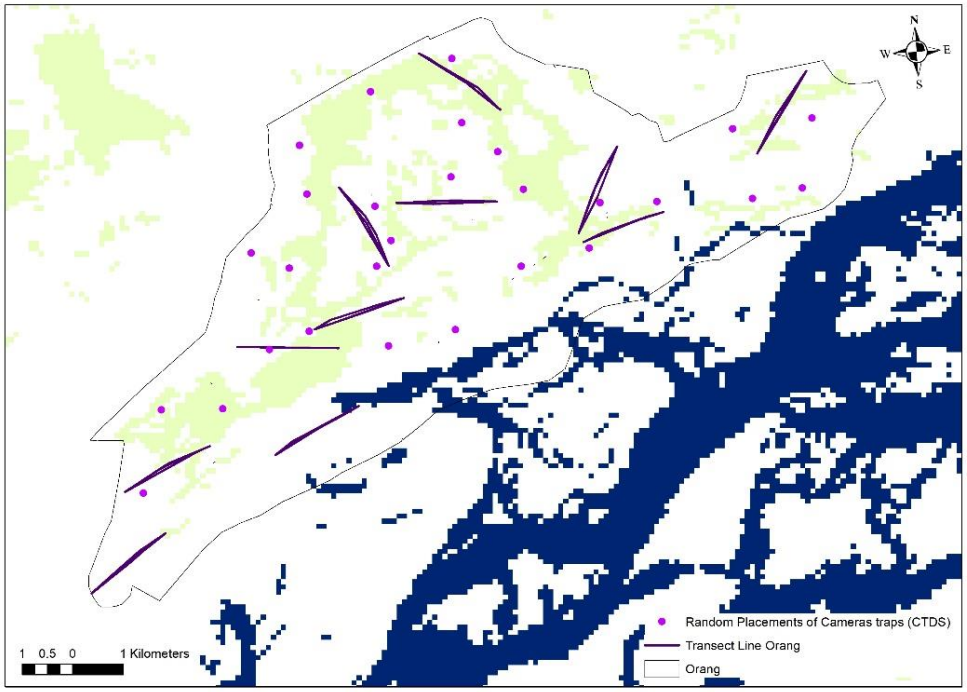


Figure:2 Line transect and Random camera placement at Orang Tiger reserve

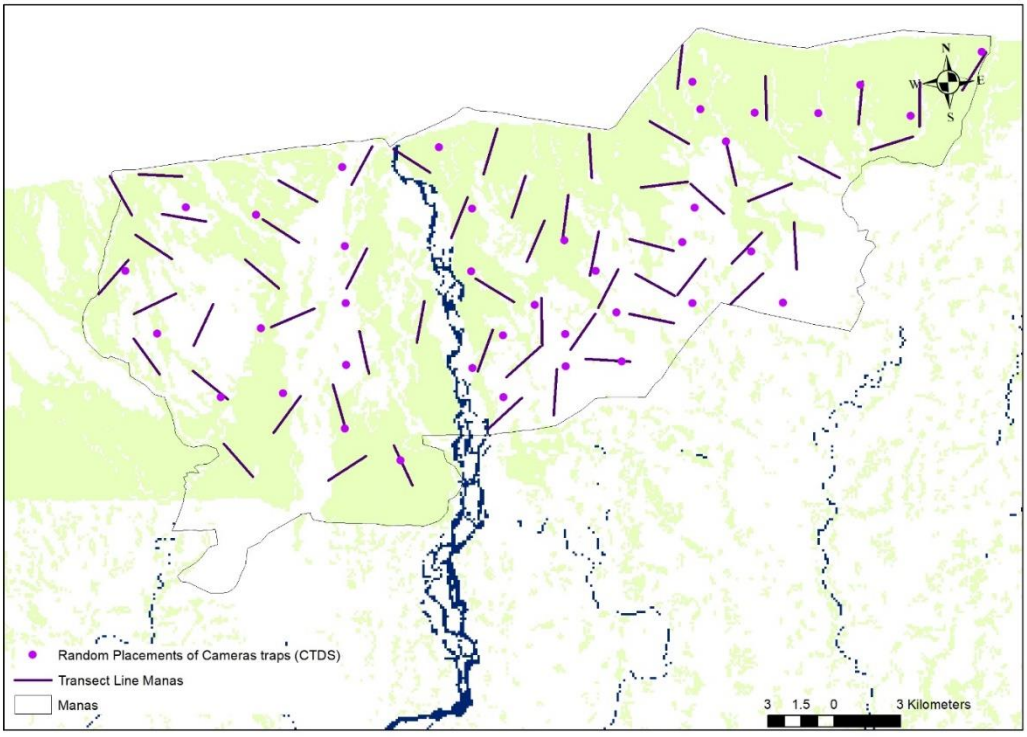


Figure:3 Line transect and Random camera placement at Manas Tiger reserve

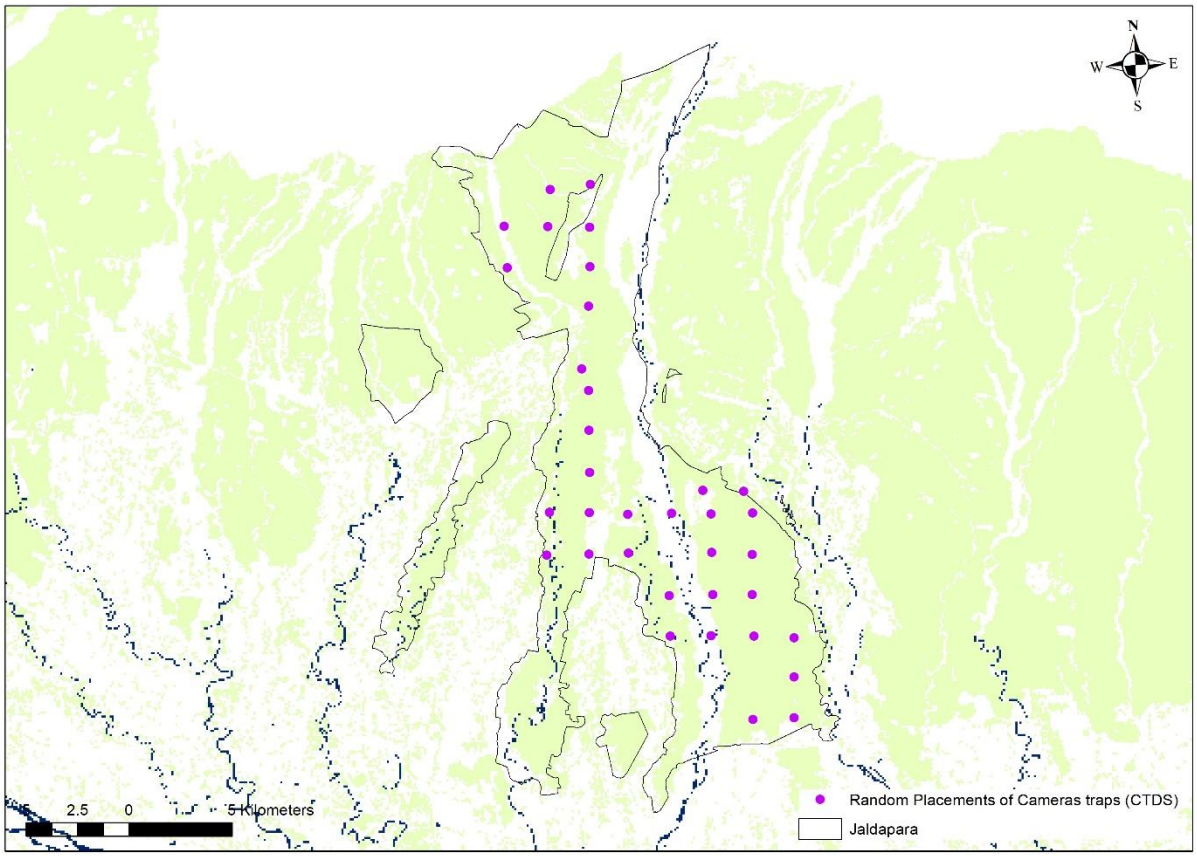


Figure:4 Random camera placement at Manas Tiger reserve

Figure:5 Camera trap placement for CTDS in Manas Tiger reserve

Figure:6 Camera trap capture of Rhinoceros in Jaldapara NP from CTDS

2. PLAN OF WORK (FOR 2023-24):

a) Field work for testing and comparing different population monitoring methodologies of rhinoceros will be done for a known population.
b) Workshop with stakeholders and officials of current and historic range states will be conducted.
c) Methods for assessing population and habitat will be standardized after incorporating the outcomes of the workshop and field data analysis.
d) Population habitat viability analysis (PHVA) will be done.
e) Report preparation

8. BUDGET RECEIVED & AMOUNT SPENT

Total Funds Approved	Funds Received (60% of Total Amount) FY 2021-22	Committed Indents	Total Expenditure Including Committed	Balance
20,00,000.00	12,00,000.00		-	12,00,000.00

REFERRNCE:

1. Buckland, S.T., Anderson, D.R., Burnham, K.P. & Laake, J.L. (1993) Distance Sampling: Estimating Abundance of Biological Populations. Chapman & Hall, London.

2. Howe, E.J., Buckland, S.T., Despres-Einspenner, M.-L., Kühl, H.S., 2017. Distance sampling with camera traps. Methods Ecol. Evol. 8 (11), 1558–1565

3. Jhala, H. Y., Qureshi, Q., Jhala, Y. V., & Black, S. A. (2021a). Feasibility of reintroducing grassland megaherbivores, the greater one-horned rhinoceros, and swamp buffalo within their historic global range. Scientific Reports, 11(1), 4469.

4. Jhala Y. V., Qureshi Q, Yadav SP (2021b) Status of leopards, co-predators, and megaherbivores in India, 2018. National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun

5. Kumar, R., & Ashokkumar, M. (2023). An Assessment of the Population Density of Greater One-Horned Rhinoceros in Uttar Pradesh and Their Distribution in India. In Tropical Forests-Ecology, Diversity and Conservation Status. IntechOpen.

6. One-horned rhino population crosses 4,000-mark (Read more at: https://www.deccanherald.com/india/one-horned-rhino-population-crosses-4000-mark-1147070.html)

PAN India Assessment and Monitoring of endangered species covered under theDevelopment of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Swamp deer (*Rucervus duvaucelii*)

2. SUPERVISORS: Qamar Qureshi, Samrat Mondal, Vishnupriya Kolipakam, Lallian Kawlni

3. BRIEF BACKGROUND:

The swamp deer (*Rucervus duvaucelii*) has three sub-species: the northern swamp deer (*R. d. duvauceli*), inhabiting flooded tall grasslands of the Indo-gangetic plain (Dudhwa Tiger Reserve and some terai forests of UP and Uttarakhand); the central swamp deer (*R. d. branderi*), or the hard ground barasingha found in Kanha, Satpura, and Bandhavgarh National Park in Madhya Pradesh; and the eastern swamp deer (*R. d. ranjitsinhi*), found largely in Kaziranga and Manas National Park of Assam. The species is listed in the IUCN Red List as "vulnerable" due to severe population decline and range contraction during the last century (Duckworth et al. 2015). This has resulted in a global population size of <5000 individuals, restricted to isolated populations in north, north-east, and central India and south-west Nepal (Qureshi et al., 2004; Tewari and Rawat, 2013).

Table 1: Current Status of Swamp deer in India

Subspecies	**Study Area**	**No. of individuals**	**Literature sighted**	**Threats in different zone (North, Central & Eastern)**
	Dudhwa National Park	2538	2019 (pers com. Forest department Dudhwa)	Grassland management and occasional poaching threats
	Pilibhit Tiger Reserve	50-90	Qureshi et al. 1995	
	Kishanpur Wildlife Sanctuary	400-600	Qureshi et.al. 1995	

Northern Swamp deer (Rucervus duvacellii)	Hastinapur Wildlife Sanctuary	145	2020	Overgrazing, habitat conversion and occasional poaching and highly fragmented habitat
	Katarniaghat Wildlife Sanctuary	10-25	1990	
	Jhilmil Jheel Conservation Reserve	250	2016, 2017 (Paul et al 2018)	
	Bijnor barrage	12	(Paul et al 2018)	
Central India Swamp deer (Rucervus duvacelli branderi)	Kanha Tiger Reserve	956	2022	Need of appropriate Grassland management and invasive/ weed monitoring
	Satpura Tiger Reserve	172	2023	
	Bandhavgarh Tiger Reserve		2023	
Eastern Swamp deer (Rucervus duvacelli ranjitsinhii)	Kaziranga Tiger Reserve	907	2018	Rapid conversion of grasslands to agriculture, unchecked hunting for trophy and floods
	Manas Tiger Reserve	121	2021	

4. OBJECTIVES:

- Assess the current status of Swamp deer
- Development of long-term monitoring protocols for populations and their habitats of swamp deer
- Develop conservation action plan

5. APPROACH /METHODOLOGY:

a) Population Assessment: We used line transect based distance sampling and Camera trap-based distance sampling both the approaches to estimate densities, Barasingha (Swamp Deer). We are also considering the possibility to modify the total count survey with statistical robustness.

Line transect surveys is the preferred formal population estimation method based on visual detection of animals (Buckland et al. 1993). Population estimation of the Ungulates can be carried out by using line transects of length 2.0 km. Each transect were walked between 6:30 am and 8:30am. GPS locations for beginning points and end points of transect were recorded. Broad forest type and terrain type for each transect line were recorded. For each cluster of

prey animals encountered on transects, the following variables have been recorded: (1) species (2) cluster size (3) angular sighting distance and (4) bearing.

The computer Program DISTANCE Version 6.0 (Laake et al., 2004) is used for analyses of line transects data to yield density estimates of the different tiger prey species. Distance is a Windows-based computer package that allows us to design and analyze distance sampling surveys of wildlife populations. It gives us best fit model to calculate cluster density (DS), population density (D), estimated population (N), Detection probability (*p*).

Camera trap distance sampling (Howe et al 2017) is mostly used to estimate density of ungulates or animals which are not individually identifiable and difficult to study in the wild due to hostility of the terrain and elusiveness of the species. However, to estimate the density, this sampling method requires accurate camera to animal distance. This distance can be acquired by performing calibration process before conducting the survey. This calibration process involves taking images of objects of known dimensions at know distances from the camera. CTDS is also effective at areas where animal density is very low. It minimizes the risk of hostile landscape and chance of observer fatigue.

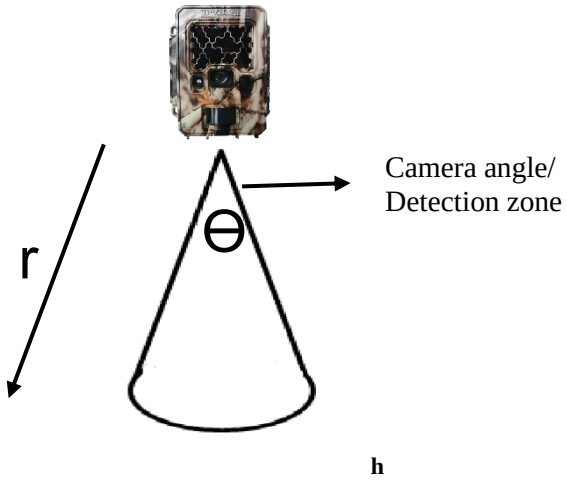


Figure:1 Schematic diagram of Camera trap-based distance sampling approach

a) Habitat mapping and assessment: spatial surveys using advanced GIS tools will be used to prepare georeferenced grasslands map and spatial distribution map.

6. PROGRESS TILL DATE

a) We used line transect based distance sampling and Camera trap-based distance sampling both the approaches to estimate densities of Wild Buffalo, Barasingha (Swamp Deer) and Rhinoceros. We are also considering the possibility to modify the total count survey with statistical robustness. We used line transect based distance sampling in Kanha Tiger reserve where swamp deer population is known with certainty since Kanha has history of monitoring Barasingha since last 30 years. We also did sample with the help of Forest Department of Manas Tiger reserve for estimating Barasingha population, since mamas

has re- introduced barasingha population with known population.

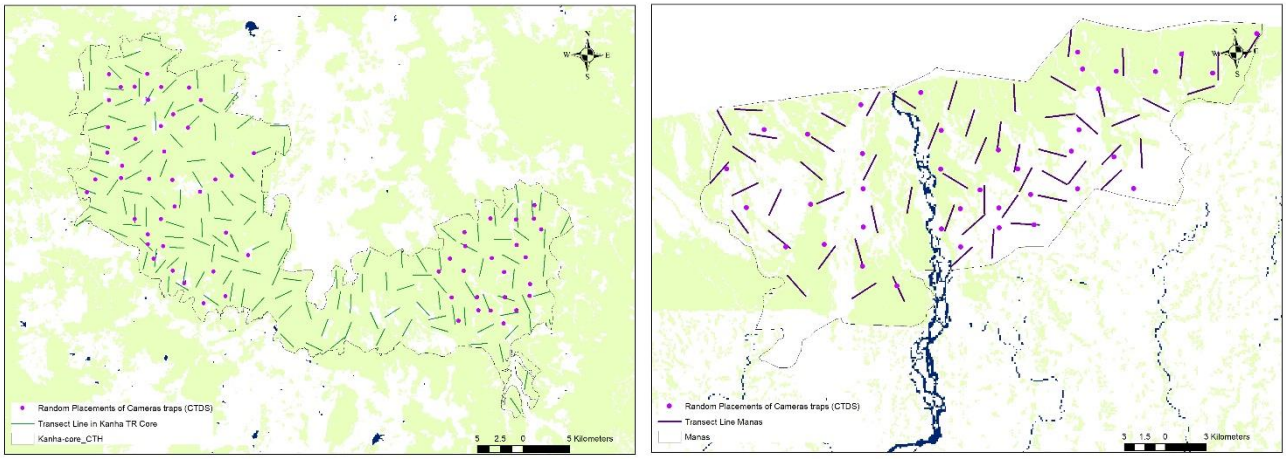


Figure:2 Distance sampling with Camera Trap & Line transect in Kanha & Manas Tiger reserve

Analysis of Camera trap-based distance Analysis is in Progress.

Figure:3 Swamp Deer (Barasingha) Observation on Line transect at Kanha TR

Figure: 4 Direct observation based total count in Kanha Tiger reserve

b) Conservation action plan for swamp deer is under progress

7. PLAN OF WORK (FOR 2023-24):

a) Workshop with range wise states will be conducted in November 2023
b) We intend to use similar approach in Kaziranga & Dudhwa landscape
c) In March, action plan will be submitted

8. BUDGET RECEIVED & AMOUNT SPENT

Sr. No.	Total Funds Approved	Funds Received (60% of Total Amount) FY 2021-22	Committed Indents	Total Expenditure Including Committed	Balance
12	15,00,000.00	9,00,000.00	–	-	9,00,000.00

Sr. No.	Particulars	P.I. Name	Total Funds Approved	Funds Received (60% of Total Amount) FY 2021-22
1	Snow Leopard	Dr. S Sathyakumar	1,50,00,000.00	90,00,000.00
2	Hangul	Prof Qamar Qureshi	10,00,000.00	6,00,000.00
3	Nilgiri Thar	Dr. S Sathyakumar	40,00,000.00	24,00,000.00
4	Marine Turtles	Dr. R Suresh Kumar	2,00,00,000.00	1,20,00,000.00
5	Andaman Edible Swiftlet	Dr. R Suresh Kumar	20,00,000.00	12,00,000.00
6	Wild Buffalo	Dr, K. Vishnupriya	30,00,000.00	18,00,000.00
7	Nicobar Megapode	Dr. R Suresh Kumar	30,00,000.00	18,00,000.00
8	Vultures	Dr. R Suresh Kumar	25,00,000.00	15,00,000.00
9	Malabar Civet	Dr, K. Vishnupriya	5,00,000.00	3,00,000.00
10	Great Indian Onehorned Rhinocores	Prof Qamar Qureshi	20,00,000.00	12,00,000.00
11	Asiatic Lions	Prof Qamar Qureshi	90,00,000.00	54,00,000.00
12	Swamp Deer	Prof Qamar Qureshi	15,00,000.00	9,00,000.00

RERFRENCE:

1. Buckland, S.T., Anderson, D.R., Burnham, K.P. & Laake, J.L. (1993) Distance Sampling: Estimating Abundance of Biological Populations. Chapman & Hall, London.
2. DUCKWORTH, J.W., KUMAR, N.S., POKHERAL, C.P., BARAL, H.S. & TIMMINS, R.J. (2015) Rucervus duvaucelii. The IUCN Red List of Threatened Species.
3. Howe, E.J., Buckland, S.T., Despres-Einspenner, M.-L., Kühl, H.S., 2017. Distance sampling with camera traps. Methods Ecol. Evol. 8 (11), 1558–1565

4. Paul, S., Pandav, B., Mohan, D., Habib, B., Nigam, P. A. R. A. G., & Mondol, S. (2018). Current distribution and status of swamp deer Rucervus duvaucelii duvaucelii in the upper Gangetic plains of north India. Oryx, 52(4), 646-653.
5. QURESHI, Q., SAWARKAR, V.B. & MATHUR, P.K. (2004) Ecology and Management of Swamp Deer (Cervus duvaucelii) in Dudhwa Tiger Reserve U.P. (India). Project Report, Wildlife Institute of India, Dehradun, India.
6. QURESHI, Q., SAWARKAR, V.B., RAHMANI, A.R. & MATHUR, P.K. (1995) Swamp deer or barasingha (Cervus duvauceli Cuvier, 1823). In Ungulates of India (eds. K. Sankar and S.P. Goyal), pp. 181–192. Envis Bulletin: Wildlife and Protected Areas, Vol. 07, No. 1, Wildlife Institute of India, Dehradun, India
7. Tewari, R. & Rawat, G.S. (2013) Factors influencing seasonal changes in the herd size and composition of swamp deer in Jhilmil Jheel Conservation Reserve, Haridwar, Uttarakhand, India. International Journal of Pharmacy & Life Sciences, 4, 2870–2875

PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. **Species:** Jerdon's Courser
2. **Supervisor(s):** Dr. Sutirtha Dutta, Dr. Suresh Kumar & Dr. P. Jegannathan (NCF)
3. **Brief background:**

Jerdon's courser is a Critically Endangered endemic bird restricted to a very narrow range in the Eastern Ghats of Andhra Pradesh. It was first recorded in 1848 by Blyth and the first scientific description was given by T. C. Jerdon in 1864. Since then, sparse records of the bird were documented majorly from Sri Lankamalleshwara Wildlife Sanctuary (SLWL) and adjoining regions. It was documented by Bhushan in 1986 and was re-discovered by Jegannathan in 2002 using camera traps and sand strip methods. Although historically, the bird has been recorded from various parts of the Eastern Ghats, recent study reveals its presence only in SLWL, where it was last detected in 2008. Various conservation actions have been undertaken to spread awareness and protection the species from trapping. A canal has been redirected to avoid destruction of its crucial habitat. A species recovery plan has also been put forward to study the species and its habitat and implement habitat recovery, management such as light grazing and wood cutting, research and monitoring, protection plan and awareness activities for conservation of the species in 2010. The aim of this project is to record the species' presence, develop a methodology for its detection and population estimation.

4. **Objectives:**

    1. Develop an approach to assess the species' presence, occupancy, and abundance / index
    2. Assess the species' occurrence and local usage in its last known habitat (SLWL) and other potential habitats elsewhere in its range.

5. **Approach/Methodology:**

Study Area: The Lankamalai ranges are 20 km from Cuddapah. The hill range majorly comprises of the Red Sanders accompanied with the scrubs in the foothills and plains. The SLWL lies between the Nallamalais and the Seshachalam hill ranges in the central part of the Eastern Ghats and it extends over 464 sq. km (Jegannathan, 2005). Previous studies show that the bird inhabits thorny and non-thorny foothill scrub jungle of this region interspersed with bare ground in gently undulating to rocky foothills (Bhushan, 1986, Birdlife, 2023).

Approach:

a) Intensive and systematic camera trapping to detect the species' presence in its last recorded location (Sri Lankamaleswara WLS) that involves optimization of techniques to suit the species and habitat contexts

b) Habitat characterization of camera trap sites to supplement existing knowledge on the species' habitat use

c) Identification of potential areas that may serve as suitable habitat for the species outside of its last recorded location, using a combination of RS/GIS techniques and ground surveys

6. **Progress till date:**

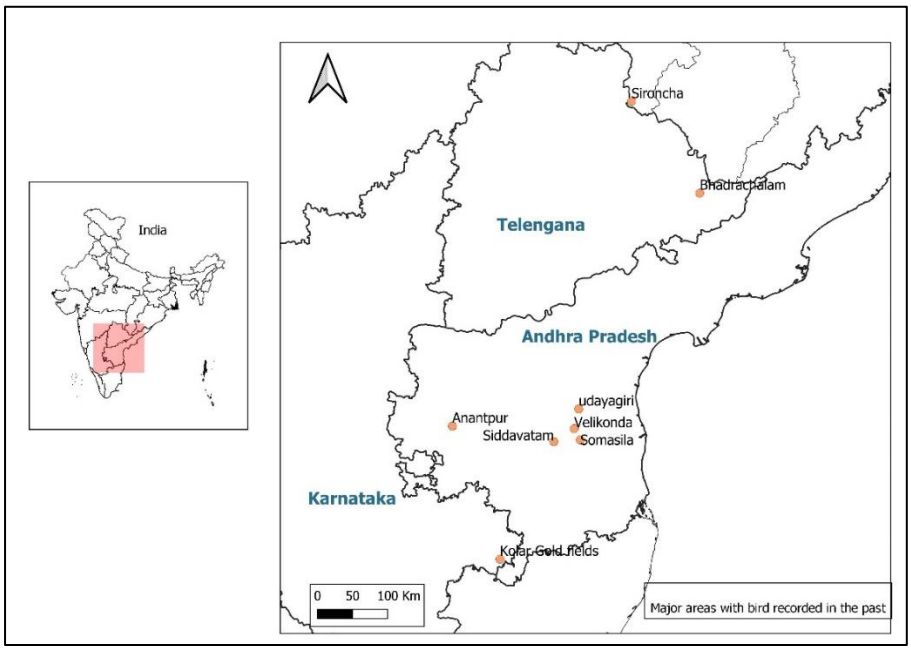
1.	Research personnel and Field assistants engaged
2.	Procurement of camera traps, binoculars and other equipment / accessories for fieldwork
3.	Literature review on the species' biology and presence records Desk preparation (mapping of survey areas on GIS) for survey
4.	Base station setup in Badvel, Kadapa, Andhra Pradesh near the study area
5.	Permission obtained for fieldwork inside SLWL during September 2023 – August 2024
6.	Regular field visits to understand the landscape, species and habitat contexts since September
7.	Work plan prepared to place camera-traps in *a-priori* known habitats of the species in / aroun SLWL
8.	Commencement of fieldwork: deployment of camera-traps and testing of various trap arrange for standardisation of sampling since October 2023

Details of work progress is provided below.

Literature review on the species' ecology and distribution for survey planning

The Jerdon's Courser is a cursorial ground nesting bird. It rests during the day under thorn scrubs and is active after dusk and at night. It prefers to walk mostly, and flies only when approached very closely by a threat. Its ecology is poorly known. Studies on the species' distribution have shown that it inhabits scrub jungle and thorn forests interspersed with bare ground in gently undulating rocky foothills of Lankmalleshwara Wildlife Sanctuary (SLWL) and adjoining regions of Cuddapah District, Andhra Pradesh (Bhushan, 1986, Birdlife, 2023). The scrub vegetation of this region includes *Prosopis julioflora, Carissa carandus, Acacia, Zizyphus. Cassia, Hardwickia binata, Dalbergia, Butea, Dodonea viscosa, Maytenus emerginata, Vachellia horrida* and *Anogeissus*. Although its nest has not been found (Mohan, 1999), foot prints of an adult with a juvenile have been recorded in tracking strips, indicating successful breeding in SLWL two decades back (Jegannathan, 2004). Historically, the bird was recorded from Nellore and Cuddapah districts in Andhra Pradesh (Jerdon, 1864), Siroucha District in Maharashtra (Blandford, 1867), Bhadrachalam district in present-day Telangana (Blanford, 1889), Anantpur valley from Pennar river (Ali and Ripley 1981), and from Kolar Gold field near Bengaluru (1917), wherefrom an egg was collected for the University of Aberdeen's Zoology Museum and was later confirmed to be that of Jerdon's Courser through DNA

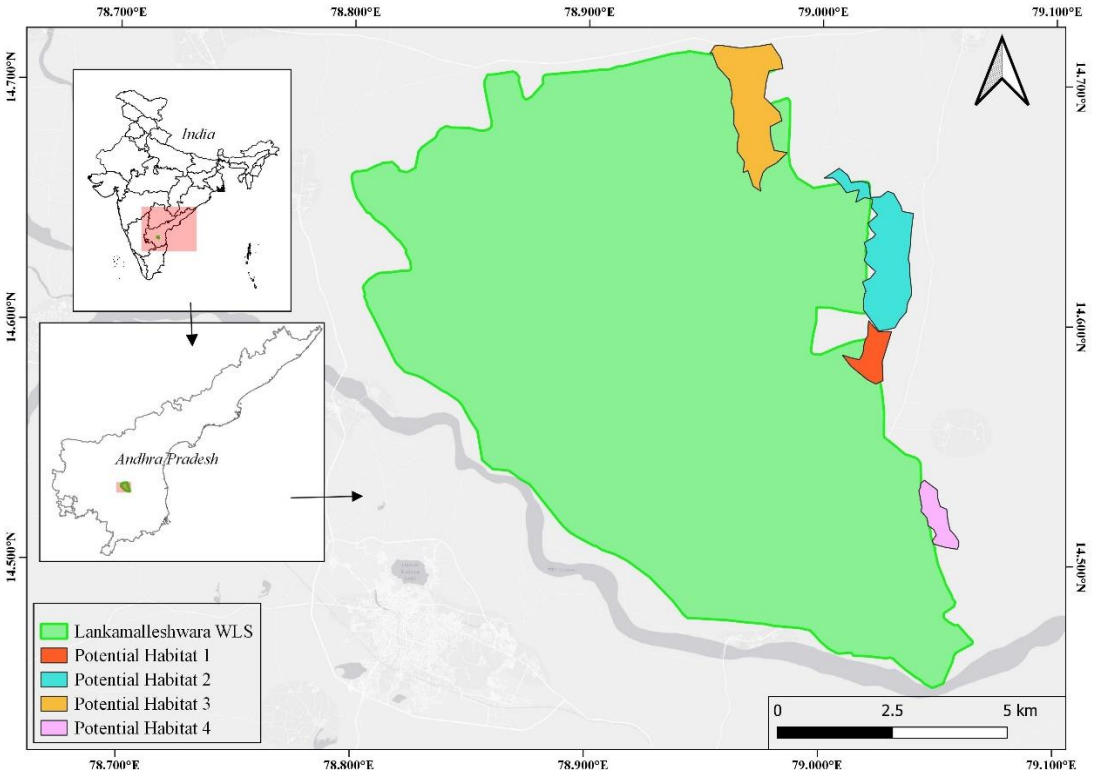
analysis (Knox, 2014). The last confirmed sighting of the species is from SLWL (Jegannathan, 2008). It has not been recorded elsewhere lately, indicating that it is currently range restricted and endemic.



Historical records of Jerdon's Courser

Species' survey fieldwork

To assess the species' presence, intensive camera trap based field survey is being carried out in Sri Lankamalleshwara Wildlife Sanctuary. This work involves placing camera traps in four potential habitats identified from extensive studies on the species' habitat and ecology (Jegannathan, 2004b) that covers 29.3 sqkm area of thorny scrub forests in the foothills of the Lankamalla Range. To execute this work, field station has been setup in Badvel near the survey site. Necessary field materials have been procured. Field survey is being carried out by the research team comprising a researcher and field assistants. Camera traps have been deployed on trial basis to optimize the placement, settings and other aspects that best suit the field conditions. A grid of 250 sqm cells has been overlaid on the 29 sqkm survey area. Work is in progress to deploy camera traps at the centroid of every cell for a period of 20 days. Around 380 such points have been generated to cover the survey area. Camera traps (55 units) will be deployed in staggered manner to cover all points during October 2023 to March 2024. Every camera trap is being calibrated at the time of field deployment for estimation of detection distance from species' photocapture based on camera trap images, so that the species' density can be estimated, if found (following Howe et al. 2017). For this purpose, a marker (1m pole) is being placed at every 1 m from the camera trap up to a distance of 15m along the central axis and at an angle of 15 degrees on either side of the centre.



Map of survey sites for Jerdon's Courser presence in Sri Lankamaleswara Wildlife Sanctuary

Field photograph of camera trap calibration

7. **Future plan of work (for 2023-24):**

1	Field work to be continued to camera-trap the entire optimal / suitable habitat for the species
2	Species' occurrence outside of the last record in the predicted potential habitat to be assessed
3	Field data processing, estimation of population occupancy & abundance / index
4	Report preparation

8. **Budget received & amount spent:**

Sr. No.	Total Funds Approved	Funds Received (60% of Total Amount) FY 2021-22	Expenditure Incurred (upto 30.9.2023)	FA /TA Pending	Committed Indents	Total Expenditure Including Committed	Balance
13	20,00,000.00	12,00,000.00	669281.00	220000.00	–	8,89,281.00	3,10,719.00

List of literature reviewed:

1. Ali, S., & Ripley, D. (1983). Handbook of the Birds of India and Pakistan. Vol III: Stone Curlews to Owls, Pp11-12.
2. Anonymous, (2010). A species recovery plan for Jerdon's courser *Rhinoptilus bitorquatus*. Hyderabad.
3. Arvind, C., Joshi, V., Charif, R., Jeganathan, P., & Robin, V. V. (2023). Species detection framework using automated recording units: a case study of the Critically Endangered Jerdon's courser. Oryx, 57(1), Pp 55-62.
4. Bhushan, B. (1986a). Rediscovery of the Jerdon's or Double-banded Courser Cursorius bitorquatus (Blyth). J. Bombay Nat. Hist. Soc. 83: 1-14.
5. Bhushan, B. (1986b). Photographic record of the Jerdon's or Double-banded Courser Cursorius bitorquatus. J. Bombay Nat. Hist. Soc. 86: 159-162.
6. Bhushan, B. 1985. Jerdon's or Double-banded Courser Cursorius bitorquatus (Blyth)-preliminary survey. Tech. Rept. No. 9. Bombay Nat. Hist. Soc./Bombay.
7. Birdlife International (2001): Threatened Birds of Asia: The Birdlife International Red Data Book. Cambridge, UK: Birdlife International.
8. BirdLife International (2023) Species factsheet: *Rhinoptilus bitorquatus*. Downloaded from http://datazone.birdlife.org/species/factsheet/jerdons-courser-rhinoptilus-bitorquatus on 06/06/2023.
9. Blanford, W. T. (1898). The fauna of British India, including Ceylon and Burma (Birds). Vol IV. London: Taylor and Francis Pp 462.
10. Chavan, R. A. H. U. L., & Barber, I. (2012). In search of the elusive Jerdon's courser: what future for one of the most endangered birds on earth. Birding ASIA, Vol:18, 102.
11. Howe, E. J., Buckland, S. T., Després-Einspenner, M. L., & Kühl, H. S. (2017). Distance sampling with camera traps. Methods in Ecology and Evolution, 8(11), 1558-1565.
12. IUCN. (2023). http://www.iucnredlist.org/. Accessed 09 June 2023
13. Jeganathan, P., & Wotton, S. R. (2004a). The first recordings of calls of the Jerdon's courser *Rhinoptilus bitorquatus* (Blyth), family Glareolidae. Journal-Bom Nat Hist Society, Vol: 101(1), Pp 26-28.
14. Jeganathan, P., Green, R. E., Bowden, C. G., Norris, K., Pain, D., & Rahmani, A. (2002). Use of tracking strips and automatic cameras for detecting Critically Endangered Jerdon's coursers *Rhinoptilus bitorquatus* in scrub jungle in Andhra Pradesh, India. Oryx, 36(2), 182-188.

15. Jeganathan, P., Green, R. E., Norris, K., Vogiatzakis, I. N., Bartsch, A., Wotton, S. R., & Rahmani, A. R. (2004b). Modelling habitat selection and distribution of the critically endangered Jerdon's courser *Rhinoptilus bitorquatus* in scrub jungle: an application of a new tracking method. Journal of Applied Ecology, Vol: 41(2), Pp 224-237.
16. Jeganathan, P., Rahmani, A. R., & Green, R. E. (2005). Construction of Telugu-Ganga Canal in and around two protected areas in Cuddapah District, Andhra Pradesh, India. Immediate threat to the world population of the Critically Endangered Jerdon's Courser *Rhinoptilus bitorquatus*. Survey Report. Bombay Natural History Society, Mumbai, India, Pp10.
17. Jeganathan, P., Rahmani, A. R., Green, R. E., Norris, K., Vogiatzakis, I. N., Bowden, C. H. R. I. S., & Pain, D. (2008). Quantification of threats and suggested ameliorative measures for the conservation of the critically endangered Jerdon's courser *Rhinoptilus bitorquatus* and its habitat. Journal of the Bombay Natural History Society, Vol: 105(1), Pp 73.
18. Jerdon TC (1864). The Birds of India, 2 Volumes (3 Parts) Published by the Author, Calcutta
19. Knox, A. G. (2014). The first egg of Jerdon's courser *Rhinoptilus bitorquatus* and a review of the early records of this species. Archives of natural history, Vol: 41(1), Pp75-93.
20. Kumar, N. N., Basha, S. A., Rajasekhar, M., & Ramakrishna, T. (2001). Jerdon's courser habitat analysis using Remote sensing. Journal of the Indian Society of Remote Sensing, Vol: 29, Pp 37-40.
21. Mohammed Ghouse, S., Ahmed, M. A., & Muneer, S. A. (2015). Dwindling Status of Rarest Bird Jerdon's Courser (*Rhinoptilus bitorquatus*) of Andhra Pradesh and its Conservation.
22. Senapathi, D., Vogiatzakis, I. N., Jeganathan, P., Gill, J. A., Green, R. E., Bowden, C. G., ... & Norris, K. (2007). Use of remote sensing to measure change in the extent of habitat for the critically endangered Jerdon's Courser *Rhinoptilus bitorquatus* in India. Ibis, Vol:149(2), Pp328-337.

14

PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: River Terrapin (*Batagur baska*)

2. SUPERVISORS: Dr. Abhijit Das

3. BRIEF BACKGROUND:

Batagur baska (Family: Geoemydidae) is a large sized river terrapin with a carapace size that reaches up to 59 cm in females (Das & Das, 2017). It is an estuarine species that mainly inhabits around mangrove belts under tidal influence and inshore areas, such as Sundarbans, Bhitarkanika and the mouth of Subarnarekha Rivers in India, Bangladesh and Myanmar (Das and Das 2017, Weissenbacher *et al*., 2015). Estuaries such as According to Praschag & Singh, (2019), they are possibly extinct in the wild from Myanmar and Thailand. In India, Sundarban Tiger Reserve in West Bengal and Bhitarkanika Wildlife Sanctuary in Odisha are perhaps the only protected areas holding population of the species. Female of this turtle travel upriver to lay eggs (clutch size~19-37 eggs in Indian Sundarbans) on sand banks and coasts (Das, 1995).

Figure:1 *Batagur baska* (Female)

Population Status

By 1970, population of *Batagur baska* has been decimated drastically to a "small population" (Moll, 1985). The total Indian population of *B. baska* now stands as fewer as 40 individuals with about three nests produced per year (Praschag & Singh, 2019). Wild population of just 10 breeding females are known. Twelve individuals consisting of seven males and five females are kept under observation at Sajanakhali Interpretation Centre, Sundarbans, India (Weissenbacher *et al.*, 2015). Madras Crocodile Bank Trust (MCBT) in Tamil Nadu, India has two adult females that were rescued and collected from Howrah market (in 1980) and one male donated by Vienna Zoo, Austria in 2014 (Weissenbacher *et al.*, 2014). However, the actual demographic status of the species in wild is a subject of priority research.

4. OBJECTIVES:

- Access the current status of Critically endangered *Batagur baska*
- Developing a long-term monitoring protocol for population and their habitat.
- Establishment of molecular detection method for *Batagur baska* in Sundarbans, India using eDNA.

5. APPROACH /METHODOLOGY (in brief):

Boat Survey:

Boat survey was conducted in the estuarine adjoining area or islands of the Sundarbans. Boat survey using a motor boat with minimum speed of up to 8-10 km/hr to avoid disturbance to any turtle surfacing on water and other wild animals. The boat method consists of two observers. As the boat moves in the middle of the river, it acts as a transect, with the observers in the boat searching for turtles on both sides of the boat. As the river width exceeds 400m, each bank was surveyed separately and the creeks and other tributaries were surveyed with additional time allocation. As the river extends to a vast area, only 50 km area were surveyed per day with 10km/hr.

The survey was conducted only when the weather was ideal for turtle basking (Sunny with less wind). The encountered turtle location recorded using Garmin Handheld GPS, and the activity of the turtle will be recorded.

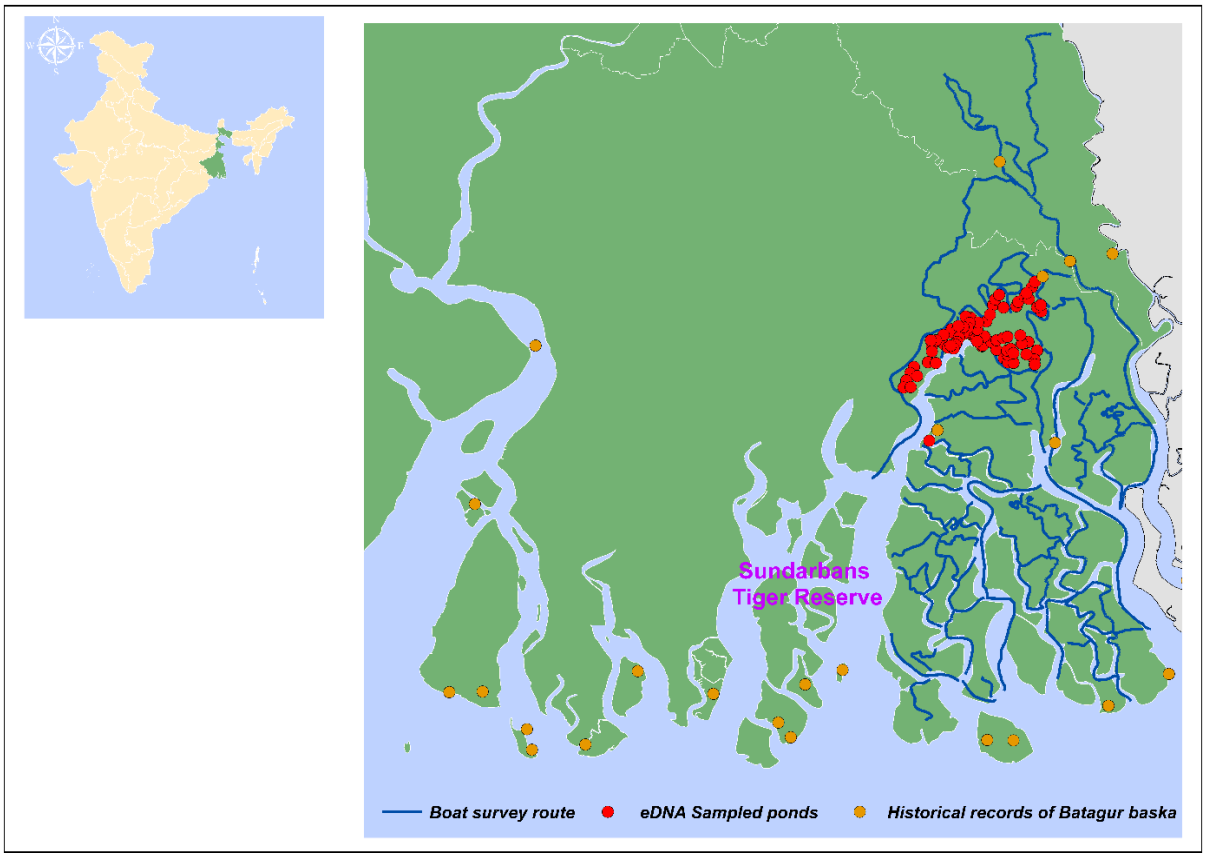


Figure:2 Map showing the historical records of *Batagur baska*, boat survey route and eDNA sampled ponds in Sundarbans Tiger Reserve

Questionnaire survey:

A grid-based questionnaire survey (2km x 2km grid) was conducted among the local fisherman inhabiting adjacent to the Sundarbans Tiger Reserve. The survey is to gather information based on turtle occurrence, basking area, distribution, habitat and other anthropogenic pressure. The interview of the local fishermen consists of questions related to their livelihood, fishing equipment's, personal profile and their attitude towards turtles in the nearby water bodies.

Figure:3 Mangrove Habitat in Netidhopani Beat

eDNA:

eDNA workflow

Environmental DNA (eDNA) assessment of *B.baska* were collected from water samples through basic steps:

Water samples were collected in 1L plastic Nalgene bottles and filtered within 24 hours. Disinfected the mason jar and other filter equipment's prior to filtering using 7% bleach solution, and rinsed with tap water. Water samples were filtered using vacuum motor and cellulose membrane filters. Filtered 1L of distilled water before and after each sample as negative pre- and post- filter controls. The filters were fixed in ATL buffer solution in -20 ºC (Sahu *et al.*, 2022).

6. PROGRESS TILL DATE:

a) Prepared a 45-page project document focusing on *Batagur baska* and distributed it among the Forest Department of West Bengal. (Annexure – I).

b) A comprehensive review of the literature and museum records was undertaken to summarize the distribution of *Batagur baska*.

c) The historical locations where *Batagur baska* was known to exist were mapped.

d) An intensive boat survey was conducted for 30 days from Feb 1st 2023 to March 3rd 2023 in Sundarban National Park and Tiger Reserve, covered Sajnekhali Range and Basirhat Range.

e) First set of environmental DNA (eDNA) samples was collected from the rivers of Sundarbans and preserved in ATL buffer at -20ºC. The second set of environmental DNA (eDNA) samples were collected from 80 potential ponds of 4 islands viz. Gosaba, Balli, Satjelia, Chotomulla Khali and control samples were collected from the *Batagur* captivity centre (Sajnekhali and Dobanki forest camps) maintained by the forest department, Sundarbans, West Bengal. The collected water samples were filtered using vacuum motor, the cellulose membrane filter paper was fixed in ATL buffer at -20ºC for further analysis.

f) Questionnaire survey was initiated among the local fishermen in Fraserganj, Bhakkali, Amrabati, Gosaba, Bali, Satjelia, Chotomulla Khali, Kumirmari, Lot no. 126 from June to July 2023. So far 422 people were interviewed.

g) Tissue samples from 100 live individuals of *Batagur baska* were collected from the captivity centre and preserved in absolute alcohol in at -20ºC for further analysis.

Figure:4 Questionnaire survey conducted among the fishermen of Balli Island

Figure:5 Questionnaire survey conducted among the fishermen of Gosaba Island

Figure:6 eDNA water sample collection from Sajnekhali Forest Camp

Figure:7 eDNA water filtration kit

7. PLAN OF WORK (FOR 2023-24)**:**

a) Winter session survey need to be carried out for the collection of eDNA samples in the western part of Sundarbans Tiger Reserve which include Bakkhali, Lothian Island, Indrapur, and Sagar Island. Beach profiling should be carried out in the sea-facing islands to assess the habitat suitability for *Batagur baska*.

b) Collected eDNA samples need to be analysed for the detection of *Batagur baska* presence.

c) Designing Primers (around 20) for sequencing the complete mitogenome of *Batagur baska.*

d) The tissue samples collected from the captive individuals will be analysed to access the population structure. It gives insight into how populations are interconnected and genetic health of *Batagur baska* in captivity.

e) Developing habitat suitability model (SDM) for *Batagur baska*,

f) Finalization of the project document and submission.

8. BUDGET RECEIVED & AMOUNT SPENT:

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower (Salary & Field Assistants)	12,50,000.00	**7,50,000.00**	9,00,739.00	0.00	**9,00,739.00**	**-1,50,739.00**
2	Boat, Field Station And Vehicle Hire	5,00,000.00	**3,00,000.00**	22,515.00	0.00	**22,515.00**	**2,77,485.00**
3	Transportation	5,00,000.00	**3,00,000.00**	62,430.00	0.00	**62,430.00**	**2,37,570.00**
4	Equipment (Binoculars, Depth Finder, Camera)	15,00,000.00	**9,00,000.00**	1,37,600.00	7,53,346.00	**8,90,946.00**	**9,054.00**
5	Public Awareness and Training	1,00,000.00	**60,000.00**	0.00	0.00	**0.00**	**60,000.00**
6	Lab Work	10,00,000.00	**6,00,000.00**	7,62,122.00	0.00	**7,62,122.00**	**-1,62,122.00**
7	Misc. Cost	1,50,000.00	**90,000.00**	32,494.00	0.00	**32,494.00**	**57,506.00**
Total		**50,00,000.00**	**30,00,000.00**	**19,17,900.00**	**7,53,346.00**	**26,71,246.00**	**3,28,754.00**
						Less : Forest Advance	2,00,000.00
						Less : Tour Advance	62,948.00
	Balance as on 10.10.2023						**65,806.00**

REFERENCE

Annexure - I

INTEGRATED DEVELOPMENT OF WILDLIFE HABITAT – NORTHERN RIVER TERRAPIN

भारतीय वन्यजीव संस्थान
Wildlife Institute of India


©DHRITIMAN MUKHERJEE

CONTENTS

SI. No.	CONTENT	Page No.
1	**Introduction**	1
1.1	Global Diversity and threat status	1
1.2	Beleaguered Batagurid Turtles	1
2	**World Rarest Estuarine Turtle-*BATAGUR BASKA***	2
2.1	Taxonomy	2
2.2	Museum records	3
3	**Morphology of *Batagur baska* (Gray, 1830)**	3
4	**Distribution of *BATAGUR BASKA***	7
4.1	Historical Distribution	7
4.2	Current Distribution	8
5	**Habitat and Ecology**	10
6	**Current Status**	10
7	**Threats**	11
8	**IDWH *Batagur baska* project**	11
9	**Materials and Methodology**	11
9.1	Boat Survey	11
9.2	Questionnaire Survey	12
9.3	eDNA	12
9.4	Persistence of environmental DNA in aquatic ecosystems	14
10	**DNA Extraction for Positive Control**	14
10.1	Primer Design	14
10.2	eDNA workflow	14
10.3	Species-specific approach/eDNA barcoding	15
10.4	Multi-species or community analysis/eDNA metabarcoding	15
10.5	Sample collection	15
10.6	eDNA capture	15

10.7	eDNA Extraction	15
10.8	PCR with species-specific primers	16
10.9	Sequencing	16
10.10	Bioinformatics Investigation	16
11	**Possible Research Outcome**	17
12	**Reference**	18
13	Annexure – I	24
14	Annexure - II	26
15	Annexure - III	32
16	Annexure - IV	35

List of Figures

SI. No.	Title	Page No.
1	*Batagur baska* Adult	4
2	Illustration of *Batagur baska* adapted from Indian Turtles Field Guide	4
3	Illustration of *Batagur baska* Carapace adapted from Handbook: Indian Testudines	5
4	Illustration of *Batagur baska* Plastron adapted from Handbook: Indian Testudines	5
5	Adult *Batagur baska* from Madras Crocodile Bank	6
6	Hatchling *Batagur baska* from Sajnekhali Captive Breeding centre	7
7	Distribution of *Batagur baska*	9
8	The major sources of eDNA in the aquatic environment	13
9	Current eDNA studies performed on different organisms	13
10	eDNA workflow	14

1. INTRODUCTION

1.1. Global Diversity and threat status:

Reptilians of the Order Chelonia/Testudines currently comprise of 14 extent families. These include freshwater turtles (Family: Geoemydidae and Trionychidae), marine turtles (Family: Cheloniidae and Dermochelyidae), and land tortoises (Family: Testudinidae) (Fritz and Havas 2007). Global chelonian diversity currently comprises of 357 living species of turtles and tortoises of which 74 per cent are threatened with extinction (Turtle Taxonomy World Group, 2021). A total of 274 turtle species and 9 separate subspecies and 21 regional subpopulations are listed under IUCN Red List (version 2021.2). Out of 274 species recorded, 8 were listed as Extinct (EX), 67 species were considered as Critically Endangered (CR), 46 species as Endangered (EN), 58 species as Vulnerable (VU), 36 species were Near Threatened, 1 species was under Lower Risk/Conservation dependent (LR/cd), 48 species were Least concern (LC), and 10 species was under Data Deficient (DD).

India hosts the wealthiest diversity of turtles in the world (Iverson 1992) with 35 species of Chelonians - 25 freshwater, five marine, and five land tortoises (Aengals *et al.* 2018). Out of this diversity, 40% Indian chelonian fauna is threatened (Stuart and Thorbjarnarson 2003). Three species of Testudines, namely, *Nilssonia leithii*, *Vijayachelys silvatica*, and *Indotestudo travancorica* (tortoise), are endemic to India (Deepak & Vasudevan 2009).

Out of 35 species reported from India, 31 species are listed under IUCN Red List, viz. 10 species are listed as Critically Endangered (CR), 11 species as Endangered (EN), 6 species as Vulnerable (VU), 2 species as Near Threatened (NT) and 2 species as Least Concern (LC).

Out of the world's top 25+ most threatened chelonians, *Batagur baska*, *Batagur kachuga* and *Chitra indica* are found in India (Turtle Conservation Coalition 2018).

1.2. Beleaguered Batagurid Turtles:

Batagur turtles are large riverine or estuarine turtles reaches a size of approximately 60-65 cm, all species in this genus are morphologically similar, large sized riverine species with similar natural history, except *B.dhongoka* all other species share the highly unusual sexual dichromatism, which is being important for selection of mate. In breeding colours, *Batagur*'s are considered to be one of the most beautiful turtles. Due to over exploitation of adults and eggs for human consumption, rampant hunting and even it's been kept as pet by local people occasionally lead to the decline in population of *Batagur* species all over the distributional range. Earlier in 1982 Groombridge added *Batagur baska* as Endangered species in IUCN Red Data Book. Anon 1991 reported *Batagur* is placed in the Schedule I of the Indian Wildlife Protection Act 1972.

The genus *Batagur* consists of five species and two sub species distributed in the South East Asia viz, *Batagur baska* (Northern River Terrapin), *Batagur boneoensis* (Myanmar roofed Turtle), *Batagur dhongoka* (Three-striped roofed turtle), *Batagur kachuga* (Red-crowned

roofed turtle), *Batagur trivittata* (Burmese roofed Turtle), and two subspecies viz, *Batagur affinis affinis* and *Batagur affinis edwardmolli*. The species belonging to this family are Critically endangered.

Historically, *B.baska* was reported from eastern India to Malaysia. In the *Batagur* genus two species share a common character the presence of 4 claw in the forelimb. Praschag *et al.* 2007 split this species based on morphology and genetic study into two species *B.baska* (Sundarband to Myanmar) and *B.affinis* (Indonesia, Cambodia, Malaysia, Thailand and Vietnam). Based on the phylogenetic analysis Moll *et al.* (2015) resurrected two sub species of *Batagur affinis* viz., *Batagur affinis affinis* is distributed along the west coast of Malayasia and eastern Sumatra in Indonesia and in southernmost Thailand and *Batagur affinis edwardmolli* is distributed along the east coast of Malaysia and the Songkhla region od southernmost eastern peninsular Thailand bordering Cambodia and south China (Moll *et al*. 2015)**.**

B.kachuga once inhabited the entire Gangetic river system but now it's been distributed only in few parts of Bangladesh, India (Chambal River) and Nepal (Turtle Conservation Coalition 2018). *B.borneoensis* is distributed in Brunei, Indonesia, Malaysia and Thailand. *B.trivittata* is distributed in some parts of Myanmar.

2. WORLD RAREST ESTUARINE TURTLE-*BATAGUR BASKA*

2.1. TAXONOMY

Gray (1830), in the book 'A synopsis of the species of the class Reptilia' described ***Emys baska*** based on a juvenile specimen with a suborbicular shell, depressed, pale olive, chin and lips yellowish which belongs to the order Testudinata. In the same book, he described another species named ***Testudo baska*** with an oblong shell and ovate (Gray, 1831a). Gray explains about the specimen received from India sent by Cuvier to the Paris museum with four claws, and he placed it in ***Trionyx (Tetraonyx) cuvieri*** (Gray, 1831a). From the description of three species, it's clear that Gray named the same species under three different genera; the best example is River Terrapin. Later *Tetraonyx* became a junior homonym of a coleopteran and was replaced with *Tetronyx*.

Gray, in 1856 resurrected a new genus named *Batagur* belonging to the family Emydidae (Terrapins), which includes six species viz. *Batagur baska, Batagur lineata, Batagur dhongoka, Batagur ocellata, Batagur tecta and Batagur tentoria*.

In the past 170 years, *Batagur baska* has been placed in different genera, i.e. *Emys baska* Gray 1830; *Tetraonyx* Gray 1831a; *Trionyx* (*Tetraonyx*) *cuvieri* Gray, 1831a, *Tetronyx* Lesson, 1832, *Emys* Temminck & Schlegel, 1835, *Tetraonyx* Dumeril & Bibron, 1835, *Tetronyx* Dumeril & Bibron, 1835, *Batagur* Gray, 1856, *Tetraonyx* Theobald, 1868.

Subsequently introduced names, viz. *Emys baska* Gray 1830; *Emys batagur* Gray 1831a; *Testudo baska* Gray 1831a; *Trionyx (Tetraonyx) cuvieri* Gray 1831a; *Tetronyx longicollis* Lesson 1834; *Tetronyx baska* Dumeril & Bibron 1835; *Tetraonyx lessonii* Dumeril & Bibron 1835; *Tetraonyx longicollis* Dumeril & Bibron 1835; *Clemmys batagur* Fitzinger 1835;

Hydraspis (Tetronyx) lessonii Fitzinger 1835; *Emys tetraonyx* Temminck & Schlegel 1835; *Tetraonyx batagur* Gray 1844; *Tetraonyx affinis* Cantor 1847; *Batagur baska* Gray 1856; *Clemmys longicollis* Strauch 1862; *Batagur affinis* Gunther 1864; *Kachuga affinis* Gray 1869; *Tetraonyx baska* Gray 1869; *Batagur batagur* Lindholm 1929; *Tetraonyx lessoni* Bourret 1941; *Batagur baska ranongensis* Nutaphand 1979; *Batagur ranongensis* Nutaphand 1979; *Batagur baska baska* Stubbs 1989; *Batagur batagur batagur* Joseph-ouni 2003; *Batagur batagur ranongensis* Joseph-ouni 2004.

Batagur, Praschag *et al.* 2007 demonstrated that *Batagur baska* comprises two genetically distinct species. Praschag *et al.* 2008b, the name *Batagur baska* should retain the northern species (India, Bangladesh and Myanmar) and the southern species *Batagur affinis* (Cantor 1847) occupying Thailand, Malaysia and Indonesia.

Currently, the Genus *Batagur* consists of five species and two subspecies worldwide, viz. *Batagur affinis affinis* (Southern River Terrapin), *Batagur affinis edwardmolli, Batagur baska* (Northern River Terrapin), *Batagur borneoensis* (Myanmar roofed turtle), *Batagur dhongoka* (Three-striped roofed turtle), *Batagur kachuga* (Red-crowned roofed turtle) and *Batagur trivittata* (Burmese roofed turtle). In India, only three *Batagur* species have been reported, namely, *Batagur baska* distributed in the Odissa and West Bengal of India, Bangladesh probably extinct from Myanmar, *Batagur kachuga* distributed in North East India and Central Nepal and *Batagur dhongoka* distributed in North East India and Nepal.

2.2. Museum Records:

Praschag *et al.* 2008b, genotyped a *Batagur baska* collected in the 1850s in the Indus Delta of Sindh and deposited in the Vienna museum (NHMW 1841). (National History Museum United Kingdom) NHMUK 1974484 two adult female collected from Rangoon (Pegu), NHMUK 1974482 one adult collected from Burma (Pegu). NHMUK 1974474 one adult collected from Ganges. NHMUK 1974470 one adult collected from Ganges. NHMUK 1974472 one adult collected from Ganges. NHMUK 1974481 one adult female collected from Moulmein, Burma. NHMUK 428351 one adult female collected from Moulmein. NHMUK 428353 two adult female from Rangoon (Pegu). NHMUK 428355 one individual, NHMUK 1974478 one adult female collected from India. NHMUK 1974480, 1974493, 1974488 sex is not mentioned and the location mentioned as India.

3. Morphology of *Batagur baska* (Gray, 1830)

Carapace domed, heavily buttressed; long plastron; head small with narrow, upturned snout; forehead covered with small scales; jaws serrated; 4 claws on each forelimb, which has wide webbing; carapace olive-grey or brown, and head similar coloured but lighter on sides; plastron unpatterened yellow (Das 2017). Keel is present in the early stage, and it reduces gradually as development takes place and disappears entirely when it attains adulthood. Vertebral shields are five in number; the second and third vertebral shielda are subequal, fourth is smaller when compared to the previous. Costall shields four on each side. Marginal shields are generally 25

(rarely 26). The digits are fully webbed and are provided with four claws. Tail is extremely short when compared with the body.

Fig 01: *Batagur baska* Adult © Dhritiman Mukherjee

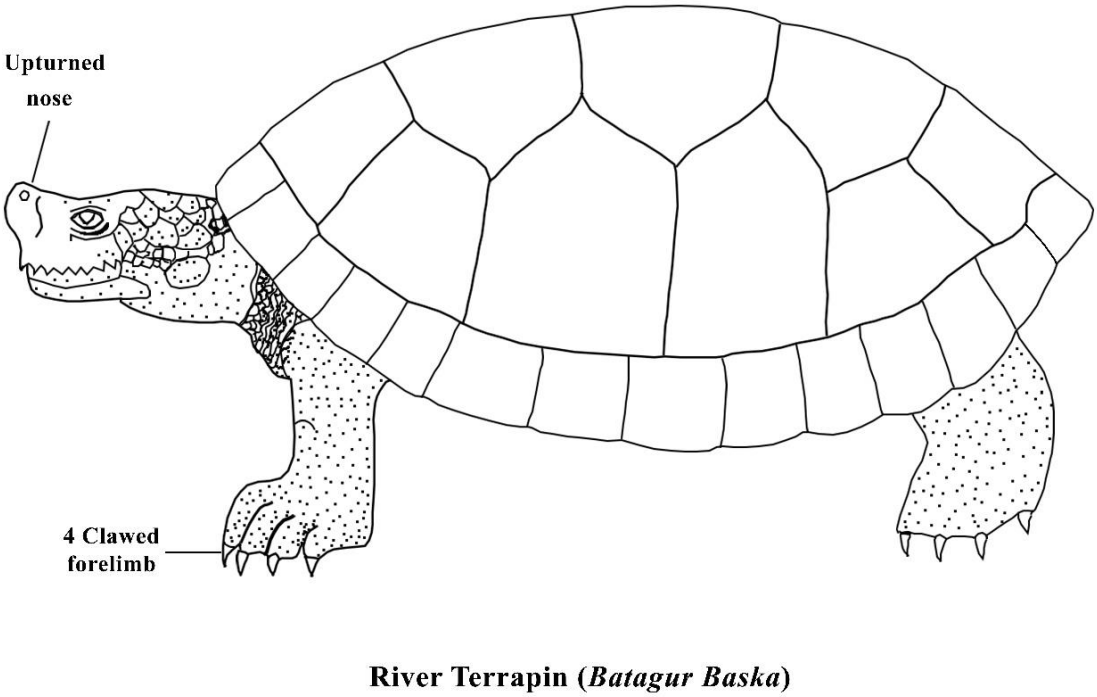


Fig 02: Illustration of *Batagur baska* adapted from Indian Turtles Field Guide (Das 1985)

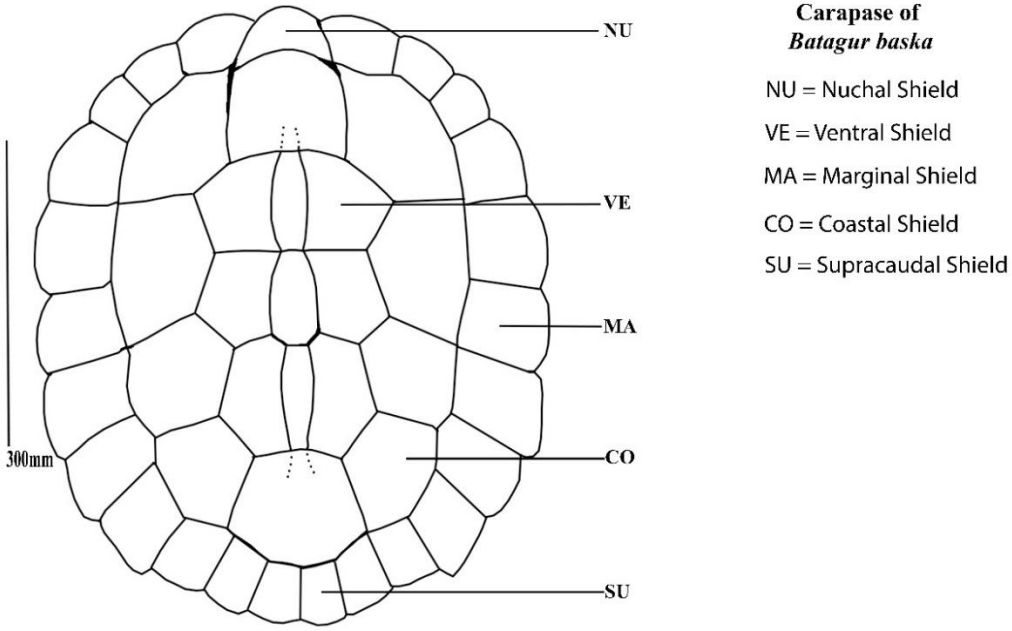


Fig 03: Illustration of *Batagur baska* Carapace adapted from Handbook: Indian Testudines (Tikader & Sharma 1985)

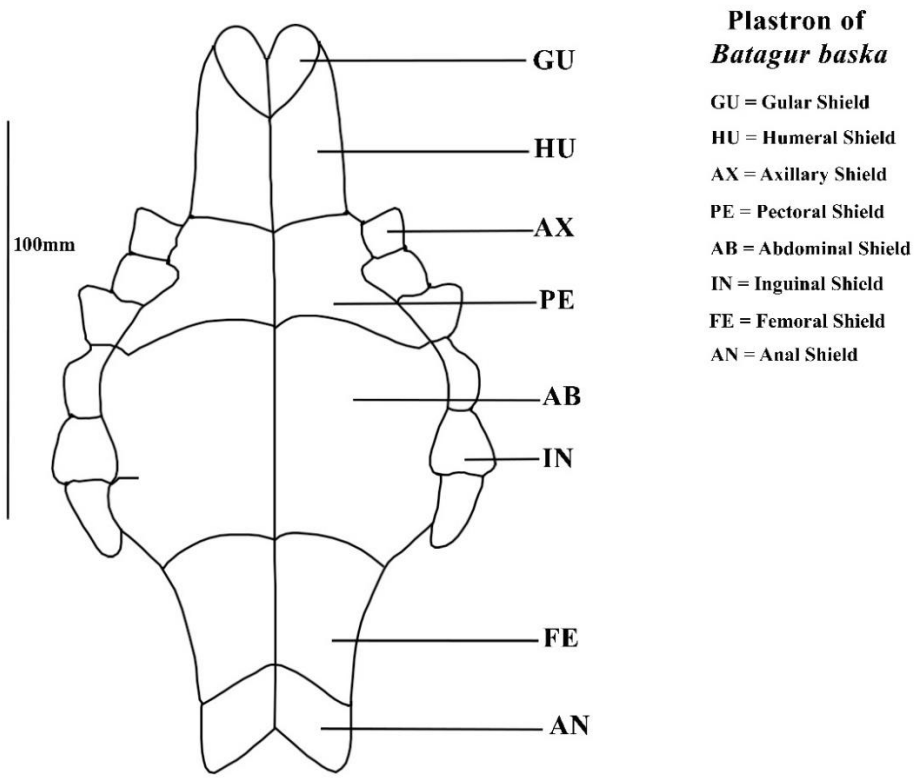


Fig 04: Illustration of *Batagur baska* Plastron adapted from Handbook: Indian Testudines (Tikader & Sharma 1985)

Breeding males develop black forehead and back of neck; front portion of neck attains bright red colouration. The Shells of females tend to be olive-brown or olive-grey above and pale yellow below, while the soft parts are dull grey to olive-grey anteriorly and lighter grey posteriorly. Male in breeding colouration having the head and ventral part of the neck black, with the colouration of the dorsal portion of the neck to its base depicted as “rich crimson” and the whole of the forelimbs as “brilliant rosy carmine” (Anderson, 1879). In the genus Batagur, females typically exceed males in size. The shells of the male are brown, and the forelimbs described by Anderson as “rich crimson” are rusted to light orange.

Seam Contact Formula: 1> 4> 6> 8> 11<

Plastral Formula: abd > pect > < fem > hum > an > gul.

The Northern River Terrapin is distributed in West Bengal (Sundarbans), Odisha, Bangladesh, and Myanmar.

Fig 05: Adult *Batagur baska* from Madras Crocodile Bank

Fig 06: Hatchling *Batagur baska* from Sajnekhali Captive breeding centre

4. DISTRIBUTION OF *BATAGUR BASKA*

4.1. Historical Distribution:

Batagur baska was reported by Murray (1884) from Indus River, Sindh, Pakistan. Based on the shells found in Mohan-jo-Daro (3300 BC), and it is supported by Tikader and Sharma (1985), Sharma (1998) and Das (2010). Gunther 1864 reported in the river mouth of the Hugli river of West Bengal and the Subarnareka and Brahmani rivers of Orissa, India (Vijaya, 1982). In the past Century, *Batagur baska* ranges from the Sundarbans (Estuary of the Ganges and Brahmaputra) eastwards to the Ayeyarwady and Bagi estuaries and possibly the Thanlwin (Salween), Sittaung Rivers in Myanmar (Burma) (Iverson 1992), Thailand, Cambodia, Vietnam, western Malaysia, and Indonesia (Moll 1980; Das 1985, 1991, 1995; Platt *et al.* 2003; Fritz and Havas 2007). The previous literature and museum specimens suggest it was formerly a widespread region. The *Batagur* population in Indonesia and Malaysia represent a distinct species Praschag *et al.* 2008.

Annandale (1912) suspected the presence of river terrapin in the Mahanadi drainage in India. Das (1989) reported Salt Lake (Chilika lake), Calcutta as the northernmost record of *Batagur baska* from India.

The Old remains of *Batagur baska* in Sarnath, Uttar Pardesh is much far from the type habitat (Mangrove estuaries) and which may be a misidentification of its relative species *Batagur kachuga* (Nath, 1959).

In Myanmar, the terrapin is distributed in Ayeyarwady Delta, common in south (Pegu) (Theobald 1868; Maxwell 1911), few museum specimens have been reported from Salween and Sittaung rivers (Iverson 1992). Platt *et al.* (2007) reported *B.baska* from the coast of Rakhine state from the description of the villagers. The population of *B.baska* is regionally extinct but the survey conducted in the year 2004 revealed small populations of terrapins in the Ayeyarwady Division (platt *et al.* 2008).

Vyas (2017) reported a specimen of *Batagur baska* from Rudramata Dam, Kutch, Gujarat. Praschag *et al.* comm confirmed that the female specimen is *Batagur kachuga* and claims it might be a released trade specimen.

4.2. Current Distribution:

There are no recent records of *Batagur baska* from Sundarbans of West Bengal, and Orissa in the recent years. Praschag (2008a) reported the presence of unknown population of *Batagur baska* from the devi river of Orissa.

In Bangladesh, Reza (2005) found one individual during his survey of Sundarbans in 2005. Praschag (Unpubl. Data) identified one juvenile Batagur baska in the weekly market during 2007 obtained from Chittagong (Moll et al. 2009). Praschag *et al.* (2008a) reported the presence of *Batagur baska* in Kutubdia island based on the information collected from a professional turtle catcher, St. Martin Island (Platt *et al.* 2008).

In Myanmar, Platt *et al.* (2008) reported a small population of *Batagur baska* in the Baung River (Ayeyarwady Division) and along the Southern Tanintharyi Division. A female Batagur baska have been found in a pond Botahtaung Pagoda near yangon (Kalyar *et al.* 2007).

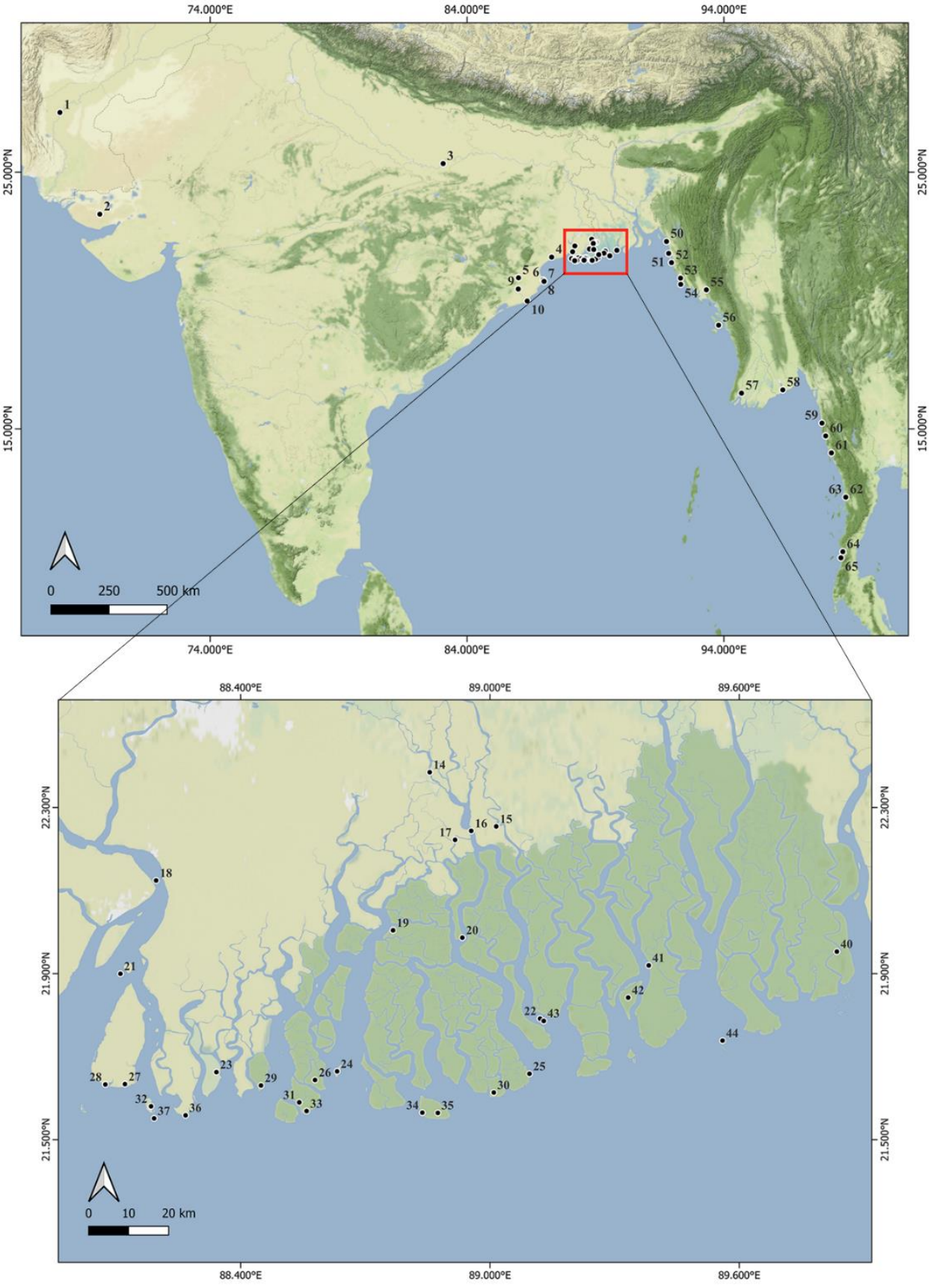


Fig 07: Distribution of *Batagur baska*

5. HABITAT AND ECOLOGY:

B.baska is aquatic, inhabiting the estuaries and tidal portions of larger rivers. Gunther 1864, reported the *B.baska* inhabiting the Hugli river of West Bengal, estuaries of Sundarbans of India and Bangladesh (Moll 1985, 1990; Whitaker 1983) and estuaries associated with Ayeyarwady and Bago river systems of Myanmar (Maxwell 1911; Platt *et al.* 2006, 2008).

Estuarine turtles are truly omnivorous they feed on fish, invertebrates, carrion and plant materials. Hence, they are called Water Vultures. The faecal samples of *Batagur affinis* sister species of *Batagur baska* are composed of 45% leaves, and stems, 25% fruits (Mangrove fruits) and 30% molluscs shell from the above content, Moll (1980) claim it predominantly feeds on Herbivores.

The closely related species *Batagur affinis* move to the upper river and nest in the sand banks or sandy islands found in the middle of the river but the *Batagur baska* nest on the coast of Sundarbans of India, Bangladesh and Myanmar and it may be due to the unavailability of Sandy substrate in the upper river stretch (Das 1995).

In 1931, Smith stated that terrapins were herbivorous, but no additional details about breeding were provided. Bangladesh fishermen caught many terrapins using hooks bait with *Sonneratia apetala* (Mangrove fruit) (Whitaker 1983). The river terrapins mainly inhabit the area dominated by mangroves, and it feeds on the leaves of mangroves. The double-serrated beak helps cut the plant material and acts as a ratchet to engulf large leaves into the oesophagus (Das 1995).

Northern river terrapin starts mating from September to November (Sharma 1998); it nests on the coast of West Bengal and occurs in February and March along with Olive Ridley Sea turtles (Bhupathy 1995) they lay clutches of 10-30 eggs; females lay about three clutches totalling 50-60 eggs and the incubation period of 65-66 days (Sanyal and Seth 1992) temperature ranges from 24.6-33.2º C (Das 1995). The egg-laying interval varies from 15 to 20 days. To lay eggs, the terrapins excavate a body pit with fore and hind limbs in the coastal area.

In 2016, Turtle Survival Alliance released 10 sub-adults with acoustic transmitters near the core zone of the Sundarbans Tiger Reserve. All the 10 telemetered animals escaped from the soft-release enclosure due to the storm blown in February 2016 (Mallick *et al.* 2021).

Later on in Jan 2022, 10 sub adults were aided with satellite telemetry was released in the wild as a pilot reintroduction program. This telemetry data will provide information about the movement pattern, habitat preference, and ecological data.

6. CURRENT STATUS:

The global population of *Batagur baska* has declined in the past two centuries with a mere population of less than 100 mature individuals remaining (Praschag & Singh 2019) and few claim its ecologically extinct from the wild (Moll, *et al.* 2009), the wild population in

Bangladesh had been decimated (Moll, *et al.* 2009, Reza, 2005). But in 2013 a small population of *Batagur baska* is discovered from the Bangladeshi Sundarbans (Weissenbacher, 2015).

This species is listed as Critically endangered in the IUCN Red Data Book and protected under Schedule I of the Indian Wildlife Protection Act, 1972 and Appendix I of CITES to protect the species from poaching and trade.

7. THREATS:

The primary cause for the decline of *Batagur baska* is the over-exploitation of eggs and adults for meat and habitat degradation and fragmentation of habitat (Praschag & Singh 2019, Moll, *et al.* 2009; Pandit, 2013; Platt, 2008) due to the degradation of mangrove forests and sand mining (Moll, *et al.* 2009; Moll, 1997; Behera, 2019), illegal turtle trade and due to fishing practices (Praschag & Singh 2019, Rashid and Khan 2000). Pandit 2013, reported that incidental capture in fishing gear, watercraft, accidental collision with motorboats, and other natural factors are unseasonal floods, and loss of nesting beaches are the primary cause of the species decline globally. Meat is treated as a delicacy among the people of West Bengal, and predators like Stray dogs, dogs, monitor lizards and crocodiles eat eggs and the young ones.

8. IDWH *BATAGUR BASKA* PROJECT

The Integrated Development of Wildlife (IDWH) is an ongoing centrally sponsored Scheme. One of the components of this scheme is 'Recovery Programmes for saving critically endangered species and their habitats'. In all 22 endangered species have been covered under this scheme, *Batagur baska* is one among them.

The main objective of the project is

1. Access the current status of *Batagur baska* and
2. Developing a long-term monitoring protocol for populations and their habitat.

In consonance with the above-mentioned objectives, Wildlife Institute of India, Dehradun Plan to access the current status of *Batagur baska* from its known habitat Sundarbans, West Bengal. Using eDNA technology and manual boat-based survey during 2023.

9. MATERIALS AND METHODOLOGY

9.1. BOAT SURVEY:

Boat survey will also be conducted in the estuarine adjoining area or islands of the Sundarbans. Boat survey will be done using a motor boat with minimum speed of up to 8-10 km/hr to avoid disturbance to any turtle surfacing on water and other wild animals. Boat method consist of two observers, as the boat moves in central line act as a transect the observes in the boat searching for turtles on both sides of the boat. As the river width exceeds 400m, each bank should be surveyed separately and the creeks and other tributaries should be surveyed with additional time allocation. The major river flows through Sundarbans are Saptamukhi,

Thakuran, Matla, Haribhanga, Raimangal, and Goasaba. As the river extends to a vast area, only 50 km area should be surveyed per day with 10km/hr. Estimation of relative abundance individual per Km (ind/Km).

The survey will be conducted only when the weather was ideal for turtle basking (Sunny with less wind). The encountered turtle location will be recorded using Garmin Handheld GPS, and the activity of the turtle will be recorded.

10.2. Questionnaire Survey:

A questionnaire survey will be conducted among the local fisherman inhabiting adjacent to the Sundarbans Tiger Reserve. The survey is to gather information based on turtle occurrence, basking area, distribution, habitat and other anthropogenic pressure. The interview of the local fishermen consists of questions related to their Livelihood, fishing equipment's, personal profile and their attitude towards turtles in the nearby waters.

10.3. eDNA

The term "Environmental DNA (eDNA)" was initially used in the field of microbiology to describe a method for extracting DNA from soil samples without first isolating the desired bacteria in order to extract microorganism nucleic acids from environmental samples, the idea of using eDNA to identify organisms was initially put forth in 1986. (Olsen et al., 1986). However, eDNA wasn't used by researchers to assess microbes until the early 2000s. The initial use of eDNA to macro-organisms was to determine the diversity of mammals, plants, and birds in ancient sediments. (Sahu *et al.*, 2022).

Since 2012, there has been an abundance of studies on eDNA metabarcoding applied in biodiversity conservation, species identification, management, invasive species, and biomass/abundance estimation. Around 25 research papers related to eDNA metabarcoding/metagenomics by Indian authors are predominantly relating to the study of microbial biodiversity from food, soil and deep-sea sediments. Not a single publication related to such a study in Freshwater turtles has been cited from India till 2018 until Kundu et al. (2018) successfully carried out the DNA barcoding method to test eDNA in a temple pond for freshwater turtles in India where PCR was performed with the published reptile specific primer pairs targeting fragment (~650bp) of Cytochrome C oxidase subunit I (COI) in mitochondrial DNA (mtDNA) standardized to identify turtle species (Jayasankar *et al.*, 2017; Kundu and Kumar, 2018; Kundu *et al.*, 2016).

A survey of aquatic species in several European ponds in the range of the European pond terrapin (*Emys orbicularis*;(Thomsen *et al*., 2012)) failed to detect turtle eDNA, although this study did not specifically target turtles. Universal primers used in the metagenomic analysis were unable to detect eDNA from a green sea turtle (*Chelonia mydas*) in a large mesocosm (Kelly et al., 2014), but targeted PCR-based amplification of the same water samples with species-specific primers was successful, suggesting that a targeted primer panel might be able to detect turtles in natural aquatic systems. The eDNA was broadly used to detect terrestrial, freshwater & marine organisms such as insects, reptiles, fishes, mollusks, crocodiles, whales, sharks, rays, otters, etc. (Kahler and Goldberg, 2022; Mariani et al., 2021; Rose *et al.*, 2020; Thomsen and Willerslev, 2015).

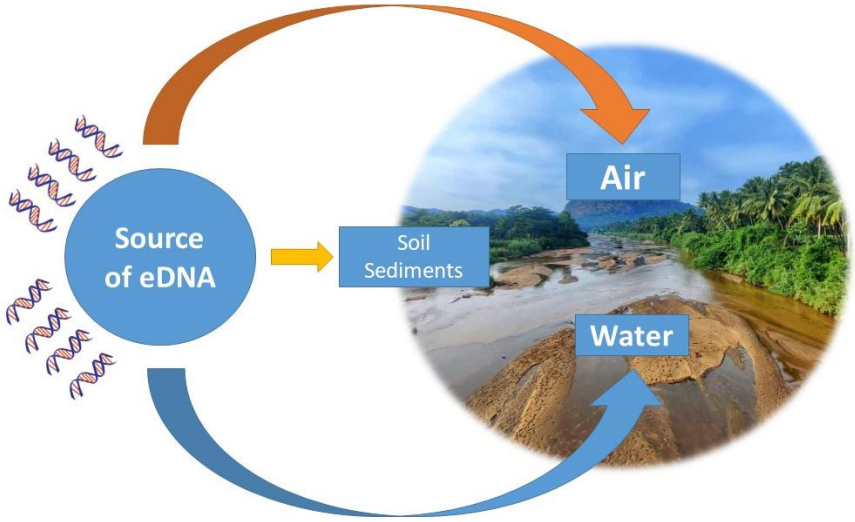


Fig 08: The major sources of eDNA in the aquatic environment.

In the current research, we will test whether eDNA can effectively detect Northern River Terrapin (*Batagur baska*). We are expecting to develop and test species-specific or genus-specific qPCR primers to target the *B. baska* found in Sundarbans, West Bengal.

Our primers should be able to target species native and exotic to our study area, including other related species in need of global conservation. We will validate the use of these primers to detect turtle eDNA in controlled water samples. We will conduct a preliminary field evaluation of *B.baska* by taking permission from the Forest officials in Sundarbans to validate our method by taking live samples from a small pond where many *B.baska* are captivated.

This survey is focused on two major tasks:

- **DNA Extraction for positive control:** DNA taken directly from available species of *Batagur Baska* and sequenced for species-specific primer designing.
- **eDNA sampling from potential sites.**

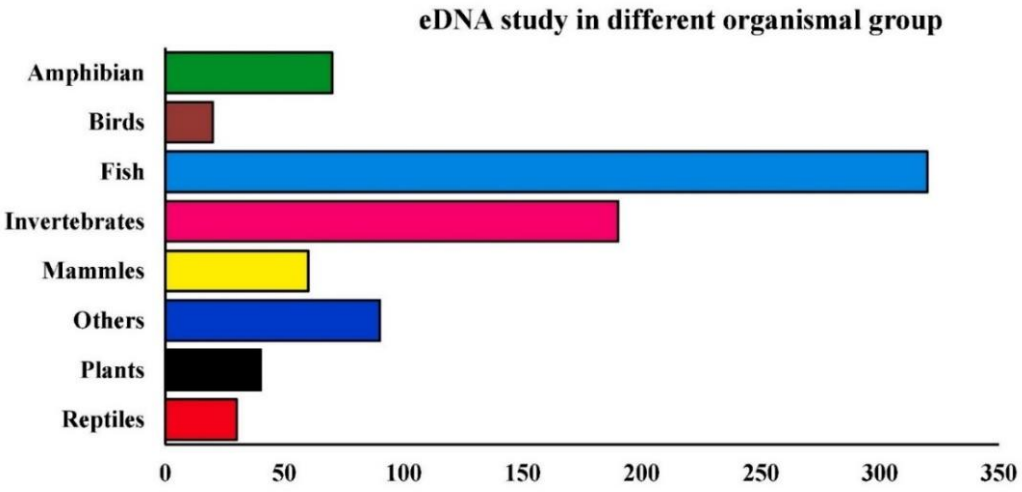


Fig 09: Current eDNA studies performed on different organisms. *Sahu et al. (2022).*

10.4. Persistence of environmental DNA in aquatic ecosystems

Environmental DNA breaks down pretty quickly in a watery setting. Less than a day to a few weeks were used in trials to determine how long eDNA remained detectable in aquariums or artificial ponds. eDNA is diluted and dispersed throughout the water in aquatic habitats, where it can persist for up to 21 days, depending on environmental factors (Jayasankar, 2017). The degradation rate varies with various environmental and biological factors, including mechanical forces, U.V. radiation, acidity and temperature, spontaneous chemical reactions (oxygenation), and endonucleases and exonucleases, which can fragment DNA into tiny pieces that are challenging to detect and identify. At higher light intensities, DNA-degrading microbes are frequently more abundant (Sahu *et al*., 2022).

11. DNA Extraction for positive control

DNA from individuals of same species could be extracted to confirm primer specificity and to create standards of known DNA concentration for quantitative polymerase chain reactions (qPCR) (Davy et al., 2015).

11.1. Primer Design

Primers can be designed from mitogenomes of related *Genus* available on the GenBank database (Davy et al., 2015; Kumar *et al*., 2021; Wilson *et al.*, 2018).

11.2. eDNA workflow

Environmental DNA assessment of *B.Baska* could be done from water samples through basic steps: sample collection, eDNA capture, eDNA extraction, **PCR with species specific primers** and sequencing, bioinformatics analysis, and following statistical analysis (Sahu *et al.,* 2022).

Note: The eDNA can be separated into two main methods, a single-species method i.e., eDNA barcoding and a multi-species method i.e., eDNA metabarcoding.

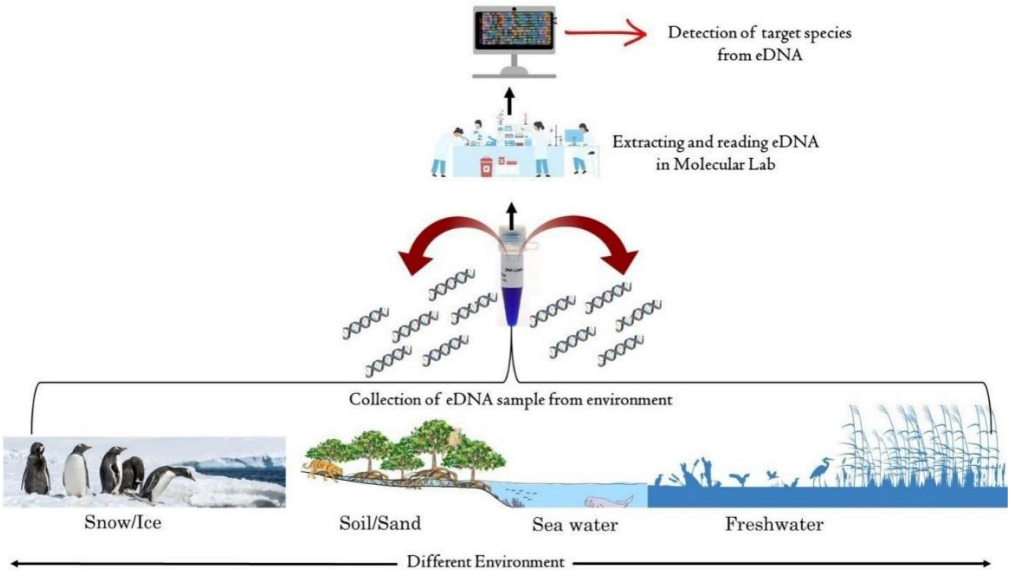


Fig 10: eDNA workflow. *Sahu et al. (2022).*

11.3. Species-specific approach / eDNA barcoding

The target species method amplifies and detects tiny eDNA fragments discharged from a target species using PCR and species-specific primers. In tests for species-specificity, the following techniques are typically used to identify the target species' eDNA: Gel electrophoresis of conventional PCR amplicons, quantitative PCR (qPCR), nested PCR (nPCR), or digital PCR (dPCR). Using standard PCR techniques, it is possible to determine whether *B.baska* is present in the ecosystem or not. The primary method used for the species-specific detection in eDNA analysis is real-time qPCR (Sahu *et al.* 2022).

11.4. Multi-species or community analysis / eDNA metabarcoding

When attempting to identify the species present in a water sample using high throughput sequencing of a standardized gene segment, environmental DNA metabarcoding is a fantastic technique (Yu *et al.*, 2012). Multiple species can be recognized using a same analytical procedure. Metabarcoding works on the same principles as barcoding for a single species. The DNA sequenced differs between species and exposes a unique code, but the primers for metabarcoding are designed to locate a section of DNA that is common across all species within a group, such as all freshwater turtles or fishes. Metabarcoding is the term used to describe the simultaneous analysis of many species. It is extremely helpful for investigating various species because the eDNA often contains data from many different species (Sahu *et al.* 2022).

11.5. Sample collection

Water samples of 15-20 ml can be taken from study sites. Before DNA extraction, each water sample should be maintained by adding 1.5 ml of 3M sodium acetate and 33 ml of 100% ethanol. Next, centrifuge the water samples at 5500 g for 30 minutes at 4°C to remove the cellular components from each sample and discard the supernatant. After that, the pellet could be treated for DNA extraction using a DNeasy Blood & Tissue Kit following the manufacturer's instructions (Kundu and Kumar, 2018).

11.6. eDNA capture

Three main strategies for extracting eDNA from aquatic environments are the following: filtration, precipitation, and centrifugation (Sahu *et al.* 2022).

11.7. eDNA Extraction

The DNeasy Blood & Tissue Kit or the DNeasy PowerWater Kit (Qiagen) for DNA isolation are the two most widely used commercial kits for eDNA extraction/purification after eDNA capture. The analysis and significance of the results may be impacted by choice of the extraction kit. The Power Water kit has the lowest yield with inhibition, the DNeasy Blood & Tissue Kit showed some PCR inhibition and is not recommended for quantification, the FastDNATM Spin Kit (M.P. Biomedicals) and PowerSoil® DNA (Qiagen) Isolation Kit were recommended for detection or quantification, respectively. The PowerWater kit has the lowest

yield with inhibition (Eichmiller *et al.*, 2016). To prevent contamination, researchers should always work while wearing protective masks and full protective clothes (Sahu *et al.* 2022).

11.8. PCR with species-specific primers

Using a Veriti® Thermal Cycler and the species/genus-specific primer pairs, PCR could be carried out at 94°C for 3 min, followed by 40 cycles of 94°C for 40 s, 48.5°C for 30 s, and 72°C for 60 s, 72°C for 7 min, and storage at 4°C (Kundu and Kumar, 2018).

11.9. Sequencing

The PCR products could be purified using a QIAquickRGel extraction kit and cycle sequencing products are cleaned using a standard BigDye X Terminator Purification Kit. Bidirectional sequences can be generated with a 48 capillary array Applied Biosystems 3730 DNA Analyzer or any other sequencer available at the institute (Kundu and Kumar, 2018).

11.10. Bioinformatics Investigation

The generated sequences could be verified by the online BLAST search engine and ORF finder, as well as by sequence analysis software. The resulting sequences can be entered into GenBank, an extensive database, to receive individual accession numbers. The eDNA-derived sequences should produce 99–100% identity with the sequences of *Batagur baska* to confirm the detection (Kundu and Kumar, 2018).

POSSIBLE RESEARCH OUTPUTS:

- **Recording Wild Population**
- **Detecting aquatic biodiversity including *Batagur baska* using eDNA protocol**
- **Identifying crucial habitats for further monitoring**

12. POSSIBLE RESEARCH OUTCOME:

1. Standardizing the eDNA survey protocol for *Batagur baska*.
2. Establishment of molecular detection method for *Batagur baska* in Sundarbans, India using eDNA.

13. REFERENCE

1. Aengals, R., Kumar, S.V.M., Palot, M.J. and Ganesh, S.R. 2018. A Checklist of Reptiles of India. 35 pp. Version 3.0. Online publication is available at www.zsi.gov.in
2. Anderson, J. 1879. Anatomical and zoological researches: comprising an account of the zoological results of the two expeditions to western Yunnan in 1868 and 1875. London. Vol. I, 985 pp., Vol. II, Plates.
3. Annandale, N. 1912. The aquatic chelonian of the Mahanaddi and its tributaries. Records of the Indian Museum. 7:261-266.
4. Anon. 1911. The Wildlife Protection Act 1972 (as amended up to 1991). Natraj Publisher, Dehradun.
5. Behera S, Panda, A.K., and Nayak, S. 2019. Status survey of Batagur baska and Pelochelys cantorii in the state of Odisha, east coast of India. Testudo 9: 36-46.
6. Bhupathy, S. 1995. Status and distribution of the river terrapin Batagur baska in the Sunderbans of India Final Project Report, Salim Ali Centre for Ornithology and Natural History, Coimbatore, India, 37 pp.
7. Bour, R. 2009. The types of Tetraonyx longicollis Lesson, 1831 and tetraonyx lessonii Dumeril and Bibron, 1835, and the confusing history of the generic names Tetronyx Lesson, 1832 and Batagur baska Gray, 1855. Emys 16(3):30-38.
8. Bourret, R. 1941. Les Tortues de l,Indochine. 18pp.
9. Cantor, T. 1847. Catalogue of reptiles inhabiting the Malayan peninsula and islands. Journal of the Asiatic Society of Bengal. 16:607-656, 897-952, 1026-1078.
10. Das, I. 1985. Indian Turtles - A Field Guide. World Wildlife Fund-India (Eastern region), Calcutta, India.
11. Das, I. 1989. Batagur baska in Orissa. Hamadryad 14 (1): 2-3.
12. Das, I. 1991. Colour Guide to The Turtles and Tortoises of the Indian Subcontinent. R & A Publishing Ltd., Portishead, UK.
13. Das, I. 1995. Turtles and Tortoises of India. World Wide Fund for Nature – India, Oxford University Press, Bombay, India.
14. Das, I. 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers Ltd., London, UK.
15. Davy, C.M., Kidd, A.G., Wilson, C.C., 2015. Development and validation of environmental DNA (eDNA) markers for detection of freshwater turtles. PloS one. 10(7): e0130965.
16. Deepak, V. and Vasudevan, K. 2009. Endemic turtles of India, pp. 25–42. In: Vasudevan, K. (ed.). Freshwater Turtles and Tortoises of India. ENVIS Bulletin: Wildlife and Protected Areas Vol. 12(1). Wildlife Institute of India, Dehradun, 177pp.
17. Duméril, A.M.C., and G. Bibron. 1835. Erpétologie Générale ou Histoire Naturelle Complète des Reptiles, Vol. 2. Librairie Encyclopédique de Roret, Paris, iv + 680 p.
18. Ernst,C.H. and Barbour,R.W. 1989. Turtles of the World. Smithsonian Institution Press, Washington D.C. – London
19. Fitzinger, L.J. 1835. Entwurf einer systematischen Anordnung der Schildkroten nach den Grundsatzen der naturlichen Methode. Ann. Naturhist. Mus. Wien 1:103-128.

20. Fritz, U. and Havas, P. 2007. Checklist of Chelonians of the world. Vertebrate Zoology. 57(2): 149–368.
21. Fund, T.C., Alliance, T.S. and Conservancy, T., 2011. Turtles in trouble: The world's 25+ most endangered tortoises and freshwater turtles–2011. IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, c/o Chelonian Research Foundation.
22. Gaffney, E.S. and Meylan, P.A. 1988. A phylogeny of Turtles. In: Benton, M.J.(Ed.). The Phylogeny and Classification of the Tetrapods, Volume I: Amphibians; Reptiles, Birds. Systematics Association Special Volume 35A:157-219.
23. Gray, J.E. 1830. Illustrations of Indian Zoology, chiefly selected from the collection of Major-General Hardwicke. Vol. I, part 2, pl. 72. London: Treuttel, Wurtz, Treuttel, Jun. and Richter. [Published Mar 1830].
24. Gray, J.E. 1831b. Illustrations of Indian Zoology, Chiefly selected from the collection of Major-General Harwicke. Vol.I, Part 5, pl. 74. London: Treutte, Wurtz, Treuttel, Jun. and Richter. [Published Jan 1831].
25. Gray, J.E. 1832. Illustrations of Indian Zoology, chiefly selected from the collection of Major-General Hardwicke. Vol. II, Part 11, pl.60. London:Adolphus Richter and Co. [Published Jul 1832].
26. Gray, J.E. 1844. Catalogue of the Tortoises, Crocodiles and Amphibians in the collection of the British Museum. 29.
27. Gray, J.E. 1856. Catalogue of Shield Reptiles in the Collection of the British Museum. Part I. Testudinata (Tortoises). British Museum, London, 79 pp. [1855]
28. Gray, J.E. 1869. Notes on the families and genera of tortoises (Testudinata), and on the characters afforded by the study of their skulls. Proceeedings of the Zoological Society of London. Pp: 165-225.
29. Gray, J.E. 1870. Suplement to the Catalogue of Shield Reptiles in the Collection of the British Museum. Part I. Testudinata (Tortoises). London: British Museum, 129 pp.
30. Gray. J.E. 1831a. A synopsis of the Species of the Class Reptilia. In: Griffith, E. and Pidgeon, E. The Class Reptilia arranged by the Baron Cuvier, with specific descriptions. In: Griffith, E. (Ed.). The Animal Kingdom Arranged in Conformity with its Organization by the Baron Cuvier, with Additional Descriptions of the Species Hitherto Named, and of many not before Noticed. Vol.9. Reptilia. Supplement. London: Whittaker, Treacher, and Co., 110 pp.
31. Groombridge, B. 1982. The IUCN Amphibia-Reptilia Red Data Book. Part I Testudines, Crocodilia, Rhyncocephalia. IUCN, Gland.
32. Gunther, A.C.L.G. 1864. The Reptiles of British India. Robert Hardwicke, London, 452 pp.
33. Iverson, J.B. 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Privately Printed, Richmond, Indiana, 363pp
34. Jayasankar, P., Pradeep, M., Mini, K., Arun Kumar, T., 2017. Environmental DNA (eDNA) metabarcoding approach in fisheries research in India. Marine Fisheries Information Service; Technical and Extension Series. (234):29-31.
35. Joseph-Ouni, M. 2003. The Zoogeography of Turtles, Crocodiles & Tuataras. EO Wildlife Conservation & Artistry, New York, 134pp.

36. Kahler, A., Goldberg, C., 2022. Investigating the Distribution of the Smooth-Coated Otter (Lutrogale perspicillata) using Environmental DNA: Preliminary Results IUCN Otter Spec. IUCN Otter Spec Group Bull. 39(2):110-20.
37. Kalyar, J.T and Thirakhupt, K. 2007. An overview of the Current population and conservation status of the Critically Endangered River Terrapin, Batagur baska (Gray, 1831) in Myanmar, Thailand and Malaysia. The Natural History Journal of Chulalongkorn University. 7(1): 51-65.
38. Kelly, R.P., Port, J.A., Yamahara, K.M., Crowder, L.B., 2014. Using environmental DNA to census marine fishes in a large mesocosm. PloS one. 9(1): e86175.
39. Kumar, A., Yadav, P., Usmani, A., Hussain, S.A., Gupta, S.K., 2021. Comparative Mitogenomics of Two Critically Endangered Turtles, Batagur Kachuga and Batagur Dhongoka (Testudines: Geoemydidae): Implications in Phylogenetics of Freshwater Turtles. 2021.
40. Kundu, S., Kumar, V., 2018. Environmental DNA (eDNA) testing for detection of freshwater turtles in Temple Pond. Herpetology Notes. 11:369-71.
41. Kundu, S., Kumar, V., Laskar, B.A., Chandra, K., Tyagi, K., 2016. Mitochondrial DNA effectively detects non-native Testudines: Invisible wildlife trade in northeast India. Gene Reports. 4:10-5.
42. Le, M., McCord, W.P., and Iverson, J.B. 2007. On the paraphyly of the genus Kachuga (Testudines: Geoemydidae). Molecular Phylogenetics and Evolution. 45:398-404.
43. Lesson, R.F. 1834. In Belanger, C., Voyage aux Indes-Orientales, par Ie nord de I 'Europe, les provinces du Caucase, la Georgie, I 'Armenie et la Perse, suivi de details lopographiques, statistiques et autres surle Pegou, les iles de Java, de Maurice et de Bourbon, sur Ie Cap-de-Bonne-Esperance et Sainte Helene, pendant les annees 1825, 1826, 1827, 1828 et 1829, ... (ATLAS) ZOOLOGIE. Paris.
44. Lesson, R.P. 1832. Illustrations de Zoolohie, ou Recueil de figures d'Animaux peintes d'apres nature. Pl.7. Paris: A. Bertrand, 60 pls.
45. Lindholm, W. A. 1929. Revidiertes Verzeichnis der Gattungen der rezenten Schildkroten nebst Notizen zur Nomenklatur eineger Arten. Zool. Anz. 81(11-12):275-295.
46. Mallick, N., S. Singh, D. Chatterjee & S. Sharma (2021). Conservation breeding of Northern River Terrapin Batagur baska (Gray, 1830) in Sundarban Tiger Reserve, India. Journal of Threatened Taxa 13(6): 18544–18550. https://doi.org/10.11609/jott.5412.13.6.18544-18550
47. Mariani, S., Fernandez, C., Baillie, C., Magalon, H., Jaquemet, S., 2021. Shark and ray diversity, abundance and temporal variation around an Indian Ocean Island, inferred by eDNA metabarcoding. Conservation Science and Practice. 3(6): e407.
48. Marshall, J. (ed.). 1931. Mohenjo-Daro and Indus Civilization, Volume II. Arthur Probsthain, London, UK.
49. Maxwell, F.D. 1911. Reports on inland and sea fisheries in the Thongwa, Myaungmya, and Bassein Districts and the turtle banks of the Irrawaddy Division. Government Printing Office, Rangoon, 57 pp.

50. McDowell, S.B. 1964. Partition on the genus Clemmys and related problems in the taxonomy of the aquatic Testudinidae. Proceedings of the Zoological Society of London. 143:239-279.
51. Moll, E.O. 1980. Natural History of the river terrapin, Batagur baska (Gray) in Malaysia (Testudines: Emydidae). Malaysian Journal of Science 6(A): 23–62.
52. Moll, E.O. 1985. Estuarine turtles of tropical Asia: status and management. Proceedings Symposium: Endangered Marine Animals and Marine Parks. 1985(1):214-226.
53. Moll, E.O. 1990. Status and Management of the river terrapin (Batagur baska) in tropical Asia. Unpublished report of Porject WWF3901/Asia to the World Wide Fund for Nature. 37 pp.
54. Moll, E.O. 1997. Effects of habitat alteration on river turtles of tropical Asia with emphasis on sand mining and dams. In: Proc. of the Conservation, restoration and management of tortoises and turtles, New York Turtle and Tortoise Society, New York, USA, pp. 37-41.
55. Moll, E.O., Platt, K., Platt, S.G., Prashag, P., and Dijk, P.P.V. 2009. Batagur baska-Northern River Terrapin. In: Rhodin, AGJ, JB Iverson, PP. van Dijk, RA Saumure, KA Buhlmann, PCH Pritchard and RA Mittermeier (Eds,), Conservation Biology of Freshwater Turtles and Tortoises: A compilation project of the IUCN/ Tortoise and Turtle Specialist Group. Chelonian Res. Monogr. 5: 1-10.
56. Murray, J.A. 1884. The Vertebrate Zoology of Sind. Richardson & Co., London, UK.
57. Nath, B. 1959. Animal remains of the 12th Century A.D. from Sarnath, Uttar Pradesh, India. Journal of the Zoological Society of India. 10:165-175.
58. Nutaphand, W. 1979. The Turtles of Thailand Bangkok: Siamfarm Zoological Garden, 222pp.
59. Olsen, G. J., Lane, D. J., Giovannoni, S. J., Pace, N. R., & Stahl, D. A. (1986). Microbial ecology and evolution: a ribosomal RNA approach. Annual reviews in microbiology, 40(1), 337-365.
60. Pandit, P.K. 2013. Captive breeding of Batagur baska- a critically endangered species in Sundarbans tiger reserve, West Bengal, India. In: Naewboonnien, J (Eds,), Food and Agriculture Organization of the United Nations regional office for Asia and the pacific, Tigerpaper, Regional Quarterly Bulletin on Wildlife and National Parks Management, Bangkok, Thailand, pp. 1-6.
61. Piaggio, A.J., Engeman, R.M., Hopken, M.W., Humphrey, J.S., Keacher, K.L., Bruce, W.E., Avery, M.L., 2014. Detecting an elusive invasive species: A diagnostic PCR to detect B urmese python in F lorida waters and an assessment of persistence of environmental DNA. Molecular ecology resource. 14(2):374-80.
62. Platt, K., Platt, S.G., Thirakhupt, K., and Rainwater, T.R. 2008. Recent records and conservation status of the critically endangered mangrove terrapin, Batagur baska (Gray, 1831) in Myanmar. Chelonian Conservation and Biology. 7:261-265.
63. Platt, S.G., Hendrie, D., Chan, E.H., Poynter, B., Platt, K., Sovannara, H., Holloway, R., Myo, K.M., Chen, P.N., and Soh, C.L. 2006. Batagur baska: A status review and conservation action plan. Unublished report to Wildlife Conservation Society and Turtle survival Alliance, 68 pp.

64. Platt, S.G., Kaliyar, Win Ko Ko, Kin Myo Myo, Lay Lay Khaing and Rainwater, T.R. 2007. Notes on the Occurrence, natural history, and conservation status of turtles in central Rakhine (Arakan) State, Myanmar, Hamadryad 31:202-211.
65. Platt, S.G., Stuart, B.L., Sovannara, H., Kheng, L., Kalyar, and Kimchhay, H. 2003. Rediscovery of the critically endangered river terrapin, Batagur baska, in Cambodia, with notes on occurrence, reproduction, and conservation status. Chelonian Conservation and Biology 4: 691–695.
66. Praschag, P., Ghose, R., and Wollinger, F. 2008a. Field survey for the river terrapin (Batagur baska) in East India and Bangladesh. TSA, Turtle Survival Alliance Newsletter, August, P.30.
67. Praschag, P., Hundsdorfer, A.K., and Fritz, U. 2007. Phylogeny and taxonomy of endangered South and South-east Asian freshwater turtles elucidated by mtDNA sequence variation (Testudines: Geoemydidae: Batagur, Callagur, Hardella, Kachuga, Pangshura). Zoologica Scripta.36:429-442.
68. Praschag, P., Singh, S. 2019. Batagur baska. The IUCN Red List of Threatened Species 2019. International Union for the Conservation of Nature. http://www.IUCN.org.
69. Praschag, P., Sommer, R.S., McCarthy, C., Gemel, R., and Fritz, U. 2008b. Naming one of the world's rarest chelonians, the southern Batagur. Zootaxa. 1758:61-68.
70. Qiagen DNeasy Blood and Tissue kit, G.l.W., 2015.
71. Rashid, S.M.A., and Khan, M.H. 2000. Trade and Conservation Status of Freshwater Turtles and Tortoises in Bangladesh. In: Asian Turtle Trade: Proc. of a Workshop on Conservation and Trade of Freshwater Turtles and Tortoises in Asia, Lunenburg, USA. Chelonian Res. Monogr. 2: 77-85.
72. Reza, A.A. 2005. Current status of river terrapin, Batagur baska in Bangladesh. Unpublished report. Department of Zoology, Jahangir nagar University, Dhaka, Bangladesh, pp. 12.
73. Rose, A., Fukuda, Y., Campbell, H.A., 2020. Using environmental DNA to detect estuarine crocodiles, a cryptic-ambush predator of humans. Human–Wildlife Interactions. 14(1):11.
74. Sahu, A., Kumar, N., Singh, C.P., Singh, M., 2022. Environmental DNA (eDNA): Powerful Technique for Biodiversity Conservation. Journal for Nature Conservation. 126325.
75. Sanyal, P., and Seth, S. 1992. Rare terrapin (Batagur baska) breeding in Bengal. Tiger Paper. 19(4):10-11.
76. Shaffer, H.B., Meylan, P., and McKnight, M.L. 1997. Test of turtle phylogeny: molecular, morphological, and paleontological approaches. Systematic Biology. 46:235-268.
77. Sharma, R.C. 1998. Fauna of India, Reptilia - Testudines and Crocodilians, Volume: I. Zoological Survey of India, Calcutta, India.
78. Smith, M.A. 1931. The fauna of British India, including Ceylon and Burma, Reptilia and Amphibia Vol. I – Loricata, Testudines. London. 223 pp.
79. Strauch, A. 1862. Chelonogische studien, mit besonderer bezeihung auf die Schildkrotensammlung der kaiserlichen Akademie der Wissenschaften zu St.

Petersburg. Memoires de l'Academie Imperiale des Sciences de St Petersburg. (7) 5: 1-196.
80. Stuart B. L. and Thorbjarnarson J., (2003). Biological prioritization of Asian countries for turtle conservation. Chelonian Conservation and Biology., 4,642-647
81. Stubbs, D. 1989. Tortoises and Freshwater Turtles. An Action Plan for their Conservation. IUCN/SSC Tortoise and Freshwater Turtle Specialist Group [Pp. 1-47]
82. Temminck, C.J. and Schiegel, H. 1835. Reptilia Elaborantibus. I. Chelonii. In: Siebold, P.F.von. Fauna Japonica, Vol. III, Lugduni, Batavorum, pp.1-80.
83. Theobald, W., Jr. 1868. Catalogue of the reptiles of British Birma, embracing the provnces of Pegu, Martaban, and Tenasserim; with descriptions of new or little-known species. Journal of the Linnean Society (Zoology) 10:4-67.
84. Theobald, W., Jr. 1868a. Catalogue of Reptiles in the Museum of the Asiatic Society of Bengal. Journal of the Asiatic Society, Extra Number, 88 pp.
85. Thomsen, P.F., Kielgast, J., Iversen, L.L., Wiuf, C., Rasmussen, M., Gilbert, M.T.P., Orlando, L., Willerslev, E., 2012. Monitoring endangered freshwater biodiversity using environmental DNA. Molecular ecology. 21(11):2565-73.
86. Thomsen, P.F., Willerslev, E., 2015. Environmental DNA–An emerging tool in conservation for monitoring past and present biodiversity. Biological conservation. 183:4-18.
87. Tikader, B.K. and Sharma, R.C. 1985. Handbook: Indian Testudines. Zoological Survey of India, Calcutta, India.
88. Turtle Conservation Coalition [Stanford, C.B., Rhodin, A.G.J., van Dijk, P.P., Horne, B.D., Blanck, T., Goode, E.V., Hudson, R., Mittermeier, R.A., Currylow, A., Frankel, M., Georges, A., Gibbons, P.M., Juvik, J.O., Kuchling, G., Luiselli, L., Haitao, S., Singh, S., and Walde, A.]. 2018. Turtles in Trouble, The world's 25+ Most endangered tortoises and Freshwater turtles. 84pp.
89. Turtle Taxonomy World Group; Rhodin, A.G.J., Iverson, J.B., Bour, R., Fritz, U., Georges, A., Shaffer, H.B., and van Dijk, P.P. 2021. Turtles of the World: Annotated Checklist and Atlas of Taxonomy, Synonymy, Distribution, and Conservation Status (9th Ed.). In: Rhodin, A.G.J., Iverson, J.B., van Dijk, P.P., Stanford, C.B., Goode, E.V., Buhlmann, K.A., and Mittermeier, R.A. (Eds.). Chelonian Research Monographs 8:1–472.
90. Vijaya, J. 1982. Freshwater turtles. Hamadryad. 7:11-13.
91. Vyas, R. 2017. A Northern River Terrapin (Batagur baska) from Kutch, with comments on the species' distribution in Western India and Pakistan. IRCF Reptiles & Amphibians. 24(2): 128-131.
92. Weissenbacher, A., Preininger, D., Ghosh, R., Morshed, A.G.J., and Praschag, P. 2015. Conservation breeding of the Northern river terrapin Batagur baska at the Vienna Zoo, Austria, and in Bangladesh. Int. Zoo Yearb 49: 31-41.
93. Whitaker, R. 1983. Bangladesh: a general survey. Hornbill. 1983:3-9.
94. Wilson, J.-J., Sing, K.-W., Chen, P.-N., Zieritz, A., 2018. Tracking the southern river terrapin (Batagur affinis) through environmental DNA: prospects and challenges. Mitochondrial DNA Part A. 29(6):862-6.

Annexure – I

Protocol for eDNA extraction using Qiagen DNeasy Blood and Tissue kit for samples collected from water and stored in Ethanol(Qiagen DNeasy Blood and Tissue kit).

Day 1:

• Fill beaker with **50% bleach + 50% Dist H2O.** Use it to clean the surface of the work table, and sterilize the tweezers when required.

• Lay down a paper towel and use a sterile tweezer to pick the Filter from ethanol tube and lay it.

• Use the tweezers to cut down the filter into half along the grid. Store the other half in the same ethanol tube.

• Tear the other half into 4 pieces and store them in U.V. sterilized 1.5 ml pop top tubes. Make sure the pieces don't stick to each other and dry properly in the tube.

• Clean the table and tweezers and repeat the process for other samples.

• Label them and leave them undisturbed over night to dry.

Day 2:

• Add **180µl ATL** to each tube.

• Add **20µl Pro K** to each tube. Make sure the filter bits and completely immersed in the solution.

Vortex each one as per requirement.

• Incubate at 55°C in the heatblock and vortex it for few more times that day and leave for over night incubation.

Day 3:

• Use the bleach solution to sterilize the work table and tweezers. Sterilize the storage tubes under U.V. light.

• Remove the samples from heat block and turn it up to **70°C** to incubate the A.E. buffer.

• Label and set out 1.5ml pop-top tubes and set the Qiashredder spin column in those poptop tubes and label them.

• Vortex the samples for **15 seconds** and move them to Qiashredder spin column tubes by pipetting with filter tips, try to get all the samples.

• Centrifuge it for **2 minutes at 11,000 RPM.**

• Remove the columns and add **200µl buffer A**.L. to each sample and vortex immediately.

• Incubate at **70°C for 10 minutes.**

• Add **200µl 100% EtOH** to each tube, vortexing immediately each time.

• Add the mixture to DNeasy spin column (~600 µL). **Centrifuge at 8000 RPM for 1 minute.**

• Place the column in a new collection tube and pour the filtrate into the collection bottle and discard the old tube.

• Add **500 µL AW1** to each sample. Centrifuge at **8000 RPM for 1 minute**.

• Place the column in new collection tube and pour the filtrate into the collection bottle.

• Add **500 µL of AW2** and spin at **11,000 RPM for 3 minutes.**

• Remove the spin column carefully without splashing the ethanol on column. Place the spin column on new tube with no top.

• Elute the DNA with **100 µL Buffer AE** (preheated to 70℃). Incubate at **room temperature for 5 minutes** then spin at **8000 RPM for 1 minute.**

• Pipette this final elution into a permanent storage tube and label it.

• Store in refrigeration until PCR.

Annexure – II

SI. No.	Year of Sighting	District	Water System	Country	State	Status	Habitat	Source
1	NA	NA	River Indus	Pakisthan	Larkana	Dead (Shells)	Inland waters	Murray 1884; Praschag et al. 2008b
2	NA	Varanasi	Sarnath	India	Uttar Pradesh	Unconfirmed	Inland waters	Nath 1959
3	NA	Balasore	Subarnarekha island	India	Orissa	NA	Estuarine	Annandale, 1912; Vijaya 1982; Das 1987; Moll et al. 2009; Das 1989; Das 1991
4	NA	Jajpur	Brahmini River	India	Orissa	NA	Inland waters	Annandale, 1912; Vijaya 1982; Das 1987; Moll et al. 2009; Das 1989; Das 1991
5	NA	Bhadrak	Dhamra	India	Orissa	Might be Extinct	Estuarine	Mishra et al 1996
6	NA	Kendrapara	Baitarani	India	Orissa	Might be Extinct	Estuarine	Mishra et al 1996
7	NA	Kendrapara	Gahirmata	India	Orissa	Unconfirmed	Estuarine	Letter to Vijaya, Das 1989
8	NA	Cuttack	Mahanadi	India	Orissa	Might be Extinct	Inland waters	Mishra et al 1996; Praschag et al 2008a
9	NA	Jagatsinghpur	Devi River	India	Orissa	Tributary of Mahanadi River	Estuarine	Praschag et al. 2008
10	1982	Purba Medinipur	Udaipur village, Digha	India	Orissa	Fisherman Seen		Vijaya 1982 (Unpubl) Das 1989
11	1984	Kendrapara	Gahirmata , BK-WS near Ekkakula	India	Orissa	Alive	Estuarine	Vijaya Per. Comms.; Das 1989

12	NA	NA	Saltwater Lake	India	Orissa	Specimen in Museum		Das 1989
13	NA	North 24 Parganas	Kalindi river	India	West Bengal	NA	Inland waters	Bhupathy 1997
14	NA	North 24 Parganas	Govindakati	India	West Bengal	Adult found	Inland waters	Bhupathy 1997
15	NA	North 24 Parganas	Mangalchandi	India	West Bengal	Adult found	Inland waters	Bhupathy 1997
16	NA	North 24 Parganas	Amtali	India	West Bengal	Adult found	Inland waters	Bhupathy 1997
17	NA	East midnapore	Hoogly River	India	West Bengal	NA	Estuarine	Gunther 1864
18	NA	North 24 Parganas	Saznakhali	India	West Bengal	NA	Estuarine	Bhupathy 1997
19	NA	North 24 Parganas	Harinbanga STR	India	West Bengal	Released Youngones	Estuarine	Bhupathy 1997
20	NA	South 24 Parganas	Lahachara	India	West Bengal	NA	Estuarine	Bhupathy 1997
21	NA	North 24 Parganas	Raimangal river	India	West Bengal	NA	Estuarine	Bhupathy 1997
22	NA	South 24 Parganas	Lothaian (OT)	India	West Bengal	Fisherman Seen	Estuarine	Bhupathy 1997
23	NA	South 24 Parganas	Halliday	India	West Bengal	NA	Estuarine	Bhupathy 1997
24	NA	North 24 Parganas	Bagmara island Forest post	India	West Bengal	17 Nests found	Estuarine	Moll 1990b
25	NA	South 24 Parganas	Kalas (OT)	India	West Bengal	Fisherman Seen	Estuarine	Bhupathy 1997

26	NA	South 24 Parganas	Dublat (OT) - Dhablat	India	West Bengal	Turtle egg collected	Estuarine	Bhupathy 1997
27	NA	South 24 Parganas	Gangasagar (OT)	India	West Bengal	Turtle egg collected	Estuarine	Bhupathy 1997
28	NA	South 24 Parganas	Thakuran (OT)	India	West Bengal	Fisherman Seen	Estuarine	Bhupathy 1997
29	1988	North 24 Parganas	Mechua Island	India	West Bengal	10 Nesting Females	Estuarine	Bhupathy 1995; Bhupathy 1997; Pandit 2021
30	NA	South 24 Parganas	Chulkati (OT)	India	West Bengal	Fisherman Seen	Estuarine	Bhupathy 1997
31	NA	South 24 Parganas	Jambu (OT) - Jambudwip	India	West Bengal	Turtle egg collected	Estuarine	Bhupathy 1997
32	1984	South 24 Parganas	Kanak	India	West Bengal	Nesting spot	Estuarine	Das 1987; Das 1991; Ghosh & Mandal 1990; Das 1989; Das 1996
33	NA	North 24 Parganas	Chaimari (TR)	India	West Bengal	Fisherman Seen	Estuarine	Bhupathy 1997
34	NA	North 24 Parganas	Kedo	India	West Bengal	Nesting spot	Estuarine	Das 1987; Das 1991; Ghosh & Mandal 1990; Das 1989; Das 1996
35	NA	South 24 Parganas	Bakkali (OT) beach	India	West Bengal	Turtle egg collected	Estuarine	Bhupathy 1997
36	NA	South 24 Parganas	Nagbarachar	India	West Bengal	Nesting spot	Estuarine	Das 1987; Das 1991; Ghosh & Mandal 1990; Das 1989; Das 1996
37	NA	South 24 Parganas	Mechua	India	West Bengal	Nesting spot	Estuarine	Das 1987; Das 1991; Ghosh & Mandal 1990; Das 1989; Das 1996
38	NA	North 24 Parganas	Kendo (TR)	India	West Bengal	Fisherman Seen	Estuarine	Bhupathy 1997
39	NA		Katka	Bangladesh		NA	Estuarine	Das 1996

40	NA	Khulna	Kaga creeks (Kaga Khal)	Bangladesh	Khulna	NA	Estuarine	Das 1996
41	NA	Khulna	Kali char	Bangladesh	Khulna	Nesting Site	Estuarine	Das 1996; Whitaker 1983
42	NA	Satkhira	Mongla river	Bangladesh	Khulna	NA	Estuarine	Khan 1982
43	NA	Bagerhat	Passur island	Bangladesh	Khulna	Nesting Site	Estuarine	Khan 1982; Das 1996
44	NA	NA	Sipsah	Bangladesh	NA	Na	NA	Das 1996
45	NA	NA	Konga	Bangladesh	NA	Na	NA	Whitaker 1982, per. comm.
46	NA	NA	Chakaria	Bangladesh	NA	Na	Estuarine	Moll 1990b
47	NA	NA	Chakaria Sunderbans	Bangladesh	NA	Nesting Site	Estuarine	Moll 1990b
48	NA	NA	Sunderbans	Bangladesh	NA	NA	Estuarine	Reza 2005
49	NA	Chittagong	Chittagong	Bangladesh	Chittagong	Dead (Market)	Estuarine	Praschag 1997 (Unpubl)
50	NA	Chittagong	Kutubdia island	Bangladesh	Chittagong	Nest	Estuarine	Praschag et al 2008a
51	NA	Cox's bazar District	Cox's bazar District	Bangladesh	Chittagong	NA	Estuarine	Das 1996
52	NA	Cox's bazar District	Teknaf	Bangladesh	Chittagong	NA	Estuarine	Das 1996
53	NA	Cox's bazar District	St. Martin Island	Bangladesh	Chittagong	NA	Estuarine	Platt et al. 2008
54	NA	Myebon	Baung River	Myanmar	Rakhine	NA	Estuarine	Platt et al. 2008
55	NA	Ramree	Ramree Island (Rakhine state)	Myanmar	Rakhine	NA	Estuarine	Platt et al. 2007
56	NA	Ngapudaw	Wet Bu Village	Myanmar	Ayeyarwady	NA	Estuarine	Platt et al. 2008
57	NA	Kyauktan	Bago Estuaries	Myanmar	Yangon	NA	Estuarine	Praschag et al. 2007, 2008

58	NA	Ye	Ye Town	Myanmar	Mon	NA	Estuarine	Platt et al. 2008
59	NA	Yebyu	Khaw Za Town	Myanmar	Tanintharyi	NA	Estuarine	Platt et al. 2008
60	NA	Launglon	Sinzeik Village	Myanmar		NA	Estuarine	Platt et al. 2008
61	NA	Myeik	Pyin Won Beach	Myanmar	Tanintharyi	NA	Estuarine	Platt et al. 2008
62	NA	Myeik	Tanintharyi	Myanmar	Tanintharyi	NA	Estuarine	Platt et al. 2008
63	NA	Kawthoung	Par Chan River	Myanmar	Tanintharyi	NA	Estuarine	Platt et al. 2008
64	NA	Kawthoung	Kan Paw Gyi	Myanmar	Tanintharyi	NA	Estuarine	Platt et al. 2008
65	NA	Kawthoung	Thaung Phyu	Myanmar	Tanintharyi	NA	Estuarine	Platt et al. 2008
66	NA	NA	Pegu	Myanmar		NA	NA	Theobald 1868a
67	NA	NA	Kadonlay kyun	Myanmar		NA	NA	Salter 1983
68	NA	NA	NA	India	NA	Specimen in Museum	NA	**NHMUK**
69	NA	NA	NA	India	NA	Specimen in Museum	NA	**NHMUK**
70	NA	NA	Ganges	India	NA	Specimen in Museum	NA	**NHMUK**
71	NA	NA	NA	India	NA	Specimen in Museum	NA	**NHMUK**
72	NA	NA	NA	India	NA	Specimen in Museum	NA	**NHMUK**
73	NA	NA	Ganges	India	NA	Specimen in Museum	NA	**NHMUK**
74	NA	NA	Ganges	India	NA	Specimen in Museum	NA	**NHMUK**
75	NA	NA	Moulmein	Myanmar	NA	Specimen in Museum	NA	**NHMUK**

76	NA	NA	Pegu, Rangoon	Myanmar	NA	Specimen in Museum	NA	**NHMUK**
77	NA	NA	Pegu	Myanmar	NA	Specimen in Museum	NA	**NHMUK**
78	NA	NA	Pegu, Burma	Myanmar	Rangoon	Specimen in Museum	NA	**NHMUK**
79	NA	NA	Pegu, Burma	Myanmar	NA	Specimen in Museum	NA	**NHMUK**

*NHMUK-National History Museum United Kingdom

ANNEXURE - III

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

(An Autonomous Institution under the Ministry of Environment, Forest and Climate Change, Government of India)

Chandrabani, DehraDun - 248002, India

Phone: 0135-2646112

Project: Pan India Assessment and Monitoring of Endangered Species under the Integrated Development of Wildlife Habitats (IDWH) – *Batagur baska*

Interviewer

Name_____Date_____

Data Sheet Serial No:_____

Village/Town:_____

State:_____GPS

Coordinates:_____

***BATAGUR BASKA* SURVEY QUESTIONNAIRE**

1. Name, Sex and Age:_____
2. Religion: _____ Contact no:_____
3. Educational qualification: Primary ( ) HSC ( ) Graduates ( ) Illiterate ( )
4. What's your principal occupation? Fishing ( ) Other ( ) Describe (if others):_____
5. Is fishing the only way you earn a living? Yes ( ) No ( )
   (if no) Alternate occupation(s)?_____
6. Which months do you fish? (if seasonal, indicate season start and end)
   _____
   _____
7. How many days in a week do you fish?_____days (low season)____days

(peak season)

8. How many peoples, including yourself, work on the boat?_____
9. Major fish species caught/Most preferable _____days (low season)____days (peak season)
10. How regularly do you notice animals while you are fishing?

    a) Turtles : Not ever ( ) Rarely ( ) Frequently ( )

    Colour: _____ , Length: _____m, Photo identification: _____, Remarks (Spec. patterns or markings): _____

    b) Snakes : Not ever ( ) Rarely ( ) Frequently ( )

    Colour: _____, Morphology : spots ( ) stripes ( )

    Photo identification: _____, Remarks (Spec. patterns or markings): _____

11. Have you ever observed turtles/snakes/lizards entangled in the fishing gear?

    Not ever ( ) Once ( ) Frequently ( ) _____ no/year

12. Are you aware of turtles/snakes/crocodiles? Yes ( ) No ( )
13. Have you ever observed turtles while fishing? Yes ( ) No ( )
14. Where do you most often see turtle?

    While fishing ( ) While travelling to fishing areas ( ) unintentionally caught in fishing gears ( ) Other ( ) _____

15. Do you know of any areas where turtle regularly occur? Site description, if possible, with nearby landmarks_____
16. Have you often got turtle as accidental catch? Yes ( ) No ( ), if yes net type_____
17. When was the last time you see a turtle? Never ( ) In past 6 month ( )

    In past one year ( ) In past five year ( )

18. How frequently have you seen a turtle?

    Never ( ) Once in my life ( ) Once in past five year ( ) Frequently ( )

    Every year for the past five year ( ) In past six month ( ) No. of sightings ( )

19. In what months do you see turtles? _____
20. Is there any change in their seasonal sightings?

    _____

21. Is there any change in their observed location?

    _____

22. Have you seen any predator foraging on turtle nests? Yes ( ) No ( )

    Dogs ( ) Monitor Lizard ( ) Crocodile ( ) Humans ( ) Others ( )

23. How many species of snakes you seen in Sundarbans?

    Less than 5 ( ) Less than 10 ( ), Their vernacular names:

    _____

24. Do you know what turtle feed? Yes ( ) No ( ), If yes, Describe:

    _____

25. Is there any shop or market for purchasing Turtle meat in your surroundings?

    Yes ( ) No ( ) If yes, Details

    _____

26. Have you ever seen nesting site of turtle? Yes ( ) No ( ) If yes,

    When?_____ Where? _____

    How many nests? _____

27. Does your boat hit the turtle while riding?

    _____

28. Have you ever sighted Water monitor lizard? Yes ( ) No ( ) If yes,

    When?_____ Where? _____

29. How many turtles do you think might live in Sundarbans?

    Less than 5 ( ) Less than 10 ( ) More than 10 ( )

    Others_____

30. Have you found any dead Turtles/Snakes/Crocodile?

    a) Turtles Yes ( ) No ( ) If yes, When?_____

    Where? _____

    b) Snakes Yes ( ) No ( ) If yes, When?_____

    Where? _____

    c) Crocodile Yes ( ) No ( ) If yes, When?_____

    Where? _____

15

PAN India Assessment and Monitoring of endangered species covered under the Integrated Development of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Clouded Leopard (*Neofelis nebulosa*)

2. SUPERVISORS: Dr. Bilal Habib and Dr. Gopi G.V.

3. BRIEF BACKGROUND:

The Pan India Assessment and Monitoring of Endangered Species is a program implemented under the Integrated Development of Wildlife Habitats (IDWH) scheme, which is initiated by the Ministry of Environment, Forests and Climate Change (MoEF&CC) of the Government of India. The program aims to assess the population status, distribution, and threats faced by endangered species across different regions of India. These objectives are to be achieved by conducting comprehensive surveys and monitoring of endangered species to gather data on their population dynamics, habitat conditions, and threats. Under its Recovery scheme, 22 endangered species have been identified across the nation requiring protection of their critical habitats. Out of 22 species, the Clouded leopard is one of the endangered species that needs attention in this aspect due to increasing threats such as poaching, habitat loss, and human-wildlife conflicts.

4. OBJECTIVES:

- To assess the current status of endangered species covered under the IDWH scheme - Clouded Leopard
- Development of long-term monitoring protocols for populations and habitat assessment of endangered species covered under the IDWH scheme - Clouded Leopard

5. APPROACH /METHODOLOGY (in brief)**:**

For assessing the current population status of the species, field surveys viz. questionnaire, sign surveys, camera trapping, etc. would be conducted with the help of the respective Forest Departments of the states.

6. PROGRESS TILL DATE:

6.1 Forest fragmentation analysis

The fragmentation analysis was performed using FRAGSTATS 4.0 on the forest cover map (FCM) of north east region at spatial resolution of 24m and has classes such as non-forest, scrub, open forest, moderately dense forest, and very dense forest. However, the forest fragmentation analysis focused on only three classes, excluding scrub and non-forest. The software computes several statistics for each patch and class in the landscape and for the landscape as a whole. Patch-level metrics such as Patch Area (AREA), Patch Perimeter (PERIM), Mean Patch Area, Perimeter Area Ratio (PARA) and landscape level metrics includes Number of Patches (NP) were analysed to depict the status of forest fragmentation. FRAGSTATS employs a raster image as input, accompanied by text files such as class descriptors, edge similarity, edge contrast and the edge depth file. A uniform edge depth of 500 meters was specified for all edge types in this study.

Results

Analysis of forest fragmentation conducted on a forest cover raster are presented for three distinct categories based on forest density classes viz. very dense, moderately dense, and open forest.

Very Dense Forest (VDF)

VDF occupied 1,19,494 patches covering a total area of 30,721 km^2 (Range: 0.002498 – 1065.597; $\bar{x}$ = 0.257098, SD = 3.9509). Among these patches, 3035 patches are larger than 1km^2 and covering an area of 23613.17 km^2, with a mean area of 7.7802 (SD =32.2206). Perimeter-Area Ratio (PAR) is a more effective measure of habitat patch quality than area because it reflects both size and shape. When the size of the patch increases, PAR decreases and vice versa. The maximum PAR value was obtained for patches having area less than 1 km^2, while the lowest PAR value was for the size category ranging from 100–500 km^2. In comparison to all other states, Sikkim has the highest PAR value (449.81) for patches of very dense forest that are less than 1 km^2.

Moderate Dense Forest (MDF)

MDF occupied 2,82,954 patches covering a total area of 77,775.71 km^2 (Range: 0.002498 – 3931.859; $\bar{x}$ = 0.27487, SD = 11.1905). Among these patches, 5714 patches are larger than

1km^2 and covering an area of 61478.84 km^2, with a mean area of 10.7593 (SD = 103.2628). The maximum PAR value is for patches that are less than 1 km^2, while the lowest PAR value is for the size category ranging from 100–500 km^2. In comparison to all other states, Arunachal Pradesh has the highest PAR value (449.59) for patches of MDF that are less than 1 km^2.

Open Forest (OPF)

OPF occupied 3,77,960 patches covering a total area of 78,097.49 km^2 (Range: 0.0025 – 10294.93; $\bar{x}$ = 0.20663, SD = 17.01388). Among these patches, 6268 patches are larger than 1km^2 and covering an area of 56284.62 km^2, with a mean area of 8.9797 (SD = 164.746). The maximum PAR value is for patches that are less than 1 km^2, while the lowest PAR value is for the size category ranging from 100–500 km^2. In comparison to all other states, Mizoram has the highest PAR value (453) for patches of open Forest that are less than 1 km^2.

6.2 Habitat suitability under very dense, moderate and open forest fragment categories

Forest fragmentation analysis was coupled with habitat suitability modelling results to generate additional spatial information which depicts state-wise presence of forest fragments (or forest patches) in various forest density categories (open, moderately dense, and very dense) under different habitats suitability classes (high, medium, and low). Tables below provide state wise information on forest fragments based on their size categories: <1 km^2, 1-10 km^2, 10-50 km^2, 50-100 km^2, 100-500 km^2, and >500 km^2. Additionally, the tables include estimates of patch area, mean patch area, and their range across different habitat suitability classes.

Arunachal Pradesh

OPEN FOREST											Range (km^2)	
Habitat Suitability class	**Total no. of fragments**	**< 1**	**1-10**	**10-50**	**50-100**	**100-500**	**>500**	**Patch area (km2)**	**Mean patch area (km2)**	**SD**	**Smallest**	**Largest**
High	218	82	132	4	0	0	0	427.56	1.96	2.51	0.00	17.06
Medium	871	361	488	21	0	1	0	1861.53	2.14	5.38	0.00	130.03
Low	1600	176	1330	84	7	2	1	6820.53	4.26	19.52	0.00	504.06
MODERATELY DENSE FOREST											Range (km^2)	
High	220	59	144	10	4	3	0	1601.15	7.28	31.76	0.00	397.58
Medium	750	251	441	38	5	12	3	6819.47	9.09	52.26	0.00	927.39
Low	1205	192	900	83	13	10	7	16565.78	13.75	135.46	0.00	3736.60
VERY DENSE FOREST											Range (km^2)	
High	231	68	140	18	3	2	0	1426.120	6.174	21.525	0.000	240.622
Medium	955	254	636	54	5	6	0	4582.442	4.798	17.295	0.000	273.030
Low	1572	276	1162	118	7	8	1	8728.998	5.553	30.907	0.000	1024.388

Assam

OPEN FOREST											Range (km^2)	
Habitat Suitability class	**Total no. of fragments**	**< 1**	**1-10**	**10-50**	**50-100**	**100-500**	**>500**	**Patch area (km2)**	**Mean patch area (km2)**	**SD**	**Smallest**	**Largest**
High	151	53	90	8	0	0	0	446.57	2.96	4.72	0.00	36.70
Medium	541	164	347	24	4	2	0	2152.59	3.98	11.92	0.00	175.87
Low	1105	172	840	76	11	5	1	7783.47	7.04	65.89	0.00	2119.96
MODERATELY DENSE FOREST											Range (km^2)	
High	143	27	96	16	0	4	0	1252.07	8.76	26.06	0.00	174.31
Medium	275	94	150	23	5	2	1	2987.44	10.86	74.34	0.00	1180.93
Low	597	105	442	38	6	5	1	3791.82	6.35	35.38	0.00	798.10
VERY DENSE FOREST											Range (km^2)	
High	96	14	58	16	6	2	0	1453.06	15.14	36.58	0.01	230.54

Medium	135	38	84	12	1	0	0	639.75	4.74	10.17	0.01	75.71
Low	132	54	75	3	0	0	0	271.21	2.05	3.35	0.01	27.91

Manipur

OPEN FOREST											**Range (km^2)**	
Habitat Suitability class	**Total no. of fragments**	**< 1**	**1-10**	**10-50**	**50-100**	**100-500**	**>500**	**Patch area (km2)**	**Mean patch area (km2)**	**SD**	**Smallest**	**Largest**
High	4	2	1	0	1	0	0	66.33	16.58	31.41	0.06	63.68
Medium	172	71	95	5	0	0	1	1233.55	7.17	66.16	0.00	868.40
Low	345	55	258	27	4	0	1	7457.55	21.62	324.47	0.00	6029.23
MODERATELY DENSE FOREST											**Range (km^2)**	
High	7	4	3	0	0	0	0	7.05	1.01	1.05	0.11	2.48
Medium	306	106	176	21	2	1	0	1337.45	4.37	12.25	0.00	164.10
Low	649	81	507	49	7	5	0	3522.04	5.43	16.69	0.00	271.32
VERY DENSE FOREST											**Range (km^2)**	
High	1	0	0	1	0	0	0	13.82	13.82	0.00	13.82	13.82
Medium	55	7	34	13	0	1	0	542.36	9.86	19.48	0.01	130.90
Low	58	17	36	4	1	0	0	277.20	4.78	10.95	0.00	81.74

Meghalaya

OPEN FOREST											**Range (km^2)**	
Habitat Suitability class	**Total no. of fragments**	**< 1**	**1-10**	**10 - 50**	**50-100**	**100 - 500**	**>500**	**Patch area (km2)**	**Mean patch area (km2)**	**SD**	**Smallest**	**Largest**
High	65	32	29	4	0	0	0	185.04	2.85	5.56	0.00	33.26
Medium	221	79	124	18	0	0	0	762.88	3.45	5.64	0.00	38.64
Low	491	65	367	50	4	4	1	4332.08	8.82	41.86	0.00	548.63
MODERATELY DENSE FOREST											**Range (km^2)**	
High	31	11	12	6	1	1	0	656.80	21.19	74.00	0.01	410.30
Medium	121	46	61	7	2	5	0	1754.38	14.50		0.00	433.60
Low	558	30	463	53	6	4	2	5197.97	9.32	58.25	0.02	1189.91
VERY DENSE FOREST											**Range (km^2)**	

High	24	5	17	2	0	0	0	100.893	4.204	7.445	0.084	33.113
Medium	41	17	20	4	0	0	0	133.470	3.255	5.158	0.017	20.772
Low	26	9	14	3	0	0	0	101.927	3.920	4.734	0.009	18.495

Mizoram

OPEN FOREST											**Range (km²)**	
Habitat Suitability class	**Total no. of fragments**	**< 1**	**1-10**	**10-50**	**50-100**	**100-500**	**>500**	**Patch area (km2)**	**Mean patch area (km2)**	**SD**	**Smallest**	**Largest**
High	41	8	31	1	0	0	1	907.67	22.14	124.46	0.00	799.27
Medium	133	48	79	3	1	1	1	4096.70	30.80	315.49	0.00	3639.59
Low	108	32	66	6	2	1	1	6277.00	58.12	551.39	0.12	5732.90
MOD DENSE											**Range (km²)**	
High	117	38	61	15	2	1	0	811.98	6.94	18.99	0.02	176.00
Medium	505	132	337	32	2	2	0	2201.80	4.36	11.13	0.00	142.78
Low	470	161	292	17	0	0	0	1200.56	2.55	4.16	0.00	40.35
VERY DENSE											**Range (km²)**	
High	13	1	9	3	0	0	0	79.82	6.14	6.22	0.01	22.61
Medium	14	3	11	0	0	0	0	40.80	2.91	2.30	0.28	7.33
Low	9	7	2	0	0	0	0	7.56	0.84	0.63	0.02	2.03

Nagaland

OPEN FOREST											**Range (km²)**	
Habitat Suitability class	**Total no. of fragments**	**< 1**	**1-10**	**10-50**	**50-100**	**100-500**	**>500**	**Patch area (km2)**	**Mean patch area (km2)**	**SD**	**Smallest**	**Largest**
High	27	13	13	0	1	0	0	97.75	3.62	12.10	0.00	63.84
Medium	160	79	76	4	0	0	1	910.36	5.69	46.98	0.00	594.65
Low	395	44	318	24	4	4	1	4417.77	11.18	102.17	0.00	1970.46
MODERATELY DENSE FOREST											**Range (km²)**	
High	39	16	21	1	0	1	0	230.81	5.92	23.77	0.02	148.94
Medium	227	81	133	10	2	1	0	859.20	3.79	12.70	0.00	164.37
Low	506	65	399	39	2	1	0	2137.36	4.22	9.49	0.00	162.51
VERY DENSE FOREST											**Range (km²)**	
High	15	1	10	3	1	0	0	179.945	11.996	17.988	0.969	62.856
Medium	61	11	35	13	2	0	0	520.974	8.541	14.052	0.001	81.873
Low	77	21	48	6	2	0	0	438.037	5.689	11.296	0.005	56.327

Sikkim

OPEN FOREST											Range (km^2)	
Habitat Suitability class	**Total no. of fragments**	**< 1**	**1-10**	**10-50**	**50-100**	**100-500**	**>500**	**Patch area (km2)**	**Mean patch area (km2)**	**SD**	**Smallest**	**Largest**
High	89	29	59	1	0	0	0	175.74	1.97	2.01	0.00	11.70
Medium	68	24	44	0	0	0	0	102.41	1.51	1.37	0.01	7.30
Low	36	18	18	0	0	0	0	39.78	1.11	1.36	0.01	7.98
MODERATELY DENSE FOREST											**Range (km^2)**	
High	81	15	45	10	2	2	0	1051.78	12.98	41.40	0.02	321.58
Medium	74	17	51	5	1	0	0	346.27	4.68	10.96	0.01	87.49
Low	41	25	16	0	0	0	0	49.95	1.22	1.38	0.01	5.95
VERY DENSE FOREST											**Range (km^2)**	
High	78	20	38	17	3	0	0	704.750	9.035	15.751	0.003	83.234
Medium	65	19	41	5	0	0	0	202.149	3.110	5.774	0.004	38.686

Tripura

OPEN FOREST											Range (km^2)	
Habitat Suitability class	**Total no. of fragments**	**< 1**	**1-10**	**10-50**	**50-100**	**100-500**	**>500**	**Patch area (km2)**	**Mean patch area (km2)**	**SD**	**Smallest**	**Largest**
High	15	7	7	1	0	0	0	29.85	1.99	2.87	0.06	11.69
Medium	57	32	22	3	0	0	0	114.00	2.00	3.61	0.00	21.42
Low	189	26	157	6	0	0	0	519.14	2.75	3.61	0.02	28.33
MODERATELY DENSE FOREST											**Range (km^2)**	
High	16	5	10	1	0	0	0	55.20	3.45	5.84	0.05	23.15
Medium	84	22	56	5	1	0	0	813.96	9.69	62.45	0.08	574.12
Low	119	34	78	4	1	1	1	3706.85	31.15	299.87	0.01	327.37
VERY DENSE FOREST											**Range (km^2)**	
High	8	1	6	1	0	0	0	35.28	4.41	4.85	0.43	14.98
Medium	53	6	43	4	0	0	0	200.87	3.79	5.89	0.07	35.27
Low	100	15	81	4	0	0	0	297.00	2.97	3.50	0.02	22.61

West Bengal

OPEN FOREST											Range (km²)	
Habitat Suitability class	**Total no. of fragments**	**< 1**	**1-10**	**10 - 50**	**50-100**	**100 - 500**	**>500**	**Patch area (km2)**	**Mean patch area (km2)**	**SD**	**Smallest**	**Largest**
High	105	7	50	7	2	1	0	488.76	4.65	13.28	0.00	101.88
Medium	134	40	74	19	1	0	0	731.08	5.46	9.80	0.00	58.71
Low	157	64	78	13	1	1	0	787.46	5.02	13.85	0.00	121.97
MODERATELY DENSE FOREST											**Range (km²)**	
High	97	24	68	4	1	0	0	376.94	3.89	7.53	0.00	59.00
Medium	96	26	65	5	0	0	0	291.13	3.03	5.02	0.00	40.30
Low	39	26	13	0	0	0	0	46.50	1.19	1.56	0.00	5.63
VERY DENSE FOREST											**Range (km²)**	
High	81	8	54	14	3	2	0	876.114	10.816	22.809	0.123	134.675
Medium	64	23	33	6	2	0	0	367.507	5.742	13.293	0.000	74.137
Low	13	10	3	0	0	0	0	9.413	0.724	0.880	0.001	3.145

6.3 Habitat connectivity analysis using linkage mapper and circuitscape

Habitat connectivity analysis of the clouded leopard was carried out using circuit theory and least cost path approach to achieve the following objectives: a) mapping the least cost corridor and pathways between the core habitats, b) identifying the central core and central linkage areas that play a crucial role in overall connectivity, and c) identifying pinch points or bottleneck areas in the corridor.

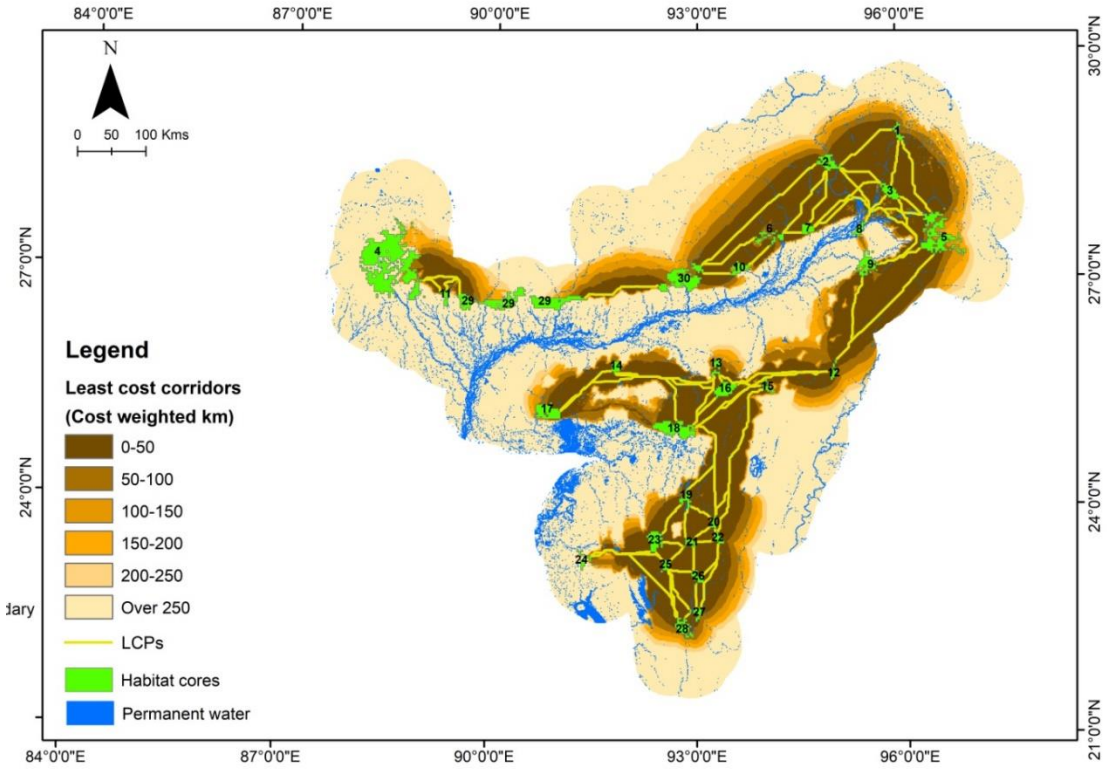
6.3.1 Preparation of resistance surface

The resistance layer was generated using the Gnarly utilities toolbox in ArcGIS. This tool merges all input layers into a single resistance raster. The input files required are an Excel sheet having resistance scores for each category in the respective layers as well as a geo-database file of the variables. Input layers such as LULC, population density, roads, and railways were used. Analytical Hierarchy Process (AHP) was used to obtain the Final weighted resistance surface (Figure 1) which was used as input for Circuitscape and Linkage mapper.

Results:

A total of 30 core habitats (CH) covering 17,235 km^2 of the area were identified which exhibit considerable variation in terms of their respective sizes (range 108- 4,581 km^2; mean 574.5 km^2, SD 870.9 km^2). The LCP analysis predicted 64 potential corridor links (Figure 2), between the core habitats with a total length of 6,097 km (ranging from 3.91 to 248.32 km), with a mean of 95.26 km and SD of 62.6 km. In terms of the LCP, the corridor link between CH 9-12 has the highest current centrality value (127), indicating that it is the most significant link for maintaining connectedness in the entire network whereas, corridor link 24-28 has the lowest centrality (10.7) (Figure 3). In addition, the core centrality analysis identified that CH-12 has the highest centrality (241.92), making it the most essential core habitat for preserving overall connectivity. On the other hand, CH-24 has the lowest centrality value (32.09) among the cores (Figure 3).

We observed pinch points in several adjacent pairs (Figure 4) of core habitats, including 4-11, 11-29, 29-30, 7-8, 7-8, 2-8, 8-5, 3-5, 5-9, 15-16, 15-20, 20-22, 18-19, 18-20, 13-16, 14-16, 13-14, and 23-24. Further analysis conducted across all pairs of core habitats (cumulative/global pinch-points) revealed bottlenecks in connectivity at the landscape level in the corridors between CH 12-15 and CH 15-16. Figure 5 presents the cumulative/global pinch-points mapped at the landscape level.



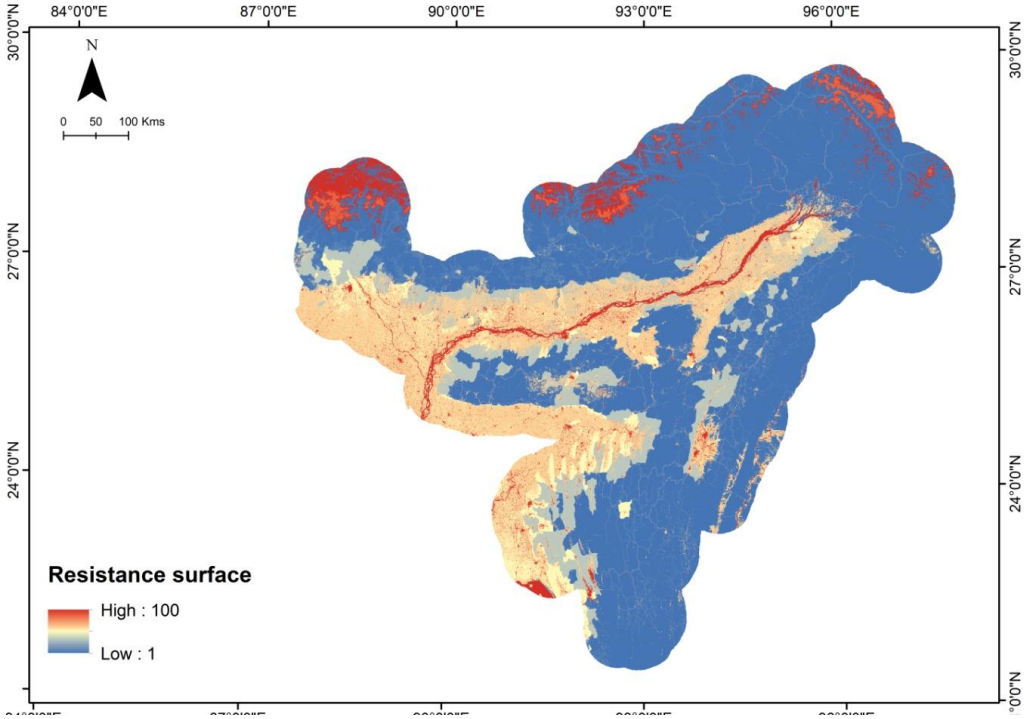


Figure:1 Resistance surface used as input for Circuitscape and Linkage mapper

Figure:2 Least cost corridors and Least Cost Pathways in NE landscape

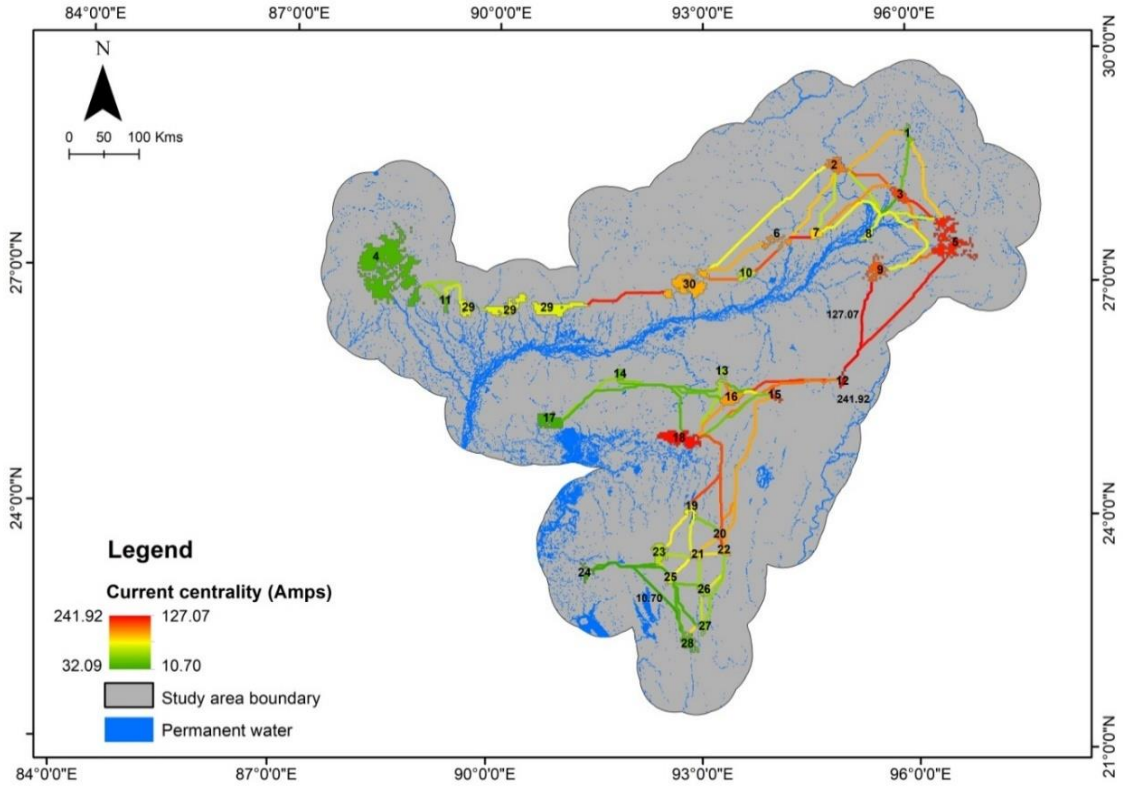


Figure:3 Core current flow centrality and LCP centrality

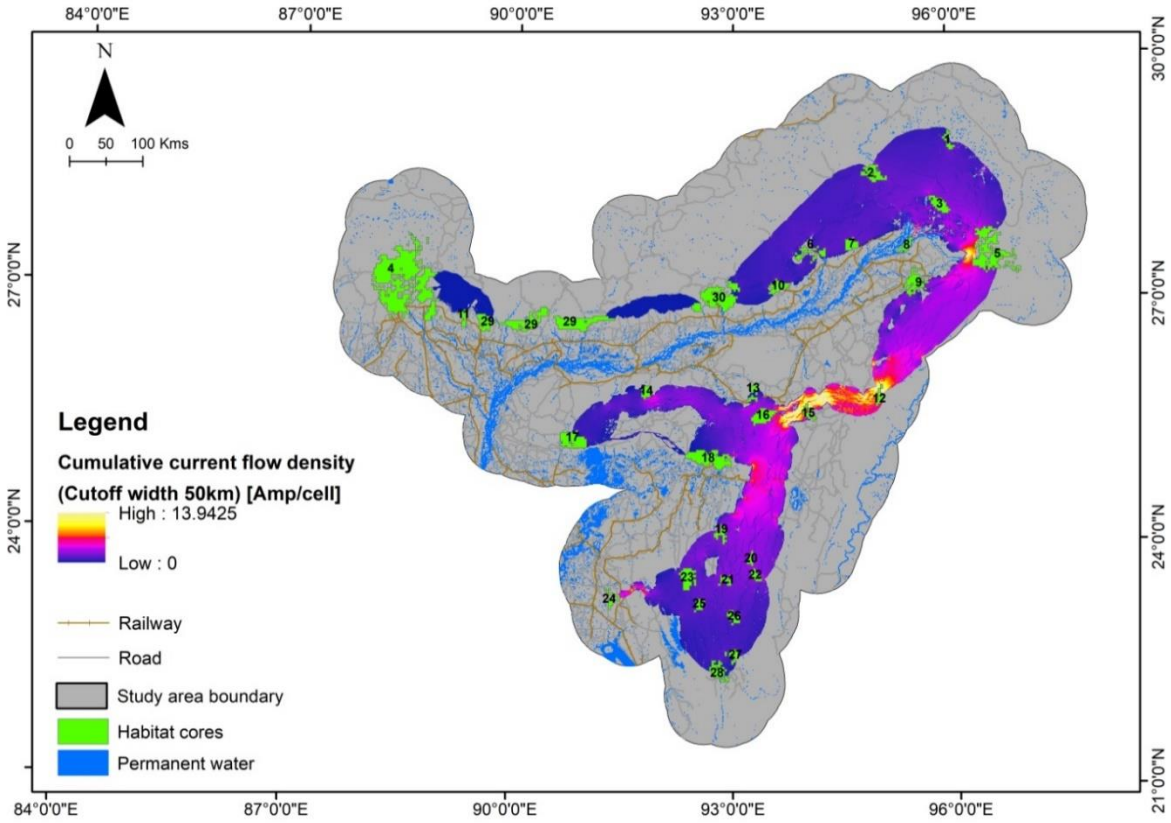


Figure:4 Cumulative pinch points mapped among all pairs of the cores indicating areas of connectivity bottlenecks

5.8 Potential corridors derived from Circuitscape

The circuit model revealed that the core habitats of clouded leopards in Sikkim, West Bengal, Assam, and Arunachal Pradesh in the north seem to be well connected through Bhutan. The populations in Mizoram have good connectivity with Manipur, Meghalaya, and the lower parts of Assam. It is evident that the northern set of core habitats are separated from the southern set of core habitats since the Brahmaputra acts as a major natural barrier which hinders any connectivity. These two sets are connected only in the East after the origin of the Brahmaputra. Thus, the passage through Nagaland and Myanmar are crucial to maintain overall connectivity in the landscape. Figure 6 presents the potential movement corridors connectivity of clouded leopards derived from Circuitscape in NE India.

The core habitat in Tripura appears to have poor connectivity with the rest of the landscape possibly due to urbanization and land cover change over the years. The population of Dibru-Saikhowa NP has very poor connectivity with the rest of the landscape. It is highly likely that the populations here have become isolated ever since the national park became an isolated patch of land forming as a River Island in 1997 when there was a sudden increase in width of the river due to high erosion (Pareta, 2021).

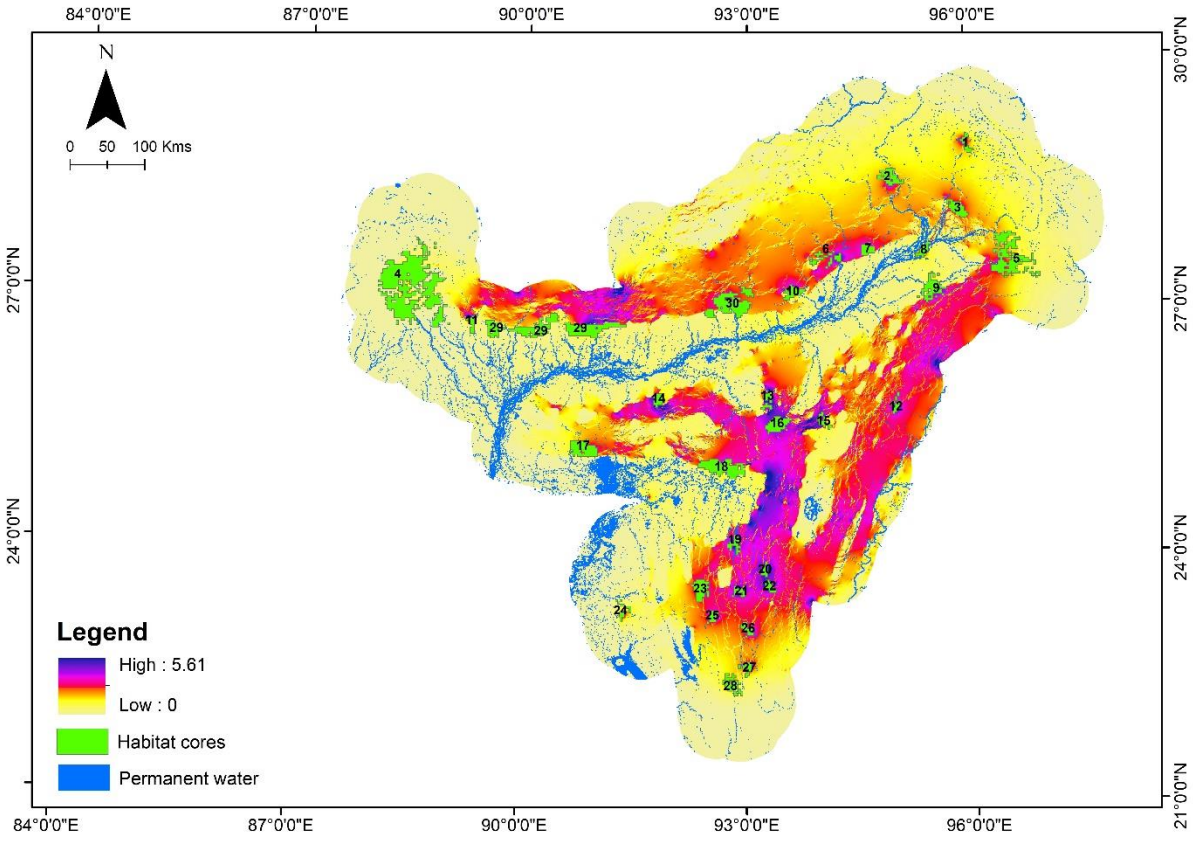


Figure:6 Potential corridors connectivity of clouded leopards, derived from Circuitscape between different in NE India. Low values represent weak connectivity

7. PLAN OF WORK (FOR 2023-24):

I. Focus will be on the accumulation of field data for monitoring of the species (November 2023 onwards)

II. Accumulation and analysis of factors causing threat to the existence of the species viz. Habitat loss, habitat fragmentation, and poaching will be considered.

III. Data compilation, analysis, and report writing (June – September 2024).

8. BUDGET RECEIVED & AMOUNT SPENT:

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower (Salary & Field Assistants, Medical & Insurance)	1,42,97,280.00	**1,80,00,000.00**	27,53,912.00	0.00	**27,53,912.00**	**76,94,808.00**
2	Equipment (Camera Traps, Binoculars, GPS, Camera)	90,00,000.00		74,10,940.00	0.00	**74,10,940.00**	
3	Consumables (Camping Gears, Stationaries)	6,00,000.00		0.00	0.00	**0.00**	
4	Travel (POL, Maintenance, Hiring)	43,92,000.00		1,16,634.00	0.00	**1,16,634.00**	
5	Miscellaneous (Base Camp & Survey)	9,00,000.00		0.00	0.00	**0.00**	
6	Contingency	8,10,720.00		23,706.00	0.00	**23,706.00**	
Total		**3,00,00,000.00**	**1,80,00,000.00**	**1,03,05,192.00**	**0.00**	**1,03,05,192.00**	**76,94,808.00**
						Less : Forest Advance	0.00
						Less : Tour Advance	14,793.00
Balance							**76,80,015.00**

PAN India Assessment and Monitoring of endangered species covered under the Development of Wildlife Habitats Scheme of MoEF&CC
Progress Report, September 2023

1. SPECIES: Arabian Sea Humpback Whale (*Megaptera novaeangliae)*

2. SUPERVISORS: Dr. J.A. Johnson, Dr. Nehru Prabakaran, Dr. K. Sivakumar (Pondicherry University) & Chinmaya Ghanekar

3.BRIEF BACKGROUND:

The Arabian Sea humpback whale (*Megaptera novaeangliae*) is a comparatively infrequent, little-known and genetically isolated population of humpbacked whales that populates the waters of the Arabian Sea ranges from India, Pakistan, Oman, Iran, Iraq, Qatar, UAE, Yemen and Kuwait. This species was severely hunted in the past as a result their population declined drastically. Because of its population declining trend and continuing threats, the International Union for Conservation of Nature (IUCN) considers Arabian Sea humpbacked whale (ASHW) as an endangered species and there are some limited research and conservation efforts enduring in the region to study and protect this population. The Indian government has also designated the ASHW as a protected marine mammal under the Wildlife Protection Act of 1972. Recently, the International Whaling Commission (IWC) has raised concerns about ASHW status and it is one of only four humpback whale populations worldwide still recognized as an endangered in United States under Endangered Species Act. Despite the global positive approaches, there are threats facing the population in India such as entanglement in fishing gear, ship strikes, and pollution. In addition, the augment of anthropogenic activities such as industrialization, coastal development, and untreated sewage disposal are also posing an indirect threat to the ASHW. However, still our understanding on population status of Arabian Sea humpbacked whale residing along the West Coast of India is remain unknown.

4. OBJECTIVES:

- To identify Arabian Sea humpbacked whale hotspots along the West Coast of India based on the fishers' local knowledge.
- To document different Arabian Sea humpbacked whale population residing in West Cost of India using acoustic device.

5. APPROACH /METHODOLOGY:

In order to understand the Arabian Sea humpbacked whale residing in Indian coastal water, a thorough literature survey was carried out based on the previous stranding records, sightings and fishery records. Additionally, interview-based fisher folk surveys were conducted between January to June 2023 in major coastal landing centers from Gujarat to Tamil Nadu along the West coast and Southern East coast of India. To ensure accurate and efficient data collection from the fisher folks (interview-based survey), all survey questions were translated into the local regional languages. Technical field

assistants who were fluent in both the official language and local languages were hired to overcome language barriers. The questionnaire consisted of 26 questions, covering general information, fishing area and activity details, marine mammal sightings and entanglement specifics, focused enquiries on ASHW details, and local threats' impact on ASHW. To facilitate the identification of marine mammals, photo IDs of different mammals were prepared. This ID chart had information on 17 types of dolphins and 7 types of whales, along with their respective behaviours such as resting, socializing, travelling, foraging, diving, breaching, tail slap, and fin slap. To cover a large area of the west coast of India (Fig. 1) and identify areas of high marine mammal activity, a unique grid- based sampling approach (20 X 20km) was adopted, covering 200 km from thesea shore. The ASHW hotspots were identified based on factors such as frequent whale sighting locations and oceanographic conditions as informed by fisherfolks.

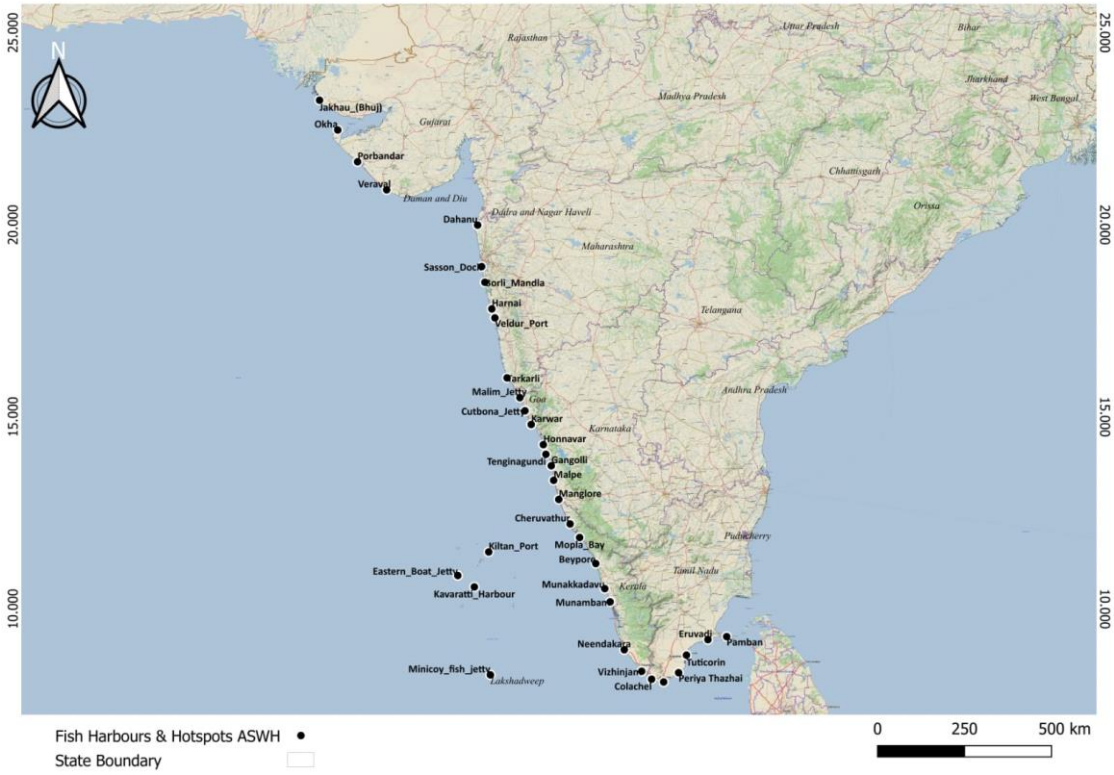


Figure: 1 Map showing the study area and questionary survey locations alongthe West and East Coasts of India.

6. PROGRESS TILL DATE:

Before initiating the field survey, an online consultation meeting was organized on17th January 2023 and marine experts from IUCN marine mammal specialist group, Wildlife Conservation Society, Pondicherry University and mode of conducting population status assessment was finalized. Based on the input from experts and literature survey entire West Coast of India was selected as the study area and the questionary survey was conducted between January 2023 and June 2023. Totally 35 major fishing landing areas were selected in west and east coasts of India and so far, 27 sites were successfully completed at the end of June 2023, which includes 4 locations from Gujarat, 6 from Maharashtra, 2 from Goa, 6 from Karnataka, 7 from Kerala and 2 from Tamil Nadu (Fig.

2). All these sites are major fish landing centers which were targeted due to the high activities of deep-sea fishing vessels. A total of 2407 interviews (Gujarat- 601; Maharashtra- 408; Goa-165; Karnataka- 745; Kerala- 381; Tamil Nadu- 107) were conducted out of 23,114 vessels from 6 states. Site wise details of number of samples and the effort taken respectively are given in Table 1.

Table 1. Site wise information on number of fishing vessels under operation and number of vessels were accessed for questionary survey.

State	Site	Total Samples	Total Sample surveyed
Gujarat	Okha	1400	199
	Jakhau	250	82
	Porbandar	2350	190
	Veraval	3224	130
	Dahanu	207	68
Maharashtra	Sasson Dock	4500	201
	Borli mandala	50	20
	Harnai	550	60
	Veldur port	80	28
	Tarkarli	100	31
Goa	Malim Jetty	180	85
	Cutbona jetty	500	80
Karnataka	Karwar	192	37
	Honnavar	100	38
	Tenginagundi	300	45
	Gangoli	331	33
	Malpe	2350	248
	Mangalore	2823	344
Kerala	Cheruvathur	230	40
	Mopla Bay	60	28
	Beypore	480	83
	Munnakadavu	60	25
	Munambam	400	42
	Neendakara	1512	126
	Vizhinjam	300	37
Tamil Nadu	Colachel	285	55
	Chinnamuttom	300	52
	Total	**23114**	**2407**

Most of the surveyed fishermen were aged between 31-50 with 16-30 years of experience in the Sea. Dolphins were the most commonly sighted marine mammal, followed by porpoises, whale sharks, and dugongs. Over 72.2% of the fishermen reported seeing baleen whales, with ASHW being the most commonly sighted. Dolphin entanglement

was the most reported among all sites, followed by porpoises and dugongs. Some sites also reported whale shark entanglement

Figure:2 Interview based surveys were conducted at Gujarat and Maharashtra

The survey of 2407 fishers along the west coast of India compared ASHW sightings in four seasons: winter, summer, monsoon and post monsoon (Figure 3). In winter, ASHW sightings were high in Gujarat, Maharashtra, and Karnataka. In summer, dominant sightings were observed in Karnataka. During the post-monsoon period, ASHW distribution minimized in Karnataka and Tamil Nadu. In the monsoon season, Tamil Nadu and Kerala were the only states where ASHW distribution was observed, possibly due to modifying boat engines to enable deep fishing during the ban period. Based on our analysis the best possible hotspots along west coast of India are Porbandar in Gujarat, Harnai in Maharashtra, Tenginagundi in Karnataka, Beypore in Kerala and Chinnamuttom in Tamil Nadu (Figure 4). The Arabian Sea Humpback Whales were observed predominantly at the site of specific fishes, including Sardine, Anchovy, Shrimp, and other small fishes.

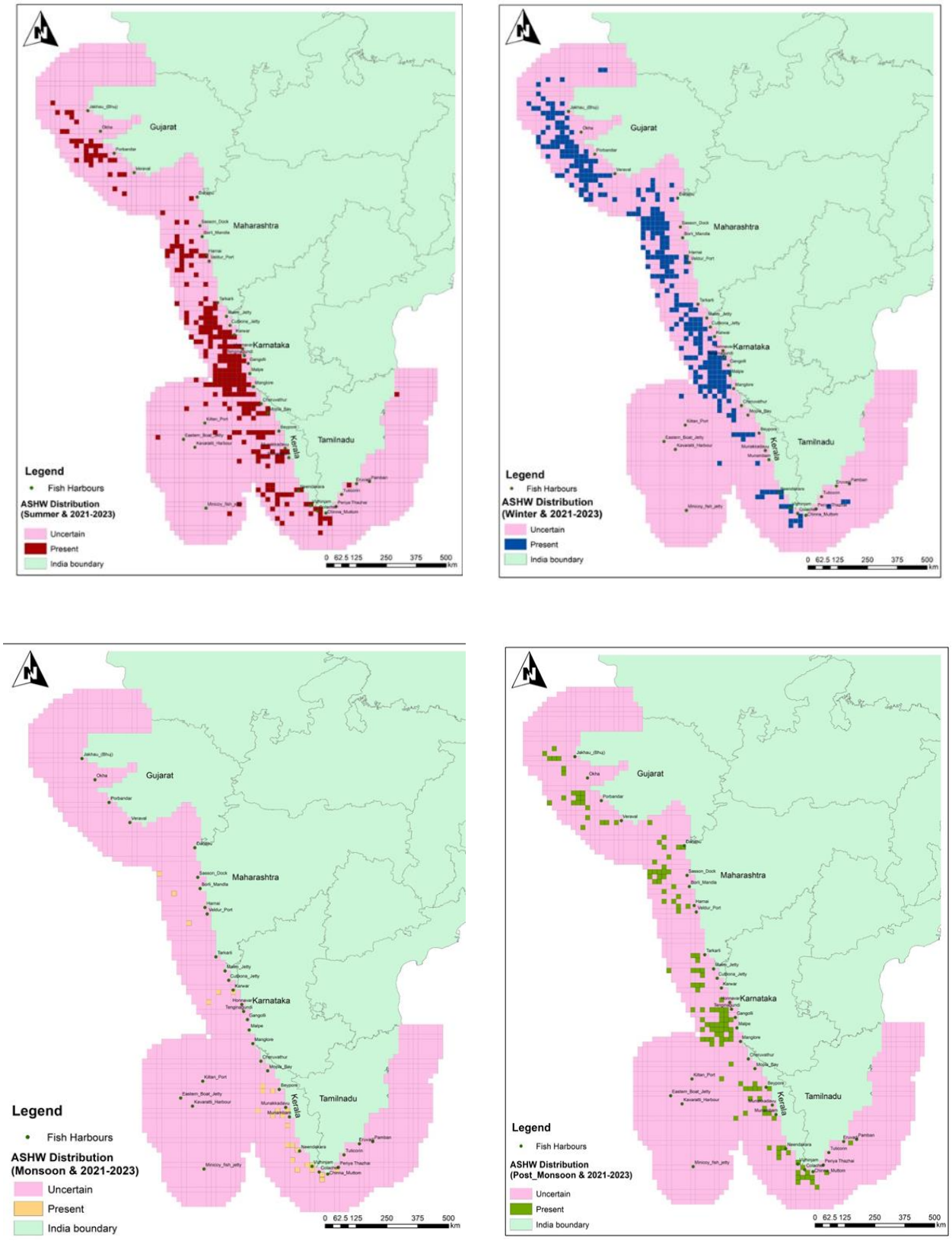


Figure:3 Recent Seasonal sightings of Arabian Sea Humpback Whale along the West coasts of India.

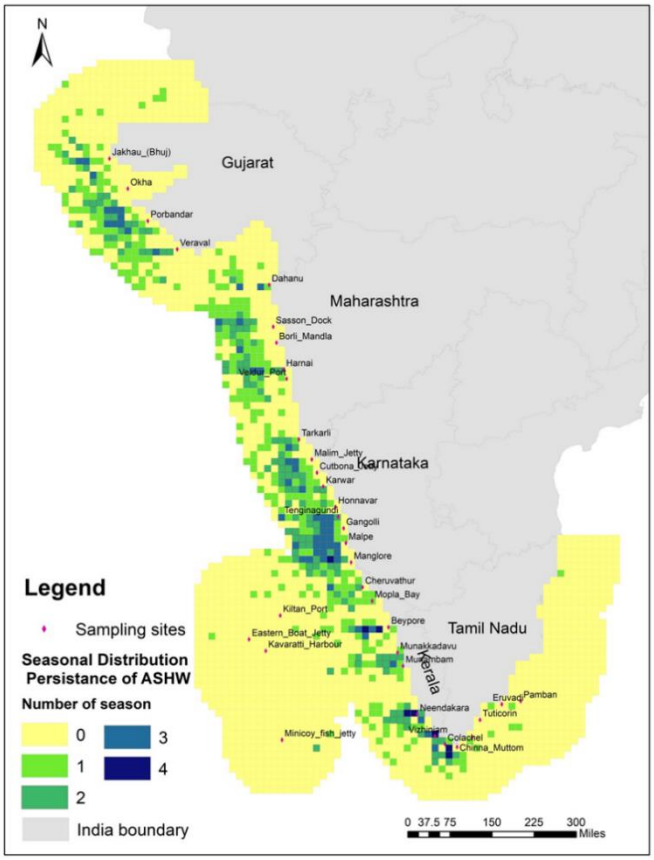


Figure:4 Hotspots of Arabian Sea Humpback Whale (all seasons) along the West coast of India

7. PLAN OF WORK (October 2023 to March 24)**:**

In order to gain a comprehensive understanding of human-ASHW interactions andtarget hotspots of ASHW, the questionary survey will be continued till the Gulf of Mannar, Tamil Nadu where there is previous record of Humpback whales and Lakshadweep Islands along India's West coast. This survey will be completed before the end of 2023. Following this, passive acoustic monitoring devices will be deployed for recording the songs of Arabian Sea Humpback Whales, which can be compared with those of other migrating populations. Selection of locations for hydrophone deployment will be based on factors such as high whale activity hotspots, oceanographic conditions, and potential for noise interference from human activities.

8. BUDGET RECEIVED & AMOUNT SPENT:

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower	4,25,00,000.00	**30,00,000.00**	19,09,950.00	0.00	**19,09,950.00**	**10,90,050.00**
2	Equipments		**1,40,00,000.00**	7,31,081.00	1,16,90,596.00	**1,24,21,677.00**	**15,78,323.00**
3	Consumables		**15,00,000.00**	80,705.00	0.00	**80,705.00**	**14,19,295.00**
4	Contingency		**15,00,000.00**	1,45,221.00	0.00	**1,45,221.00**	**13,54,779.00**
5	Travel		**55,00,000.00**	5,01,997.00	0.00	**5,01,997.00**	**49,98,003.00**
Total		**4,25,00,000.00**	**2,55,00,000.00**	**33,68,954.00**	**1,16,90,596.00**	**1,50,59,550.00**	**1,04,40,450.00**
				Less : Forest Advance			1,19,800.00
				Less : Tour Advance			1,60,000.00
Balance							**1,01,60,650.00**

PAN India Assessment and Monitoring of endangered species covered under the Integrated Development of Wildlife Habitats Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Red Panda *(Ailurus fulgens)*

2. SUPERVISORS: Dr. G.V. Gopi and Dr. Bilal Habib

3. BRIEF BACKGROUND:

The Pan India Assessment and Monitoring of Endangered Species is a program implemented under the Integrated Development of Wildlife Habitats (IDWH) scheme, which is initiated by the Ministry of Environment, Forests and Climate Change (MoEF&CC) of the Government of India. The program aims to assess the population status, distribution, and threats faced by endangered species across different regions of India. Under its Recovery scheme, 22 endangered species have been identified across the nation requiring protection of their critical habitats. Out of 22 species, Red Panda is one of the concerned endangered species that needs attention in this aspect due to increasing threats such as poaching, habitat loss, and human-wildlife conflicts. As a part of project, WII has taken project to monitor the status of the Red Panda in India and develop long-term monitoring protocol for populations and habitat assessment.

4. OBJECTIVES:

- To assess the distribution and abundance of Red Panda in India.
- To develop a monitoring protocol for Red Panda survey.
- To assess and predict the habitat and distribution of Red Panda.

5. APPROACH /METHODOLOGY:

The study includes collection of both primary and secondary data. The primary data collection includes household surveys/interviews, focus group discussions, interviews of key informants, meetings with all other stakeholders. Secondary data were collected through various government departments, scientific papers, experts and eye witnesses that will be helpful in validating the field findings. However, the information on presence or non-detection of specific wildlife is essential to develop a conservation program in a particular area or landscape. This information

helps to identify potential habitat, occupancy, quality of habitat, existing and potential threats, and appropriate conservation interventions.

6. PROGRESS TILL DATE:

Recruitment of researchers and designing of sampling protocol for the study- divided the potential red panda habitat areas into the grid of 2x2 km. The field work started in three different field sites, i.e., Arunachal Pradesh, Sikkim and West Bengal (North).

Arunachal Pradesh:

Anjaw district:

Key informant surveys (n=21) in 8 villages around the district is so far conducted. During the survey the team recorded six Red Panda signs and two scat samples were collected. The team deployed 15 camera traps around the potential Red Panda habitat within the Anjaw district. We have got first photographic capture of Red Panda (Camera trap) from this area.

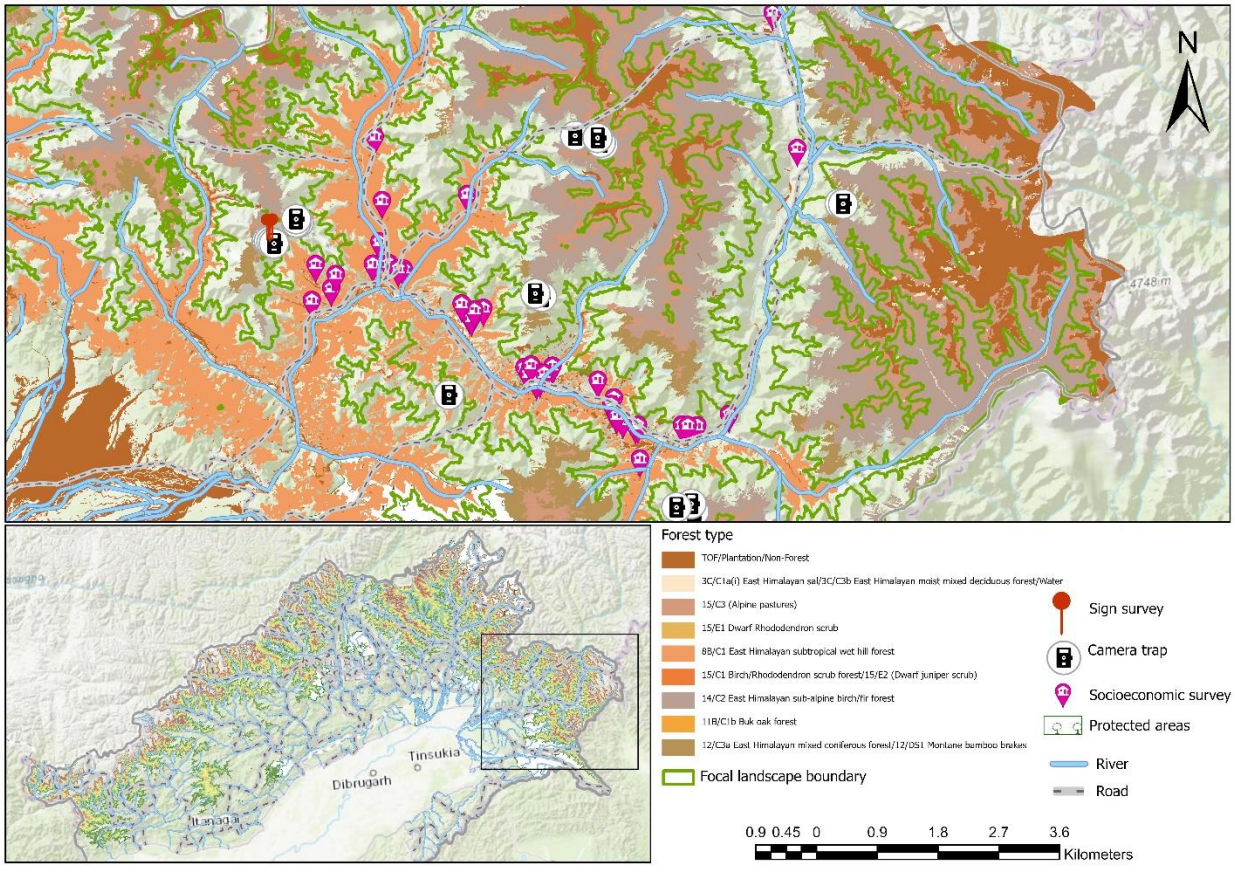
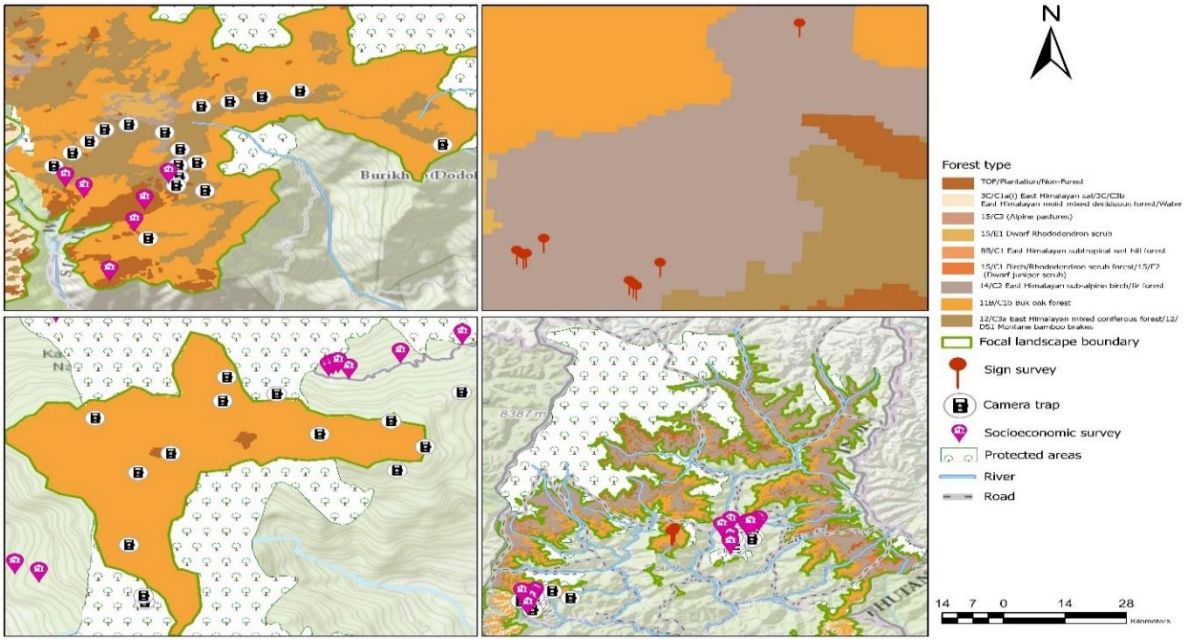


Figure:1 Map showing locations of camera traps and villages surveyed, scat samples in Anjaw district of Arunachal Pradesh

Image:1 Camera trap image showing First ever photographic record of Red Panda in Anjaw district of Arunachal Pradesh

Sikkim:

The field work in Sikkim started in the month of March. The field work was initiated with the prior reconnaissance survey of the study area, interactions with the concerned stakeholders and local communities to identify the potential Red Panda habitat. Subsequently, the total (46) cameras traps (CT) around the potential area were deployed in three (03) protected areas namely- Fambonglho WLS – 16 CT; Maenam WLS- 12 CT; Barsey Rhododendron Sanctuary- 18 CT, with the help of the forest department and the local communities. However, during the survey, 10 indirect signs in the form of scats and feeding sign of red panda were observed, out of which three scat samples were collected from Maenam Wildlife Sanctuary. Moreover, the vegetation data were collected from camera traps deployed areas and surveyed (n=160) respondents in (14) villages adjacent to the study area pre monsoon.



West Bengal (North):

Figure:2 Map showing locations of camera traps and surveyed villages, scat samples in surveyed area of Fambonglho WLS, Maenam WLS and Barsey Rhododendron Sanctuary of Sikkim

The field work in North Bengal (Darjeeling district) commenced from March till July, 2023, with a reconnaissance survey of a week in the identified potential habitat of Red Panda through interaction with local people, stakeholders and forest officials. Subsequently, a total of 38 camera traps have been deployed in three protected areas namely, Senchal Wildlife sanctuary (04 camera traps), Jorepokhari Salamander Sanctuary (02 CT) and Singalila National Park (South Range) (13 CT) and 19 camera traps deployed in different ranges of reserve forests with the help of field assistants, forest staff and local people, which captured a variety of faunal species, including Common leopard (including melanistic individuals), Asiatic black bear, Himalayan serow, Barking deer, Yellow throated marten, Wild pig, Indian hare, Flying squirrel sps., Mongoose and various avian species. A sum of 17 evidences have been recorded for red Panda from Sign survey from the South range of Singalila National Park (Gairibas beat) which comprise of 15 scat samples, out of which 10 were collected using all precautionary measures and 02 direct sightings of Red panda were recorded. This all work was done with continuation of the socioeconomic survey in 42 villages which involved interacting with people in those areas, talking to key informants, livestock holders and regular forest visitors which yielded 650 respondents. The vegetation structure data were also collected during trail surveys in the area for assessing the habitat of the species.

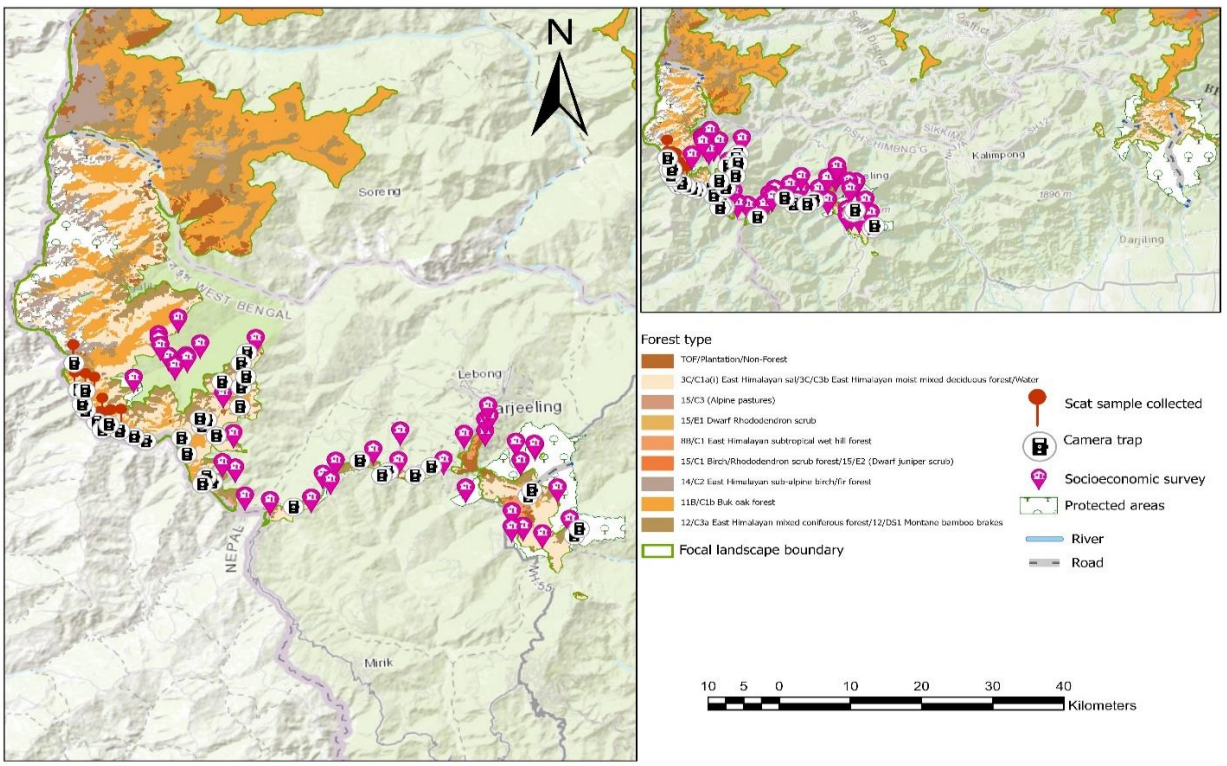


Figure:3 Map showing locations of camera traps and surveyed villages, scat samples in surveyed area of Senchal WLS, Jorepokhari Salamander Sanctuary, Singalila NP and Reserve forests of Darjeeling district of North Bengal

Image:2 Image showing direct sighting of Red Panda recorded in Singalila NP during survey

Potential Habitat Mapping for Red Panda:

Our approach to determining the potential habitat for Red pandas in India includes a vast area across the states of approximately 27633 km^2. Amongst these, 8737.05 km^2 area in Arunachal, 2839.86 km^2 area in Sikkim, and 268.73 km^2 area in North Bengal come under protected area boundaries. Altogether, we were looking at 15789 km^2 of areas that are not protected across the study landscape. The multi criteria analysis identified potential habitats for Red Pandas within the study range. The results showed 12215 km^2 area as the most suitable habitat for the species and 12422 km^2 area as least suitable. If we talk about the results state-wise, it showed 10,605 km^2 suitable area for Arunachal followed by 1447 km^2 area in Sikkim and 163 km^2 area in North Bengal.

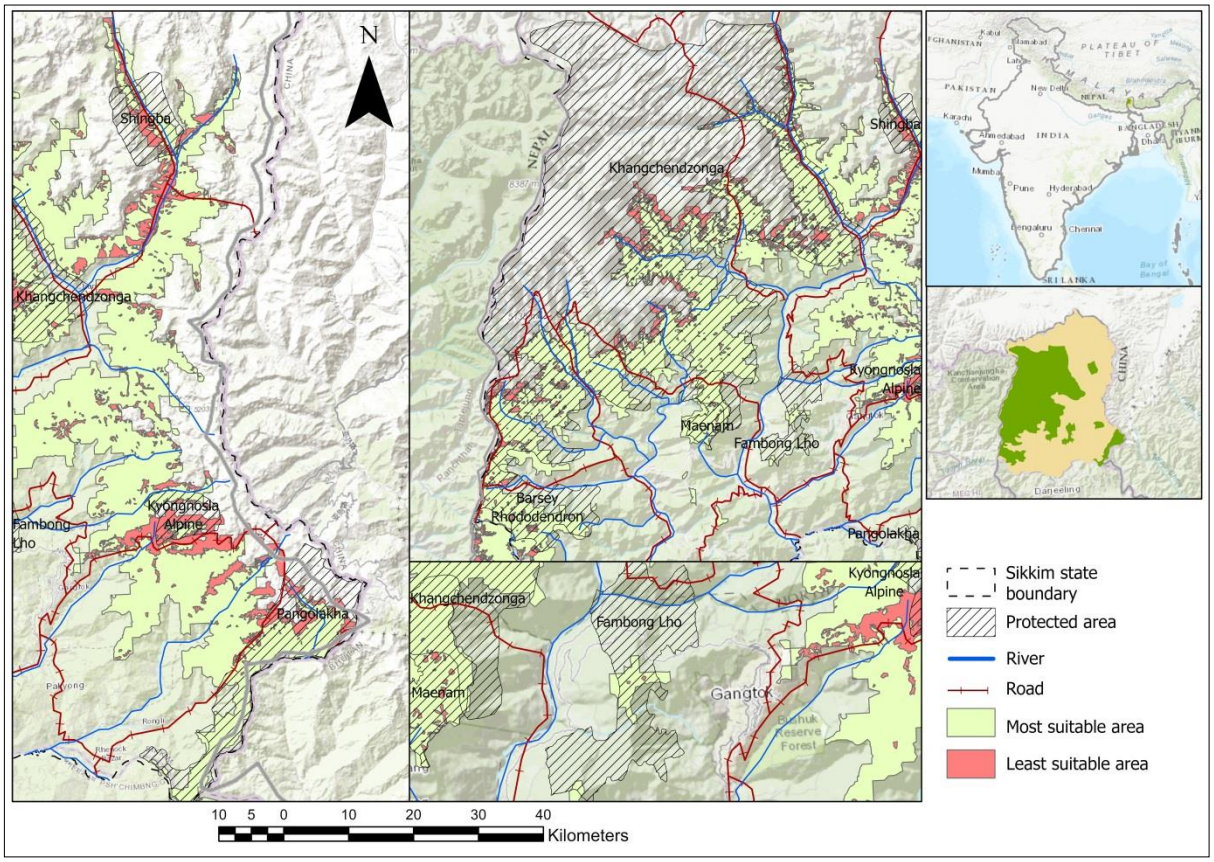


Figure:4 Map showing most and least suitable habitats for Red Pandas in Sikkim

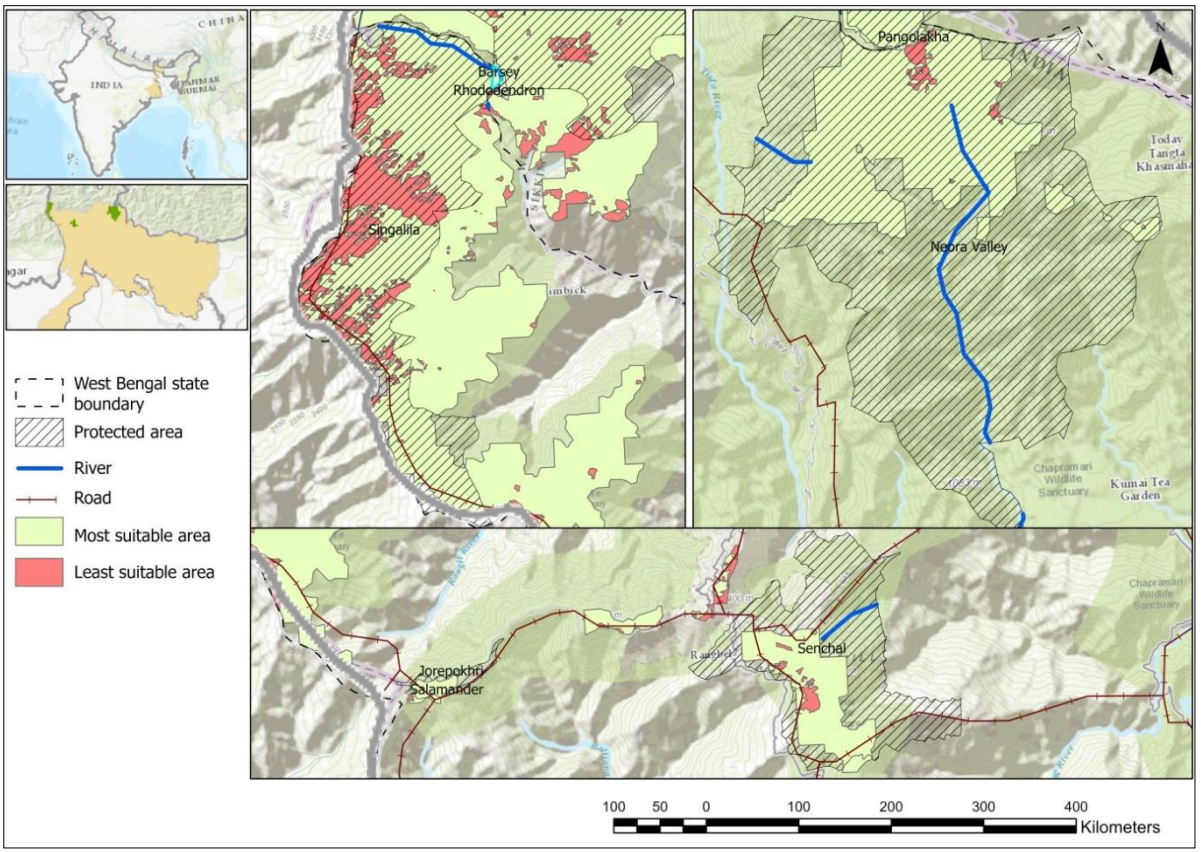


Figure:5 Map showing most and least suitable habitats for Red Pandas in West Bengal

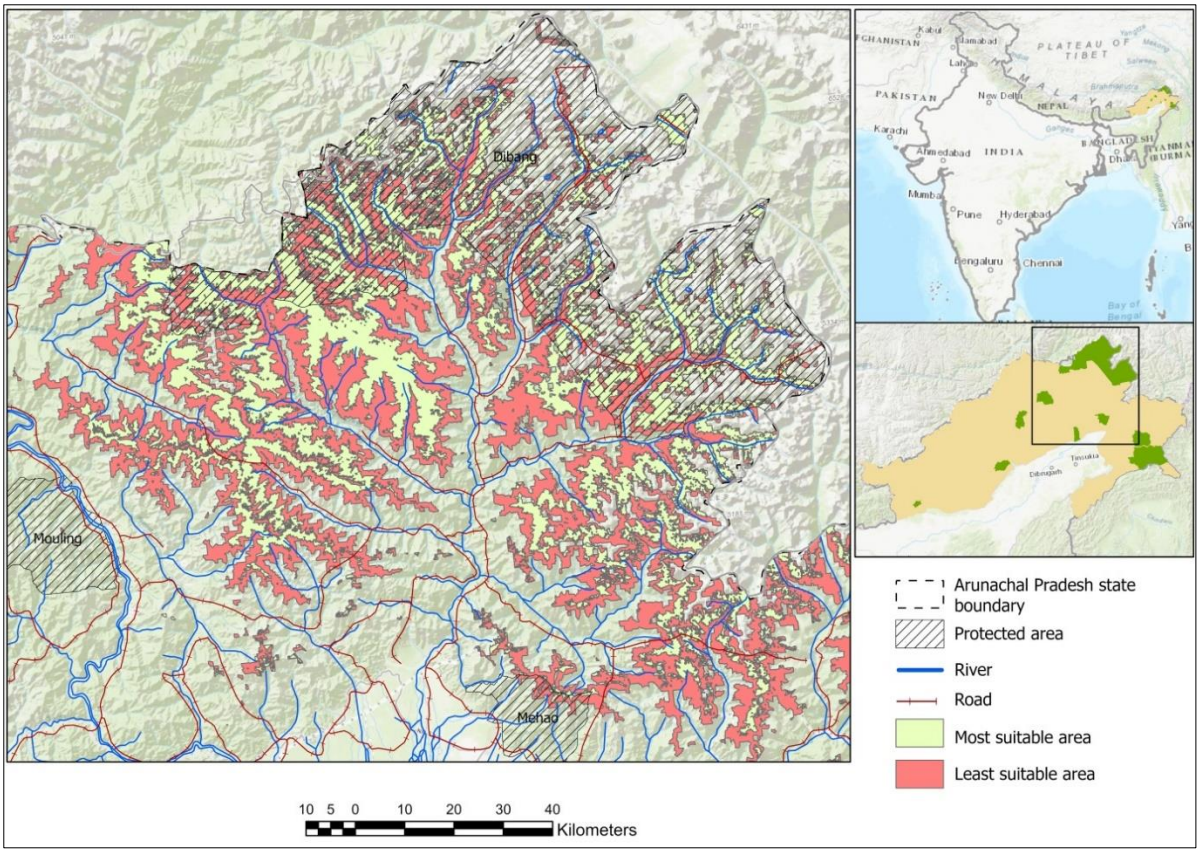


Figure:6 Map showing most and least suitable habitats for Red Pandas in Northern parts of Arunachal Pradesh

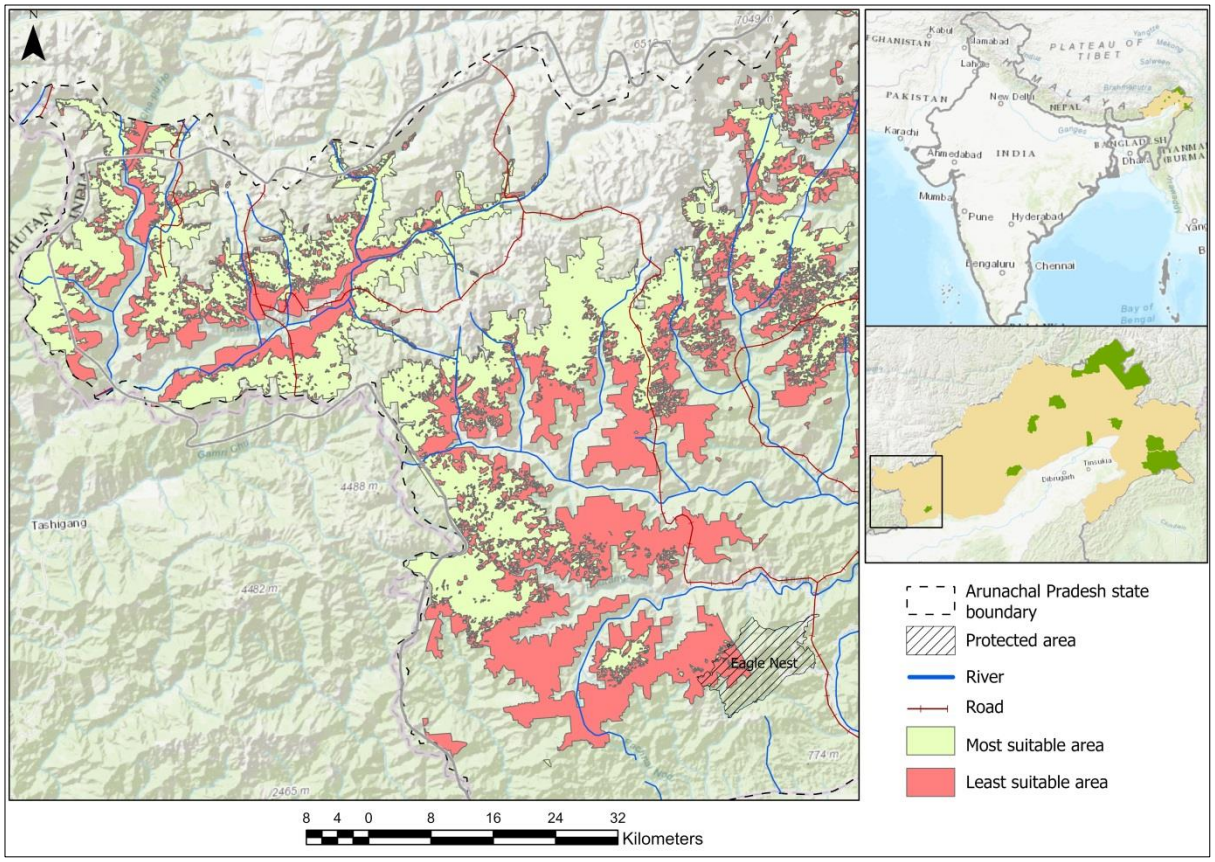


Figure:7 Map showing most and least suitable habitats for Red Pandas in Western parts of Arunachal Pradesh

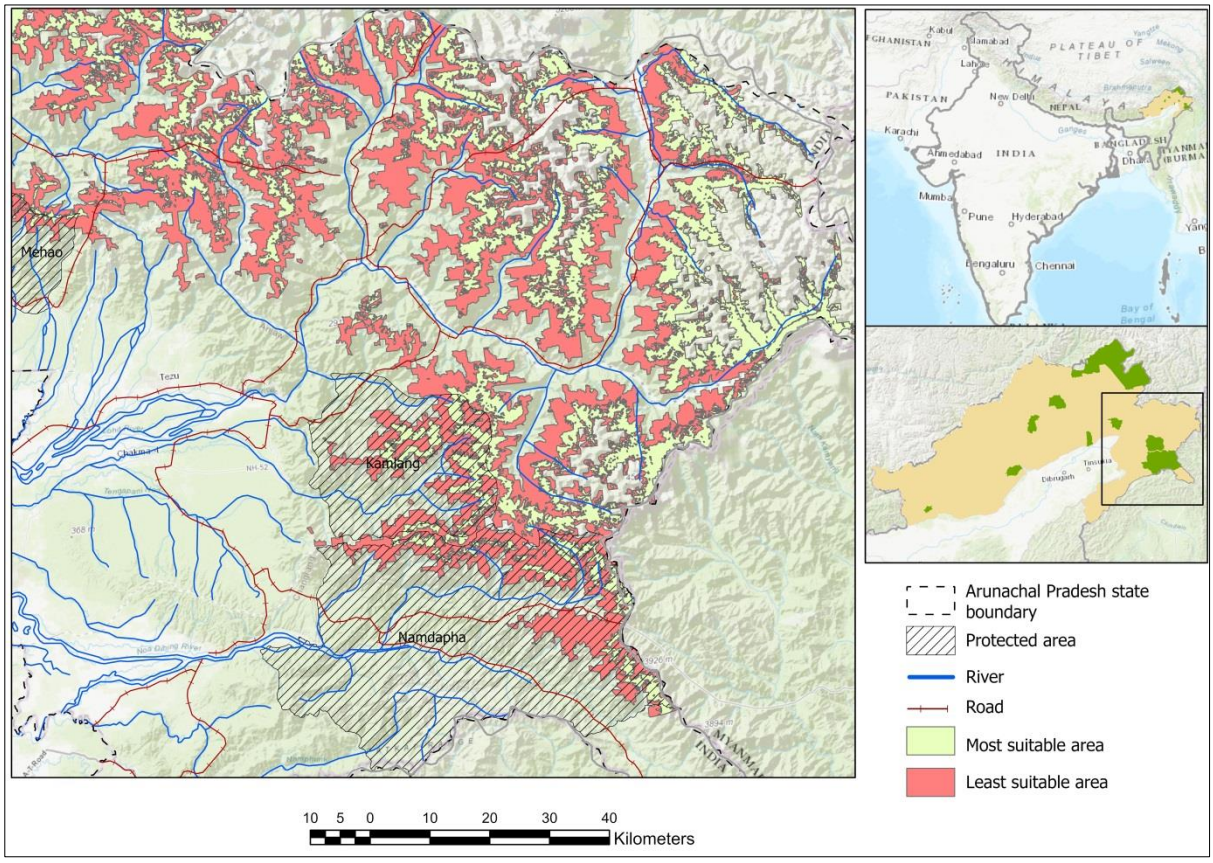


Figure:8 Map showing most and least suitable habitats for Red Pandas in North-eastern parts of Arunachal Pradesh

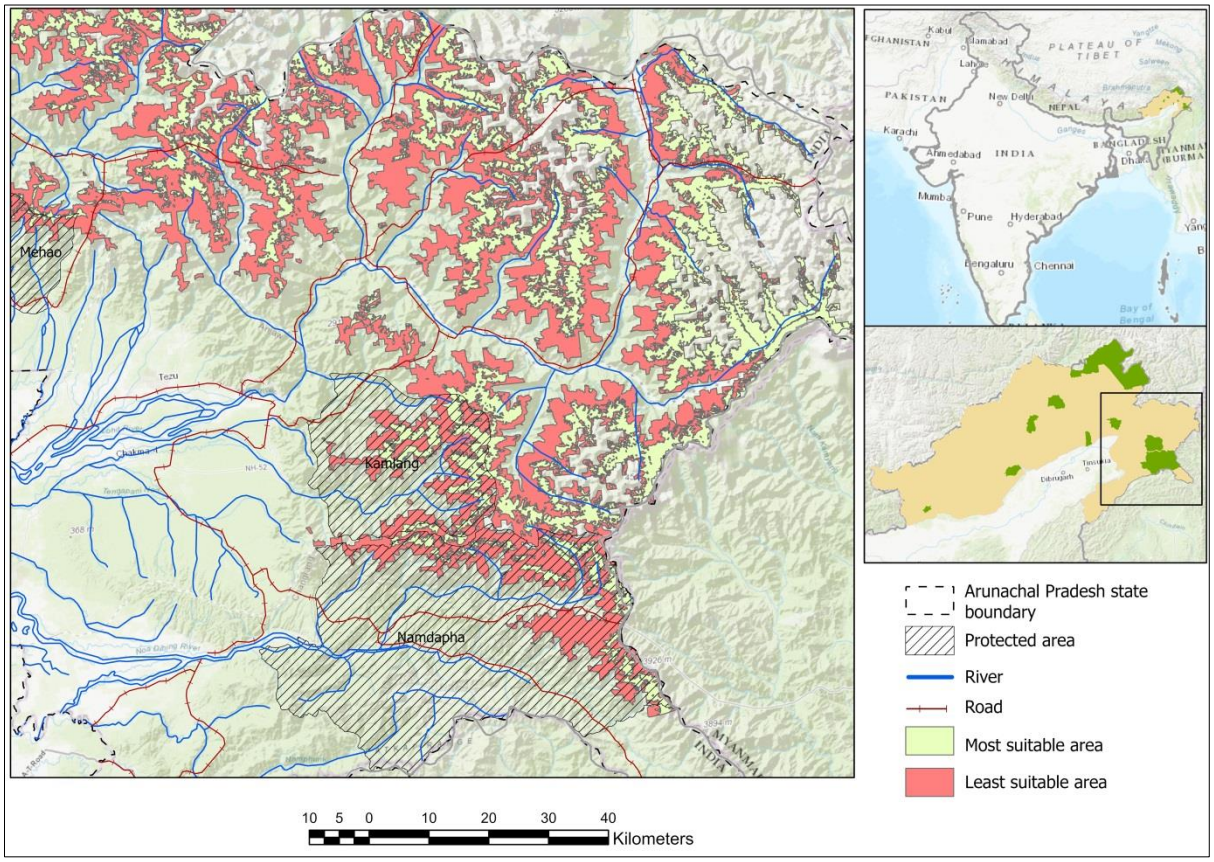


Figure:9 Map showing most and least suitable habitats for Red Pandas in North-eastern parts of Arunachal Pradesh

Habitat quality Assessment: To quantify the habitat quality, patch-level analysis was conducted using forest cover data. The data was obtained from Forest Survey of India for the three respective states. For the quantification analysis we used FRAGSTAT software, which is popular for quantifying landscape structure and its large-scale changes. We analyzed the data for three states with no sampling method and a moving window for generating the desired maps. The outputs were analyzed in Excel and ArcGIS pro for interpretation.

In our examination, we observed that among the three states, Arunachal Pradesh boasts the highest number of patches within forested areas, reflecting its extensive landscape coverage. However, a noteworthy observation was the relatively lower number of patches in the category of very dense forest across all states. Moreover, patch density was observed to be higher in moderately dense forest areas compared to very dense forest areas in all three states. Interestingly, Sikkim and Arunachal Pradesh exhibited similar patch density ratios, whereas West Bengal had the lowest. Furthermore, our analysis revealed high fragmentation levels in the very dense forest category in Arunachal Pradesh, followed by moderately dense forest in West Bengal and Sikkim. Notably, the AI index highlighted that very dense forest areas in West Bengal had the highest number of edges, with Sikkim and Arunachal Pradesh following in that order. Conversely, an inverse trend was observed in the moderately dense forest category, with Arunachal Pradesh

exhibiting the highest edge density, followed by Sikkim and West Bengal. These findings underscore the considerable variation in patch characteristics within very dense and moderately dense forest areas across the three states.

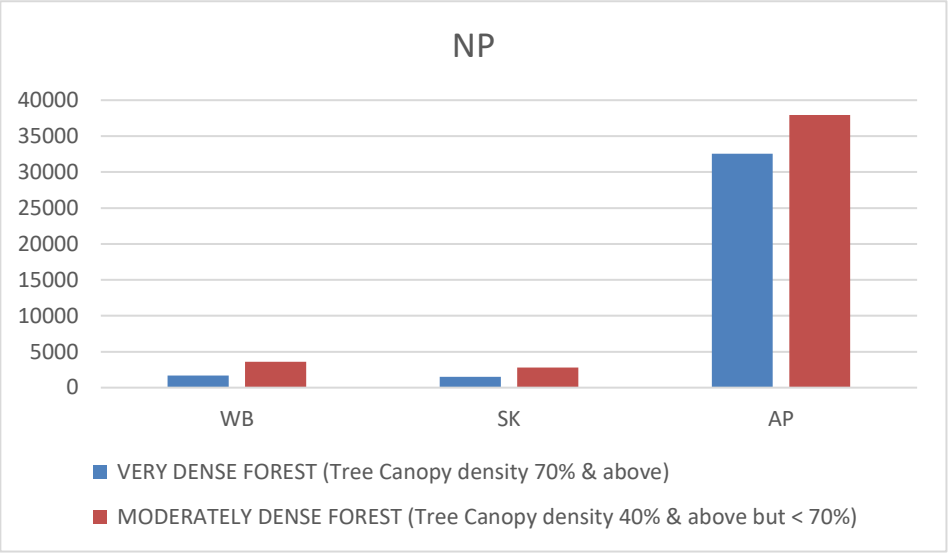


Figure:10 Frag stat results for number of patches in three states

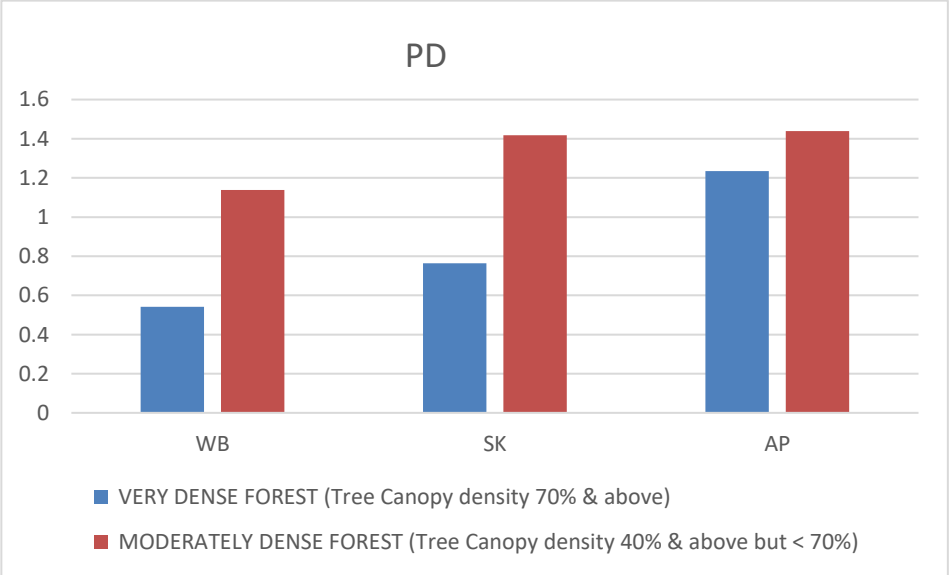


Figure: 11 Frag stat results for patch density in three states

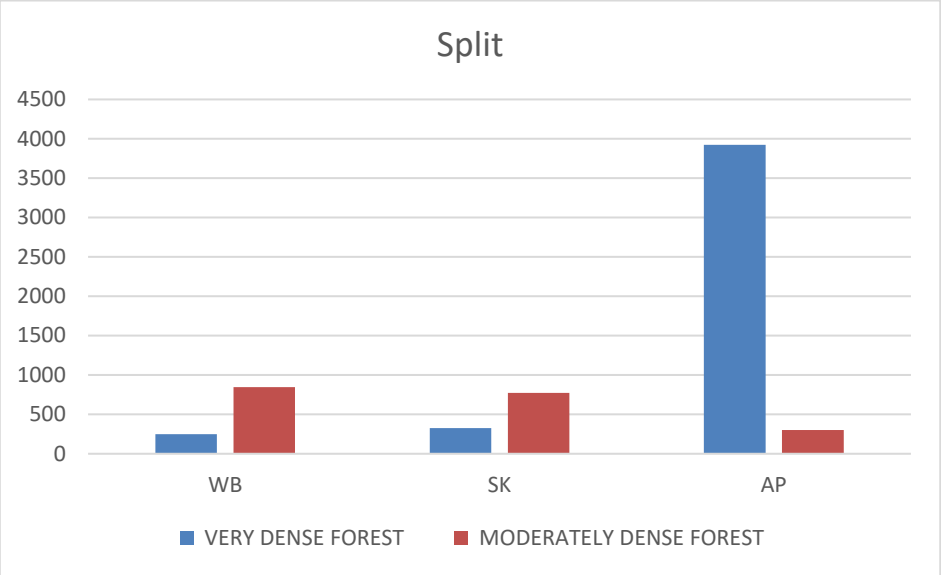


Figure: 12 Frag stat results fragmentation ratio in three states

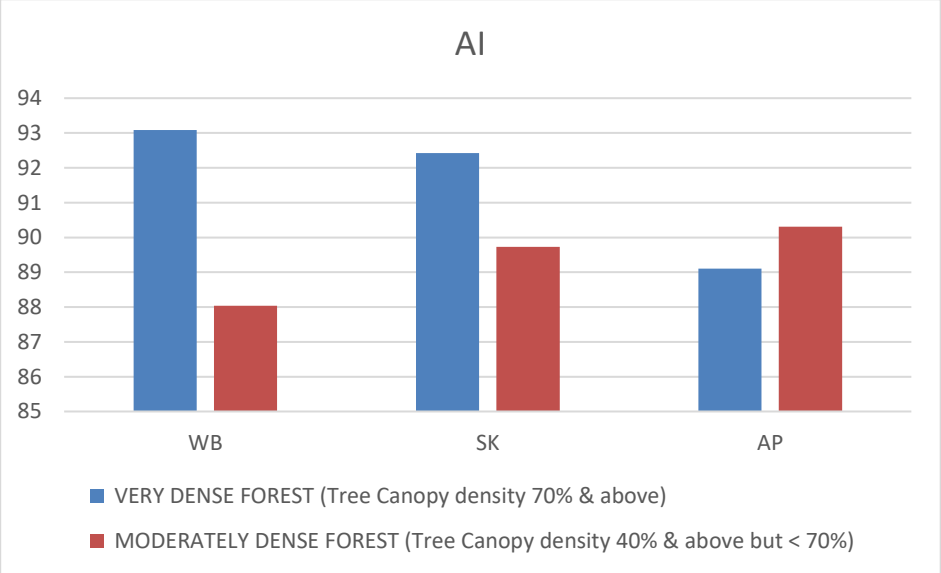


Figure: 13 Frag stat results for number of patches in three states

7. PLAN OF WORK (FOR 2023-24)**:**

Arunachal Pradesh: Pertaining to Arunachal Pradesh, the state has been divided in two parts Eastern and Western Arunachal Pradesh. The team will be divided to work in the following districts in the upcoming field sessions of 2023-2024. For Western Arunachal Pradesh- Tawang, West Kameng, East Kameng, Upper Subansiri, Lower Subansiri, Shi-Yomi districts, West Siang. And East Siang, Upper Siang, Changlang, Dibang valley, Lower Dibang Valley, Lohit districts of Eastern Arunachal Pradesh will be covered through rigorous surveys in the identified potential habitat of the species in the area.

Sikkim: Post monsoon work will cover the protected areas in the North-Sikkim and East-Sikkim districts; Khangchendzonga national park & Biosphere Reserve situated in the Mangan and Gyalshing districts and Snigbha Rhododendron Sanctuary in the North Sikkim district, Kyongnosla Alpine Sanctuary in the Gangtok district, Pangolakha Wildlife Sanctuary in the Pakyong district and remaining will also cover remaining girds of Maenam WLS and Barsey Rhododendron WLS.

West Bengal (North): Post monsoon work in North Bengal will cover rigorous field surveys in the left grids of Singalila National Park (North Range) & North and South Rimbick ranges of Reserve forest of Darjeeling District. Neora Valley National Park of Kalimpong District will also be surveyed.

8. BUDGET RECEIVED & AMOUNT SPENT:

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower (Salary & Field Assistants)	81,09,720.00	**48,65,832.00**	24,29,897.00	0.00	**24,29,897.00**	**24,35,935.00**
2	Hiring of Field Vehicle	29,00,000.00	**17,40,000.00**	5,04,785.00	0.00	**5,04,785.00**	**12,35,215.00**
3	Travel	10,00,000.00	**6,00,000.00**	4,14,046.00	0.00	**4,14,046.00**	**1,85,954.00**
4	Equipment (Camera traps, Binoculars, Depth Finder, Camera), Consumables	78,00,000.00	**46,80,000.00**	44,55,948.00	98,000.00	**45,53,948.00**	**1,26,052.00**
5	Contingency	1,90,280.00	**1,14,168.00**	3,33,055.00	0.00	**3,33,055.00**	**-2,18,887.00**
Total		**2,00,00,000.00**	**1,20,00,000.00**	**81,37,731.00**	**98,000.00**	**82,35,731.00**	**37,64,269.00**
				Less : Forest Advance			6,45,000.00
				Less : Tour Advance			2,96,309.00
Balance							**28,22,960.00**

18

Pan India Assessment and Monitoring of endangered species covered under the Integrated Development of Wildlife Habitats (IDWH) Scheme of MoEF&CC

Progress Report, September 2023

1. SPECIES: Caracal (*Caracal caracal*)

2. SUPERVISORS: Prof. Qamar Qureshi, Dr. Vishnupriya Kolipakam

3. BRIEF BACKGROUND:

Integrated Development of Wildlife Habitats (IDWH) is a Centrally Sponsored Scheme, made operational during 11th Plan Period by augmenting the existing *Assistance for the Development of National Parks and Sanctuaries* with additional components. The third component of IDWH is focused on conservation of 22 endangered and critically endangered species by understanding their current population status and distribution. Though classified as "Least Concern" in the IUCN Red List (Avgan et al. 2016), the caracal is rare and threatened in India (Khandal et al., 2020, Jhala et al. 2021). The Asian population is included in Appendix I of CITES. The extent of occurrence of the species has reduced by 95.5% of its original historic range in India (Khandal et al., 2020). Caracal might be on the verge of extinction and need immediate attention to understand status, population trends and conservation concerns (Jhala et al. 2021).

4. OBJECTIVES:

- To assess the population status of caracals in the potential caracal habitats in Rajasthan and Gujarat;
- To develop a long-term monitoring protocols for populations and habitats of Caracal.

5. METHODS:

To study the status and distribution of caracal, genetic mark-recapture and systematic camera trapping will be carried out in potential caracal habitats. Genetic capture-recapture is a robust method for estimating population of endangered and elusive species, for which we will be collecting scat samples to extract DNA and subsequently identify individuals. For initial survey (June-July 2023), we have selected an intensive study area in Ranthambhore Tiger Reserve (RTR) based on previous records of caracals in the recent past. Since RTR is a known strongholds of the species, we have started our sampling there. The intensive study area further divided into 4 Km^2 grids, and surveyed using polygon

search (3-4 Km/grid) in a systematic manner. We used M-STrIPES polygon search application for carrying out the survey.

6. PROGRESS TILL DATE:

To collect scat samples, we have walked 14 trails (around 30 km) in the intensive study area (in RTR, Fig. 1), and collected 18 potential caracal/small cat scats (since caracal scats cannot be visually distinguished from other small cat species). During polygon search walks, we also collected information on canopy cover (15m radius) and ground visibility (grass/shrub height) at every 500 m interval. We have deployed 69 camera traps (1186 trap nights) and obtained 37,241 images. We have recorded 23 species out of which 698 images were of 12 carnivores including 47 images of small cats (jungle cat and rusty spotted cat). However, we have not recorded any photographic evidence of caracal in the study area during the survey. Preliminary findings indicate requirement of more rigorous survey. Due to monsoon, the field work could not be completed. Simultaneously, in the conservation genetics lab at the Wildlife Institute of India, we have start finalising the caracal marker for DNA based species identification.

7. PLAN OF WORK:

The research team has started post monsoon field work in the intensive study area in RTR with scat collection (polygon search) and camera trapping. Apart from the intensive study area in RTR, the team will also cover potential areas in Rajasthan (the Chambal ravines, Kailadevi WLS, Dholpur) and Gujarat (Kachchh).

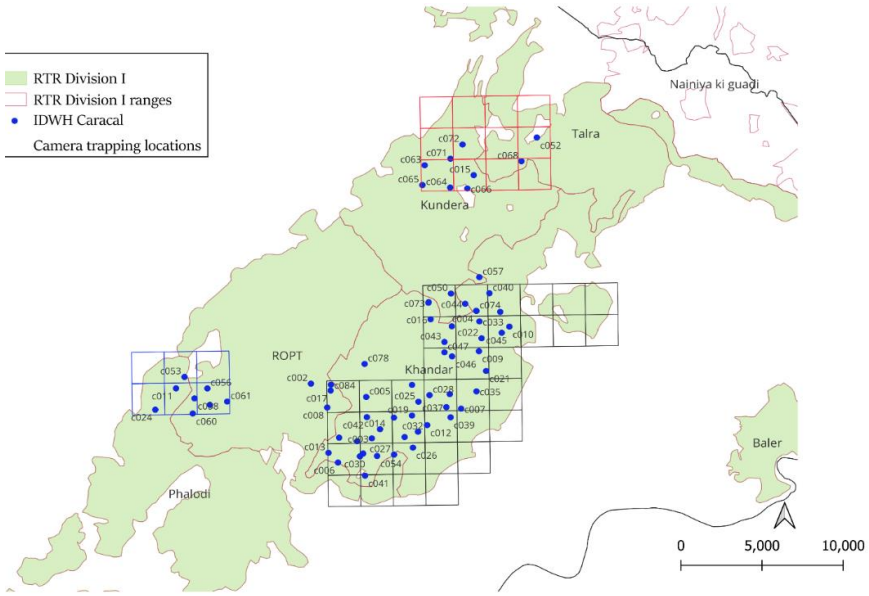


Figure:1 The insensitive study area in RTR and location of camera trap deployed during initial survey

8. BUDGET RECEIVED, AND AMOUNT SPENT:

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower (Researchers)	8,63,000.00	**5,17,800.00**	5,81,076.00	0.00	**5,81,076.00**	**-63,276.00**
2	Technical Reserchers/ Intern	1,80,000.00	**1,08,000.00**	0.00	0.00	**0.00**	**1,08,000.00**
3	Daily Labour	4,07,000.00	**2,44,200.00**	0.00	0.00	**0.00**	**2,44,200.00**
4	Vehicle Hiring	18,00,000.00	**10,80,000.00**	1,24,424.00	0.00	**1,24,424.00**	**9,55,576.00**
5	Genetic lab chemicals, consumables, glassware	24,00,000.00	**14,40,000.00**	0.00	2,22,663.00	**2,22,663.00**	**12,17,337.00**
6	Field supplies and equipments	17,00,000.00	**10,20,000.00**	0.00	0.00	**0.00**	**10,20,000.00**
7	Insurance	1,00,000.00	**60,000.00**	0.00	0.00	**0.00**	**60,000.00**
8	Publications	50,000.00	**30,000.00**	0.00	0.00	**0.00**	**30,000.00**
Total		**75,00,000.00**	**45,00,000.00**	**7,05,500.00**	**2,22,663.00**	**9,28,163.00**	**35,71,837.00**
				Less : Forest Advance			2,80,000.00
				Less : Tour Advance			54,304.00
Balance							**32,37,533.00**

REFERENCE:

1. Avgan, B., Henschel, P. & Ghoddousi, A. 2016. *Caracal caracal* (errata version published in 2016). *The IUCN Red List of Threatened Species* 2016: e.T3847A102424310. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T3847A50650230.en. .
2. Jhala, Y.V., Qureshi, Q., Yadav, S.P. 2021. Status of leopards co-predators and megaherbivores in India, 2018. National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun. ISBN - 81-85496-56-0.
3. Khandal, D., Dhar, I. & Reddy, G.V. (2020). Historical and current extent of occurrence of the Caracal *Caracal caracal* (Schreber, 1776) (Mammalia: Carnivora: Felidae) in India. *Journal of Threatened Taxa*, 12(16), 17173–17193. https://doi.org/10.11609/jott.6477.12.16.17173-17193

PAN India Assessment and Monitoring of endangered species covered under theDevelopment of Wildlife Habitats Scheme of MoEF&CC: Habitat monitoring of select IDWH species.

Progress Report, September 2023

1. SPECIES: Habitat monitoring of select IDWH species

2. SUPERVISORS: Dr. Gautam Talukdar, Dr. Amit Kumar, Dr. Navendu Page and Dr. Nehru Prabhakaran.

3. BRIEF BACKGROUND:

Wild animals are difficult to survey at a population level because their widely spaced territories and nocturnal behaviour result in low detection probability and thus, available habitat is a valuable surrogate to determine the status of the species. While occasionally conducted over small geographic areas (e.g., Radeloff et al., 1999; Lauver et al., 2002), wildlife surveys commonly require regional, or, increasingly, global perspectives that defy traditional field-based techniques (e.g., Skidmore and Gauld, 1996; Corsi et al., 1999; Osborne et al., 2001). Remote sensing has often been identified as a key data source for supporting habitat mapping and other large-area ecological applications (Graetz, 1990; Roughgarden et al., 1991; Wickland, 1991). Recent advances in RS-GIS allows ecologists to map habitat (Recio et al., 2013) and assess habitat quality in much finer details and accuracy for a large/small scale analysis more preciously with ease. It also allows mapping of inaccessible areas (Vansteenvoort et al., 2003) and broader landscape for identifying critical habitat and threats and predicting the impacts of environmental change. Also, drones are increasingly being used by ecologists to conduct habitat assessments (barnas et al., 2020).
Using RS-GIS techniques, this component aims to assess and monitor habitats of select endangered species covered under IDWH.

4. OBJECTIVES:

- Assessing the habitat information of select species covered under the IDWH project.
- Habitat suitability modelling of select IDWH species
- Ground validation of select IDWH species.

5. APPROACH /METHODOLOGY:

Assessing the habitat information of select species covered under the IDWH project.
Detailed habitat information about all species covered under the IDWH project reviewed and collated from published literature (Peer reviewed papers, grey literature). Major focus given on gathering information about species distribution, habitat preference, Threats to habitat, and ongoing conservation efforts. Depending on the literature review factsheets for each species has been prepared.
Habitat suitability modelling of select IDWH species.
Habitat suitability modelling techniques will be implemented to prepare potential habitat maps for species covered under the IDWH project. Widely used techniques like Maxent, has been used for Species Distribution Modelling.
Ground truthing of select IDWH species.
Post-modelling survey will be carried out in habitats of different IDWH species for ground truthing of the prepared habitat maps. Different field mapping techniques will be used for survey.

6. PROGRESS TILL DATE:

A detailed literature review has been performed for the species covered under the IDWH project. Detailed factsheets for the 30 species Detailed habitat requirement write-up for the species and literature review sheet prepared for all the species.
Species Distribution Models of 9 mammals and 3 bird species were prepared.

7. PLAN OF WORK (FOR 2023-24)**:** Based on SDM output habitat suitability maps will be prepared. Planning fieldwork for ground validation and data collection.

8. BUDGET RECEIVED & AMOUNT SPENT:

S. No	Budget Head	Total Budget Approved	Grant Received (60% for Approved Budget)	Expenditure	Committed Expenditure	Total Expenditure	Balance
1	Manpower	22,00,000.00	**6,00,000.00**	15,23,034.00	0.00	**15,23,034.00**	**-9,23,034.00**
2	Hardware/ Software/ Equipments	1,47,00,000.00	**1,13,00,000.00**	0.00	97,63,990.00	**97,63,990.00**	**15,36,010.00**
3	Misc/ Contingency (Field Travel, Consumables, Publication, Etc)	31,00,000.00	**1,00,000.00**	1,05,440.00	0.00	**1,05,440.00**	**-5,440.00**
Total		**2,00,00,000.00**	**1,20,00,000.00**	**16,28,474.00**	**97,63,990.00**	**1,13,92,464.00**	**6,07,536.00**
				Less : Forest Advance			35,000.00
				Less : Tour Advance			
Balance							**5,72,536.00**

REFERENCE:

1. Radeloff, V. C., Pidgeon, A. M., & Hostert, P. (1999). Habitat and population modelling of roe deer using an interactive geographic information system. Ecological Modelling, 114(2-3), 287-304.
2. Lauver, C. L., Busby, W. H., & Whistler, J. L. (2002). Testing a GIS model of habitat suitability for a declining grassland bird. Environmental management, 30, 88-97.
3. Skidmore, A. K., Gauld, A., & Walker, P. (1996). Classification of kangaroo habitat distribution using three GIS models. International Journal of Geographical Information Systems, 10(4), 441-454.
4. Corsi, F., Duprè, E., & Boitani, L. (1999). A large-scale model of wolf distribution in Italy for conservation planning. Conservation Biology, 13(1), 150-159.
5. Osborne, P. E., Alonso, J. C., & Bryant, R. G. (2001). Modelling landscape-scale habitat use using GIS and remote sensing: a case study with great bustards. Journal of applied ecology, 38(2), 458-471.
6. Graetz, R. D. (1990). Remote sensing of terrestrial ecosystem structure: an ecologist's

pragmatic view. Remote sensing of biosphere functioning, 5-30.
7. Roughgarden, J., Running, S. W., & Matson, P. A. (1991). What does remote sensing do for ecology?. Ecology, 72(6), 1918-1922.
8. Wickland, D. E. (1991). Mission to planet Earth: the ecological perspective. Ecology, 72(6), 1923-1933.
9. Recio, M. R., Mathieu, R., Hall, G. B., Moore, A. B., & Seddon, P. J. (2013). Landscape resource mapping for wildlife research using very high-resolution satellite imagery. Methods in Ecology and Evolution, 4(10), 982-992.
10. Vansteenvoort, L., De Maeyer, P., De Man, J., & Lavreau, J. (2003). Mapping Inaccessible Areas By Intergrating Remote Sensing Data and Historic Cartographic Documents. In Abstract Book of the 23rd Earsel Symposium, Remote Sensing in Transition, 2-5 June 2003, Ghent. (pp. 122-122).
11. Barnas, A. F., Chabot, D., Hodgson, A. J., Johnston, D. W., Bird, D. M., & Ellis-Felege, S. N. (2020). A standardized protocol for reporting methods when using drones for wildlife research. Journal of Unmanned Vehicle Systems, 8(2), 89-98.
12. Bushaw, J. D., Ringelman, K. M., & Rohwer, F. C. (2019). Applications of unmanned aerial vehicles to survey mesocarnivores. Drones, 3(1), 28.