FINAL REPORT

DIVERSITY AND ECOLOGY OF HERPETOFAUNA IN PANNA TIGER RESERVE

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Diversity and Ecology of Herpetofauna in Panna Tiger Reserve, Madhya Pradesh

FINAL REPORT

2019

Submitted by

Dr. Abhijit Das, Principal Investigator

Vishal Kumar Prasad, Project Biologist

Wildlife Institute of India
P. O. Box. 18
Chandrabani, Dehradun – 248001
Uttarakhand

In association with

Madhya Pradesh State Biodiversity Board
Forest Department Madhya Pradesh
Panna Tiger Reserve

Name of Project: Diversity and Ecology of Herpetofauna of Panna Tiger Reserve

Principal Investigator: Dr. Abhijit Das

Co-Principal Investigator: Shri R. Sreenivasa Murthy, I.F.S.

Project Biologist and Researcher: Mr. Vishal Kumar Prasad

Project duration: Two years (2017-2019)

Funding Agency: Madhya Pradesh State Biodiversity Board (MPSBB), Bhopal

Citation:
Das, A., Prasad, V.K., Murthy, S. (2019) Diversity and Ecology of Herpetofauna of Panna Tiger Reserve, Madhya Pradesh. Final Report, Wildlife Institute of India, Dehradun, 61pp.

For feedback and comments please feel free to write:
Dr. Abhijit Das
Email: abhijit@wii.gov.in

Wildlife Institute of India
P. O. Box. 18
Chandrabani, Dehradun – 248001
Uttarakhand

Coverphoto (front and back): Green Keelback Snake (*Rhabdophis plumbicolor*) juvenile. Photo in this page: Nilphamarai Narrow-mouthed Frog (*Microhyla nilphamariensis*)

Contents

Titles **Page no.**

Acknowledgements

We would like to thank to Madhya Pradesh State Biodiversity Board for providing financial support vide Grant No. MPSBB/MP(P)/2017/506 to this project. We thank the Forest Department of Madhya Pradesh for granting research permission to conduct the project activities within Panna Tiger Reserve. We sincerely acknowledge the support of Field Director Shri K.S. Bhadauriya (IFS), Deputy Director Ms Vasu Kanojia (IFS), Ex-Field Director Shri Ravikant Mishra (IFS), Assistant Director and other staff members of Panna Tiger Reserve. We appreciate the help of veterinary doctor Dr. Sanjeev Gupta and Mr. Tapsheel Khan for providing snake rescue data of Panna city. We thank Range forest officer Shri B R Bhagat and Shri Amar Singh, Beat Guard Shri Uday Mani Parihar, Shri Manoj Kumar Baiga, Shri Jugal Kishor and Shramiks Shri Rammu and Shri Govind for providing field support during research activities.

We are thankful to Director and Dean of Wildlife Institute of India for their constant encouragement in the project. We would like to thank Dr. K. Ramesh for helping us setting our base camp, logistics and for his time in framing field methods. We acknowledge research coordinator Dr. Bitapi Sinha and Qamar Qureshi for their encouragement in this study. Our thank goes to the field assistants Shri Ramzan Khan, Shri Rajendra Khatik, Shri Ram Singh Rekwar, Shri Kamlesh Rekwar, Shri Lokendra Yadav and We thank Shri Darshan Singh and Shri Madhav Ji (Personal Manager NMDC) for helping our team in arranging accommodation in NMDC quarters and Shri Akhilesh Yadav for his logistics and vehicle support. We thank our project interns Mr. Ajinkya D Shinde, Mr. Pritam Padhy and Mr. Sudhish Bijalwal for their wonderful contribution in the field work. We are thankful to our W.I.I. co-researchers for their valuable inputs in data collection and analysis especially to Anukul Nath, Shahid Ahmad Dar, Aishvarya Ramachandran, Naitik Patel, Bitupan Baroah, Preeti Sharma, Dnyanesh Rathor, Ravi Tripathi, Deepti Gupta and Supratim Dutta.

Finally, we thank all the faculties, staff's at finance sections in Wildlife Institute of India who helped us in our project work.

List of Figures:

List of Tables:

Kemasan Waterfall, Panna Tiger Reserve

1. Introduction

Reptiles and amphibians are essential for ecosystems functioning and play a vital role in food chains (Schleich et. al. 1996). On the other hand, herpetofauna is at the frontline of worldwide biodiversity catastrophe with one third of amphibians and one fifth of reptiles are threatened of extinction (Böhm et al. 2013; Stuart et al. 2008; Whitfield et. al. 2007). Being cryptic and poorly known, their decline and local extinction is hard to enumerate. Factors responsible for the decline of herpetofauna are habitat loss, fragmentation, invasive species, species exploitation, climate change and diseases (Dodd and Smith 2003; Gibbons et. al. 2000; Pounds et. al. 2006; Sodhi et. al. 2008; Nowakowski et. al. 2017). It is predicted that reptiles and amphibians of tropical regions are more at risk of extinctions (Stuart et. al. 2004; Hoffmann et. al. 2010; Böhm et. al. 2013).

India is one of the remarkable in terms of biological diversity. At present, 447 species of amphibians (Frost 2019) and 726 species of reptiles (Uetz et al. 2019) are reported from India. Much of this diversity is restricted to biodiversity hotspots such as Western Ghats and Northeast India. The central Indian landscape has been overlooked for systematic studies of herpetofauna in the past. These “cold spots” harbor several endemic species being reported and described recently (Mirza & Raju 2017; Mirza et. al., 2014). The extensive rocky plateau within dry scrubland, riverine ecosystems and valleys serve as potential habitats for squamate reptiles.

Flagship species approach is a popular conservation strategy in India. The conservation of iconic Tiger is at primacies due to which the conservation of lower taxa such as herpetofauna is being stalled by limited knowledge and information on their distribution, diversity and ecology. There are ample covert species which have no record or very less records after their original descriptions from type locality (AmphibiaWeb 2019; Frost 2019).

There are empirical evidences that amphibians have declined from extensively managed park such as Yellow Stone National Park, USA (Mc Menamin et. al., 2008) and have gone extinct from Australia and South America in a short span of time. Thus, there is a need to

study the status of herpetofauna even in the most protected areas such as Tiger Reserves and National Parks in India to protect the species from any local extinction. Hence, inventory and documentation of herpetofauna in protected areas becomes critical. In order to fill this lacuna, we executed systematic surveys using standard and integrated protocols to document the herpetofauna assemblage in Panna Tiger Reserve which earlier has never been investigated in the past for its herpetofaunal species assemblage.

Study Site

Panna Tiger Reserve (24°44'03.5"N 80°00'53.1"E to 24°28'07.6"N 79°53'12.8"E) in Madhya Pradesh is a part of the central Indian highlands and falls in the Vindhya mountain range. Panna Tiger Reserve (henceforth PTR), comprises of 543 km^2 of core area principally consists of tropical dry deciduous forest with teak (*Tectona grandis*), Axlewood (*Anogeissu spendula*) and Black cutch (*Acacia catechu*). PTR is surrounded by multiple-use and human-dominated lands (Chundawat et. al. 1999). There were several villages which voluntarily relocated from core to outside PTR. Its geomorphic features are composed of plateaus divided by steep escarpments, gorges and undulating sparsely distributed hillocks. In the upper is Talgaon plateau, in middle is Hinota and in the lowerside is Ken river valley. The plateaus are separated from each other and from the river valley by steep 10-80m high escarpments characterized by rocky faces, caves, thick vegetation. The reserve ranges in altitude over 204m in Pipartola Ken river valley to 540 m in Panna plateaus hillocks. The Ken River flows approx. 55 km within the tiger reserve. This region is characterized as high-rainfall dry deciduous forest and chiefly depends on monsoon rainfall from June to September with between 600mm and 1,100 mm (Jayapal, Qureshi & Chellam, 2007). The maximum recorded temp is 48 °C in summers and minimum is 6 °C in winters. Other than diverse fauna of reptiles and amphibians, Panna supports a diverse mammalian assemblage including Tigers, Leaopards, Hynas, Sloth Bears, and Ungulates such as Sambar, Chital and Chaousingha. Panna TR also has good diversity of Avifauana such as birds of prey.

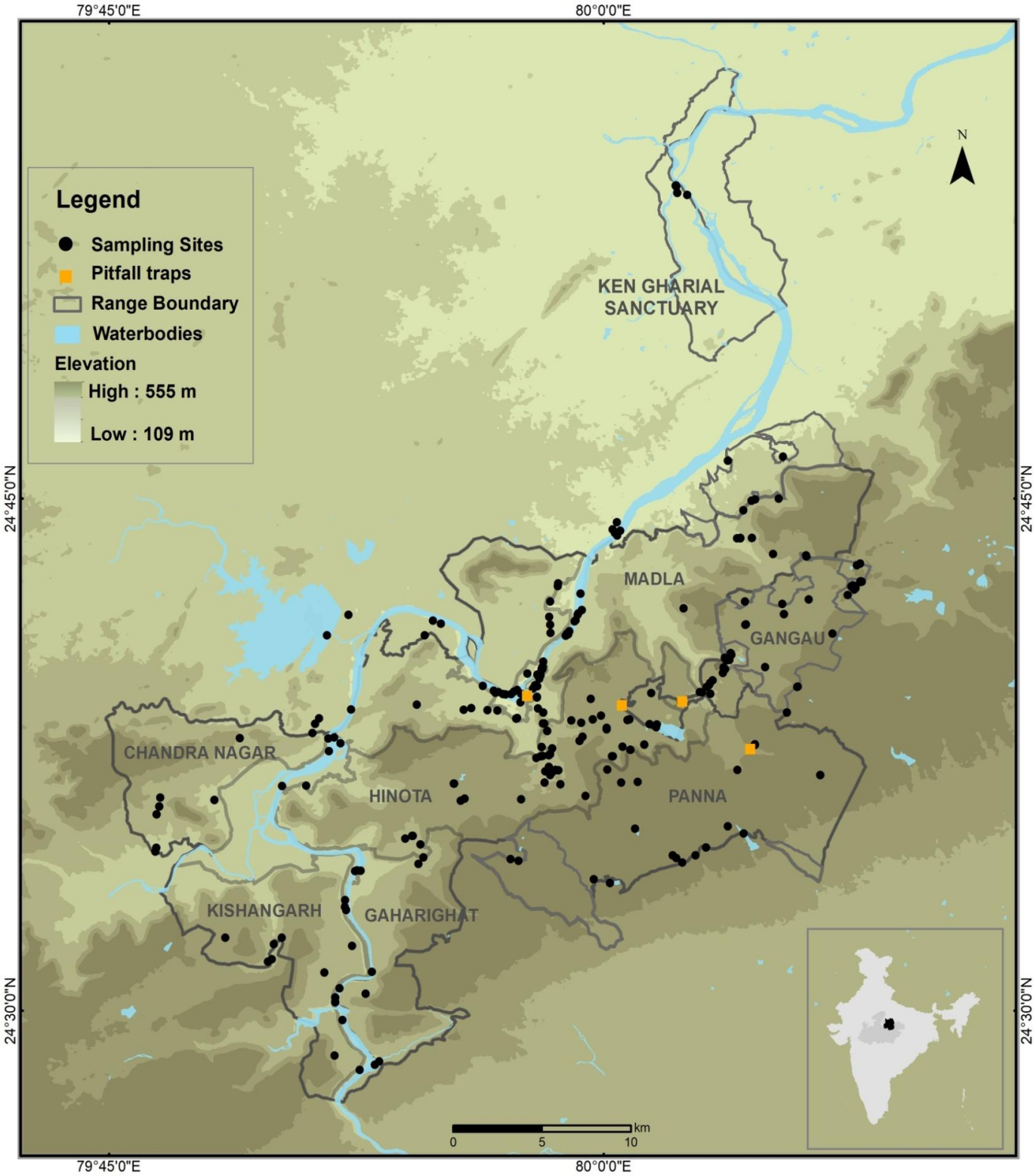

Figure 1: Map of Panna Tiger Reserve showing herpetofaunal sampling sites.

Objectives of the study

The project was sanctioned for two years starting from 2017 to 2019 with two major seasons of monsoon, post monsoon, summers and winters) to collect data from the field. The objectives of the project are follows as:-

- To determine the species richness and diversity of herpetofauna in Panna Tiger Reserve.
- To map and identify the distribution pattern of herpetofauna species with respect to their habitats and breeding sites.
- To classify the herpetofauna community assemblage across various major habitats and to identify the species diversity, richness and evenness within the various major habitats in Panna Tiger Reserve landscape.
- To discover and describe any potentially novel species in the region.
- To obtain the information on species ecology and natural history.
- Describing ecological and behavioral interaction within species and describe novel characters which be used in species monitoring programmes.
- To build capacity and create awareness and education amongst the various major stakeholders including forest department, officials, local villagers and students to promote conservation of herpetofauna.

3. Methodology:

During the project, 142 days (July to November) in 2017 and 172 days (January to November) in 2018 were spent in the field by a researcher (VKP) and an intern (Ajinkya or Sudhish) to collect field data of herpetofauna in Panna Tiger Reserve. During monsoon period from July-October in 2017 and 2018, variety of habitats such as streams, temporary and perennial ponds, muddy areas of grasslands, rocky outcrops, puddles, leaf litter, paddy field in different locations in nine beats in Hinota Range, eight beats in Panna Range, 10 beats in Madla Range, four in Gehrighat Range, five in Chandra Nagar Range, five beats in herpetofauna species.

Figure 2: Broad categories of habitats of herpetofauna: A- Rocky Streams, B- Ponds, C- Grasslands, D-Paddy Fields

Kishangad range and six beats in Gangau Wildlife Sanctuary were sampled.

The habitats were catagorised broadly into 1. Streams habitat: Rocky streams which are natural lotic system within the park; 2. Ponds: Natural or man made depression having lentic water in the rainly season, 3. Grasslands: Habitats dominated by grasslands including temporary puddles formed during monsoon and have rocky fencing at some locations; 4. Paddy fields: strictly seasonal paddy fields which occur only in fringe and village areas close to PTR. Out of 86 locations of VES, the habitats in 40 locations were Rocky Streams, 19 were Ponds, 19 were Grasslands (including several temporary puddles in it) and 8 were Paddy fields in Panna Tiger reserve. In the night, surveys are mostly restricted to survey at breeding sites using acoustic cues and night driving. While in the day time we looked for heliothermic reptiles and turned over leaflitter, rocks and logs in search of hidden herpetofauna.

3.1 Species distribution, diversity and richness:

The Visual Encounter Surveys (VES) methods was utilized to record species richness and gather point locations. We conducted time constrained VES from July to November in 2017 and July to August in 2018. Each VES was conducted for one hour in which two observers walked at slow pace scanning the potential habitats which we categorized into four main general habitats (Figure 2): The fieldwork was conducted from 18:00 hours to 00:00 hours in night and 08:00 to 12:00 in day following Indian Standard Time, during this time we performed one or more VES at spatially different sites on each day. We installed one pit fall array with drift fence (1 meter high) in three ranges of PTR. A set of ten buckets (each 40cm deep x 35cm diameter) were buried in the ground with their open fringe faced with surface of ground. This passive and non-invasive sampling technique was used to detect the presence of rare and secretive terrestrial species such as skinks, frogs and lizards. This method provides us data on species away from breeding sites as well. We decided to use this method in three most varied habitats in different ranges for optimum utilization of limited manpower and resources. Furthermore, we interviewed beat guards, forest watchers (*shramiks*), villagers to gather secondary information about potential habitats of reptiles (especially crocodilians, turtles and snakes) and amphibians. They were also

shown images from the field guides. Additionally, opportunistic Surveys were also performed occasionally during the field work to increase the species richness of PTR. Any species recorded on roads or road kill, near base camp, snakes rescued from nearby villages, species encountered during recce, frogs and turtles seen in wells etc. were treated as opportunistic records. For statistical analysis, we used R version 3.4.3. (2017-11-30, © 2017, the R Foundation for Statistical Computing) the species accumulation graphs. The software PAST 3.06 (Hammer et. al., 2001) was used to calculate Shannon diversity index (H).Lastly, the river bank walk surveys were conducted to determine the distribution of Crocodilians. The stretch of approx. 55 kms of Ken river from Madla to Gehrighat and 8.54kms in Raneh fall point to Mohare ghat (Ken Gharial Sanctuary) in Panna TR of was surveyed from 20.01.2018 to 03.02.2018. Surveys of sighting basking crocodilians and turtles was conducted by foot in daytime. Two observers equipped with binoculars, scanned the river at both sides of the riverbank. The distance of basking crocodilians from the location of surveyor was measured by Nikon laser range finder and compass bearing was taken using SUUNTO KB-14/360R G Compass.

3.2 Relative abundance and encounter rate:

In order to obtain relative abundance and encounter rate of herpetofauna, we employed time constrained VES. The method was similar as discussed in methodology part 1 however data collection and analysis techniques were different. We conducted diurnal and nocturnal surveys VES in potential sites in six ranges and a wildlife sanctuary within Panna Tiger Reserve from July to November in 2017 and July to August in 2018. The observers deeply skimmed through breeding sites using vocal and visual cues and actively searched into leaf litter, turned rocks and deadwood. We followed number of manpower per hour of effort of sampling to obtain species encounter rate per hour. The relative abundance was obtained as the composition of a species relative to the total number of species in a site. It was calculated by number of individuals of a species divided by individuals of all recorded species of amphibians or reptiles in a sampling site. Bar Graphs were prepared using Microsoft excel 2010.

3.3 Body mass distribution:

Snout to vent length (SVL) was measured (in mm) using Mitutoyo calipers and body weight (in grams) was recorded using Pesola Macro-line spring scale. GPS locations of each survey site was recorded with GPS MAP78 using the WGS84 datum and the maps were prepared in QGIS. Ecological data such as dry bulb temperature, relative humidity (using Extech EN150 hygro-thermo-anemomenter), notes on microhabitat, substrate, animal activity, sex, number of individuals, behavioral observations were recorded during each survey. We used R version 3.4.3. (2017-11-30, © 2017, the R Foundation for Statistical Computing) to create box plots of the body mass distribution and histogram.

Live specimens of representative species were photographed using Nikkon DSLR. The specimen of cryptic species were euthanized and fixed (4% for amphibians and 8% for reptiles) in formaldehyde after taking tissue samples from either thigh muscle or liver. After 48 hours the specimens were washed in running water properly and preserved in 70% absolute ethanol and stored at -20 degree Celsius in Wildlife Institute of India for later identification and molecular work.

3.4 Acoustic study and vocal behaviour of anurans:

To obtain the vital data on behaviour and ecology of species, bioacoustics surveys and frog call recordings were employed. We used Sennheiser MKH 416 unidirectional handheld microphones and Marantz MK II digital recorder to record the advertisement calls of frogs (figure 2.1). The advertisement calls of frogs were recorded in monsoon season. Acoustic properties for five calls of each species were measured using Raven Pro 1.4 (Charif et. al., 2010). Seven temporal properties (call duration, call rise time, call fall time, number of pulses per call, pulse rate and inter-call intervals and pulse duration were measured) and two spectral property (overall dominant frequency and peak power) of call were used for analyses. Oscillograms and spectrograms were prepared for graphical representation of the call. The call properties definitions were followed from Thomas et. al. (2014).

Figure 3: Pictorial illustration of frog call recording in real time in field.

Methods and techniques utilized in the field

Figure 4. Researchers conducting VES

Figure 5. Research team scanning aquatic habitat

Figure 6. Acoustic surveys

Figure 7. & 8. Pitfall monitoring

4. Results

A total of 55 species of herpetofauna belonging to 21 families and 41 genera were recorded. Amphibians are represented by 13 species (9 genera and 4 families) and reptiles by 42 species (32 genera and 17 families) were recorded. Our field techniques yielded 31 species using VES, 13 species using pitfall traps, 49 species through opportunistic sightings and 3 species during basking survey. The result is catagorised in four different sections as follows 1. Species richness, diversity and distribution 2. Relative abundance, 3. Body mass distribution and 4. Bioacoustics study.

4.1 Species diversity, richness and distribution:

We calculated Shannon diversity index (H) for our surveyed habitats in Panna TR for the amphibian and reptile diversity using statistical software PAST 3.06 (Hammer et. al., 2001). The amphibian species diversity within the habitats was highest in Paddy fields followed by grasslands. For reptiles, diversity was highest in grassland puddles followed by Ponds (figure 8).

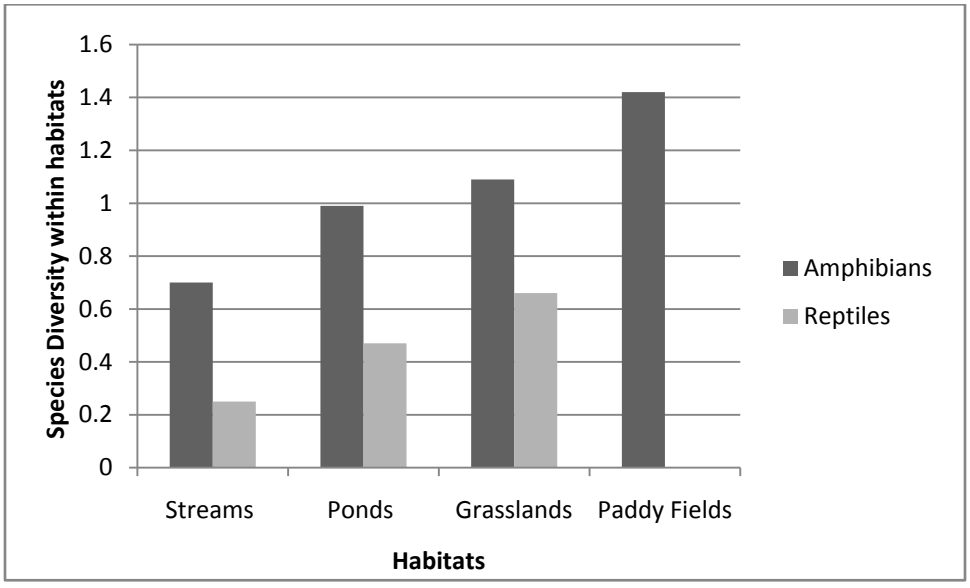

Figure 9: Species diversity of amphibians and reptiles within the habitats in PTR

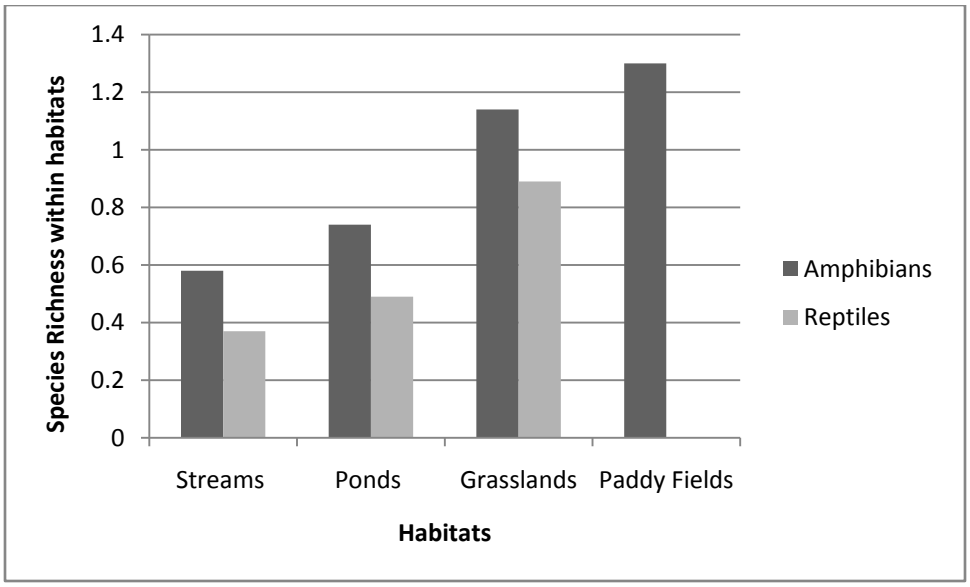

Figure 10: Species richness of amphibians and reptiles within the habitats in PTR

Our preliminary results showed that the species richness for amphibians was highest in paddy fields followed by grassland and for reptiles it was highest in grassland puddles and then in ponds (figure 9).

Table: 1: Amphibian species diversity, evenness and richness across major habitats

Habitat	Number of sampling sites	Diversity	Evenness	Richness
Streams	40	0.70 ± 0.06	0.76 ± 0.02	0.58 ± 0.06
Ponds	19	0.99 ± 0.06	0.76 ± 0.03	0.74 ± 0.06
Grasslands	19	1.09 ± 0.13	**0.83 ± 0.03**	1.14 ± 0.14
Paddy Field	8	**1.42 ± 0.13**	0.82 ± 0.04	**1.30 ± 0.23**

Table: 2: Reptile species diversity, evenness and richness across major habitats

Habitat	Number of sampling sites	Diversity	Evenness	Richness
Streams	40	0.25 ± 0.10	**0.99 ± 0.01**	0.37 ± 0.15
Ponds	19	0.47 ± 0.16	0.95 ± 0.04	0.49 ± 0.17
Grasslands	19	**0.66 ± 0.18**	0.86 ± 0.06	**0.89 ± 0.25**

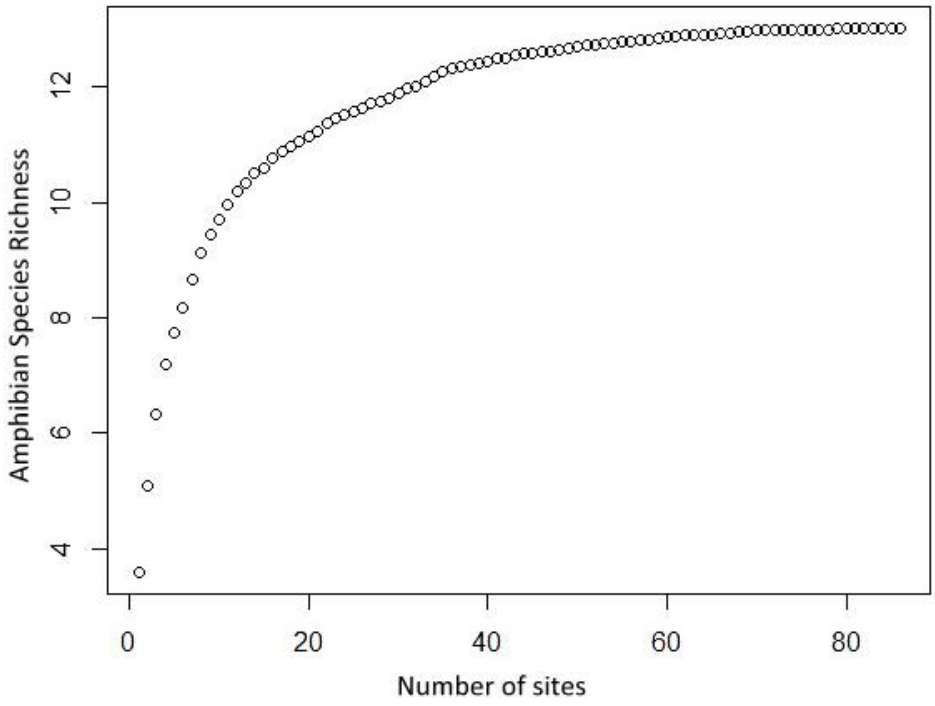

Figure 11: Species accumulation curve of amphibian richness

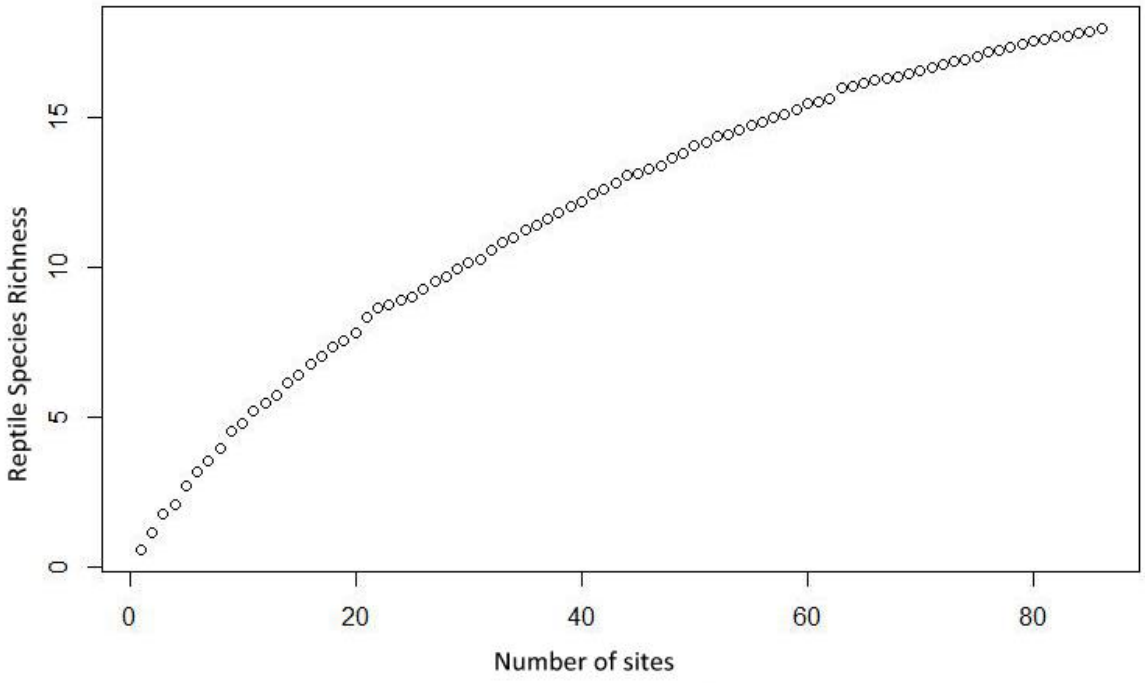

Figure 12: Species accumulation curve of reptiles richness

The results from the species accumulation graphs (Figure 10 and 11) reveal that in case of amphibians, the asymptote is achieved after the visual encounter surveys of approximately 60 sites. However, in case of reptiles, the species richness showed covert diversity even after the visual encounter surveys of 86 sites.

Distribution of Crocodilians:

We recorded Mugger (*Crocodylus palustris*) common in Ken river however it was patchily distributed across the Ken river stretch of 55 kilo meters in Panna Tiger Reserve. During river walk surveys held in January and February 2018,

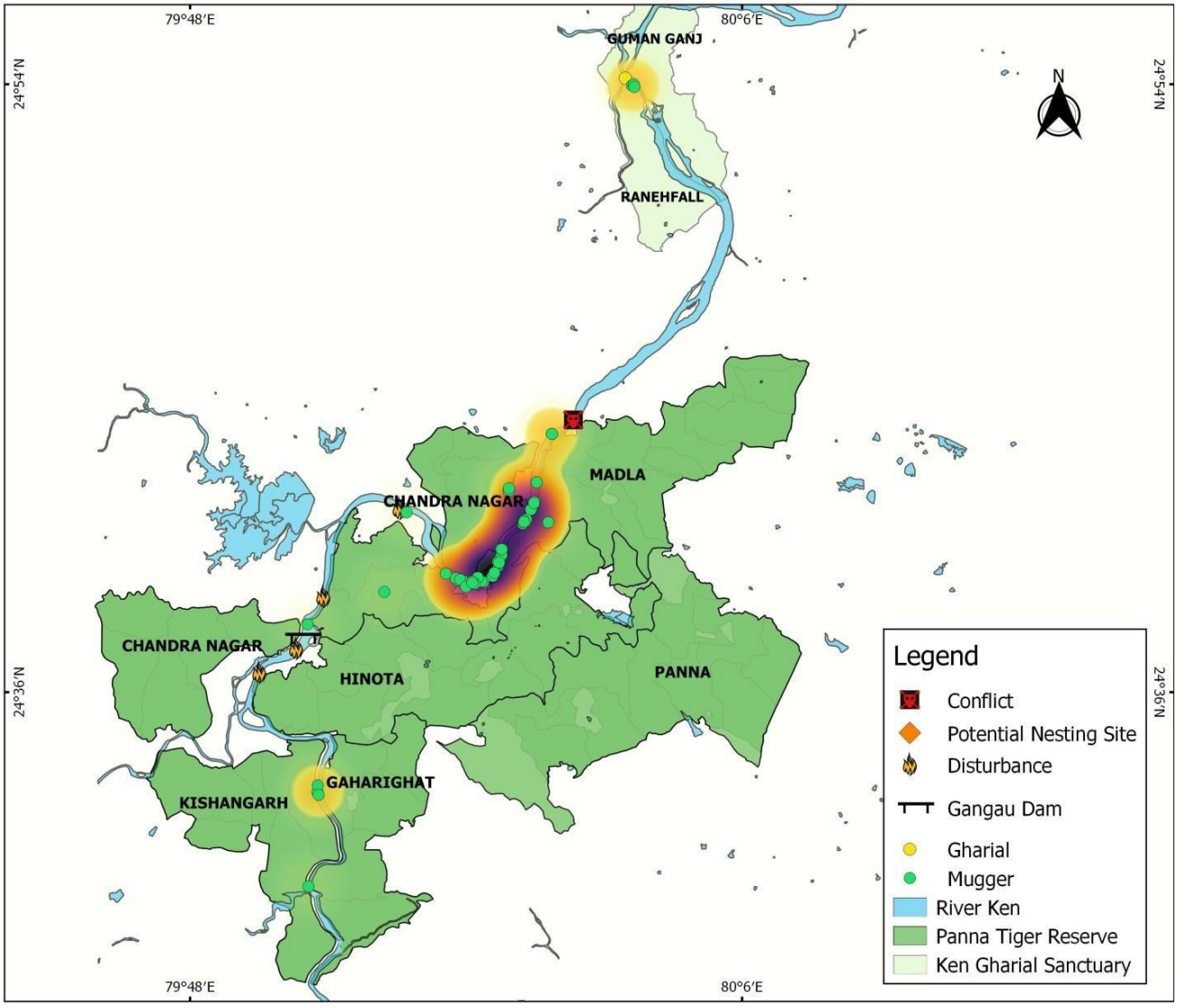

Figure 13: Heatmap showing distribution of crocodilians in Panna Tiger Reserve and Ken Gharial WS.

We had 59 sightings of Muggers in PTR (along 55 km of river stretch) and 3 in Ken Gharial Sanctuary (along 8 km river stretch). We estimated 20 adults, 11 sub adults, 4 juveniles and 1 yearling (for rest we could not estimate size as they were mostly swimming and submerged). The encounter rate of Muggers was highest from Magara Dabri to Judi in Madla (Figure 12). Two additional adults were seen in a large pond in Raipur beat of Chandranagar in August 2017. Also, a large individual of Gharial (*Gavialis gangeticus*) probably a female according to forest staff was recorded from Muhare ghat in Ken Gharial Sanctuary in January 2018 during this study. It was found swimming for sometimes and after that it came out on a sandy bank for basking. We could not find any other individual.

Table 3: Herpetofauna of Panna Tiger Reserve with its distribution and species richness recorded during this study. Abbreviations: PN-Panna Range, HN- Hinota Range, MD- Madla Range, GA- Gangau WS, CH- Chandra Nagar Range, KG- Kisangarh Range, GG- Gehrighat Range, KGS- Ken Gharial Sanctuary

S. No.	Common Name	Species Name	PN	HN	MD	GA	CH	KG	GG	KGS
	Amphibians									
	Anurans									
1	Common Indian Toad	*Duttaphrynus melanostictus*	+	+	+	+	+	+	+	+
2	Ferguson's Toad	*Duttaphrynus scaber*	+	+		+				
3	Marbled Toad	*Duttaphrynus stomaticus*				+	+			
4	Indian Skittering Frog	*Euphlyctis cyanophlyctis*	+	+	+	+	+	+	+	+
5	Orissa Frog	*Fejervarya orissaensis*				+	+			
6	Minervarya Frog	*Minervarya* sp.	+	+	+	+	+	+	+	+
7	Jerdon's Bull Frog	*Hoplobatrachus crassus*	+	+	+					
8	Indian Bull Frog	*Hoplobatrachus tigerinus*	+	+	+	+	+	+	+	+
9	Nilphamarai Narrow-mouthed Frog	*Microhyla nilphamariensis*	+	+	+	+	+	+	+	+
10	Common Indian Tree-frog	*Polypedates maculatus*	+	+	+	+	+	+	+	+
11	Western Burrowing Frog	*Sphaerotheca* cf *pashchima*	+	+	+	+			+	
12	Indian Balloon Frog	*Uperodon globulosus*	+	+		+				
13	Marbled Balloon Frog	*Uperodon systoma*		+						
	Reptiles									
	Squamates									
14	Yellow-bellied gecko	*Hemidactylus flaviviridis*	+	+	+	+	+	+	+	+

S. No.	Common Name	Species Name	PN	HN	MD	GA	CH	KG	GG	KGS
15	Common house gecko	*Hemidactylus frenatus*	+							
16	Spotted House Gecko	*Hemidactylus gleadowi*	+	+	+	+	+	+	+	+
17	Bark Gecko	*Hemidactylus leschenaultii*	+	+		+			+	
18	Sahgal's termite hill gecko	*Hemidactylus sahgali*		+					+	
19	Delhi rock gecko	*Cyrtopodion* cf *aravallensis*	+	+						+
20	Satpura Eyelid Gecko	*Eublepharis satpuraensis*			+					
21	Oriental Garden Lizard	*Calotes versicolor*	+	+	+	+	+	+	+	+
22	Blanfords Rock Agama	*Psammophilus blanfordanus*		+						
23	Common skink	*Eutropis carinata*	+	+		+			+	
24	Bronze Skink	*Eutropis macularia*	+	+		+		+		
25	Punctate supple skink	*Lygosoma punctata*		+						
26	White-spotted Supple Skink	*Lygosoma albopunctatum*		+						
27	Small-scaled lacerta	*Ophisops microlepis*	+	+						
28	Common Indian monitor	*Varanus bengalensis*	+	+	+	+	+	+	+	
29	Common Sand Boa	*Eryx conicus*	+	+	+	+			+	
30	Red Sand Boa	*Eryx johnii*		+		+				
31	Buff Striped Keelback	*Amphiesma stolatum*	+	+	+	+	+		+	
32	Banded Racer	*Argyrogena fasciolata*		+						
33	Forsten's Cat Snake	*Boiga forsteni*	+	+						
34	Common Cat Snake	*Boiga trigonata*		+						
35	Trinket Snake	*Coelognathus helena helena*	+	+		+	+		+	
36	Common Bronzeback Tree Snake	*Dendrelaphis tristis*		+	+					

S. No.	Common Name	Species Name	PN	HN	MD	GA	CH	KG	GG	KGS
37	Common Wolf Snake	*Lycodon aulicus*	+	+	+	+	+		+	
38	Barred Wolf Snake	*Lycodon striatus*		+						
39	Green Keelback	*Rhabdophis plumbicolor*		+						
40	Common Kukri Snake	*Oligodon arnensis*		+	+					
41	Indian Rat snake	*Ptyas mucosa*	+	+		+	+	+	+	
42	Checkered Keelback	*Fowlea piscator*	+	+	+	+		+	+	
43	Common krait	*Bungarus caeruleus*	+	+	+	+			+	
44	Spectacled cobra	*Naja naja*	+	+	+		+			
45	Indian Rock Python	*Python molurus*		+	+			+		
46	Beaked Worm Snake	*Grypotyphlops acutus*						+		
47	Brahminy blind snake	*Indotyphlops braminus*		+						
48	Russell's viper	*Daboia russelii*	+	+	+	+	+	+	+	
49	Indian saw-scaled viper	*Echis carinatus*		+		+				
	Testudines									
50	Indian roofed turtle	*Pangshura tecta*					+			
51	Indian tent turtle	*Pangshura tentoria*					+			
52	Indian flapshell turtle	*Lissemys punctata*	+	+	+					+
53	Softshell turtle	*Nilssonia* sp. Unknown			+		+			
	Crocodilians									
54	Mugger crocodile	*Crocodylus palustris*			+		+	+	+	+
55	Gharial	*Gavialis gangeticus*								+

Photo plate : Amphibians

Duttaphrynus scaber

Duttaphrynus melanostictus

Duttaphrynus stomaticus

Euphlyctis cyanophlyctis

Fejervarya orissaensis

***Minervarya* sp.**

Hoplobatrachus tigerinus

Hoplobatrachus crassus

Microhyla nilphamariensis

Polypedates maculatus

***Sphaerotheca* cf *pashchima,* Male**

***Sphaerotheca* cf *pashchima,* Female**

Uperodon globulosus

Uperodon systoma

Panna Tiger Reserve Landscape with major stream, a key herpetofauna habitat

4.2 Relative abundance and encounter rate:

We obtained the herpetofauna species relative abundance using visual encounter survey. We found that Indian Skipper frog (*Euphlyctis cyanophlyctis*)

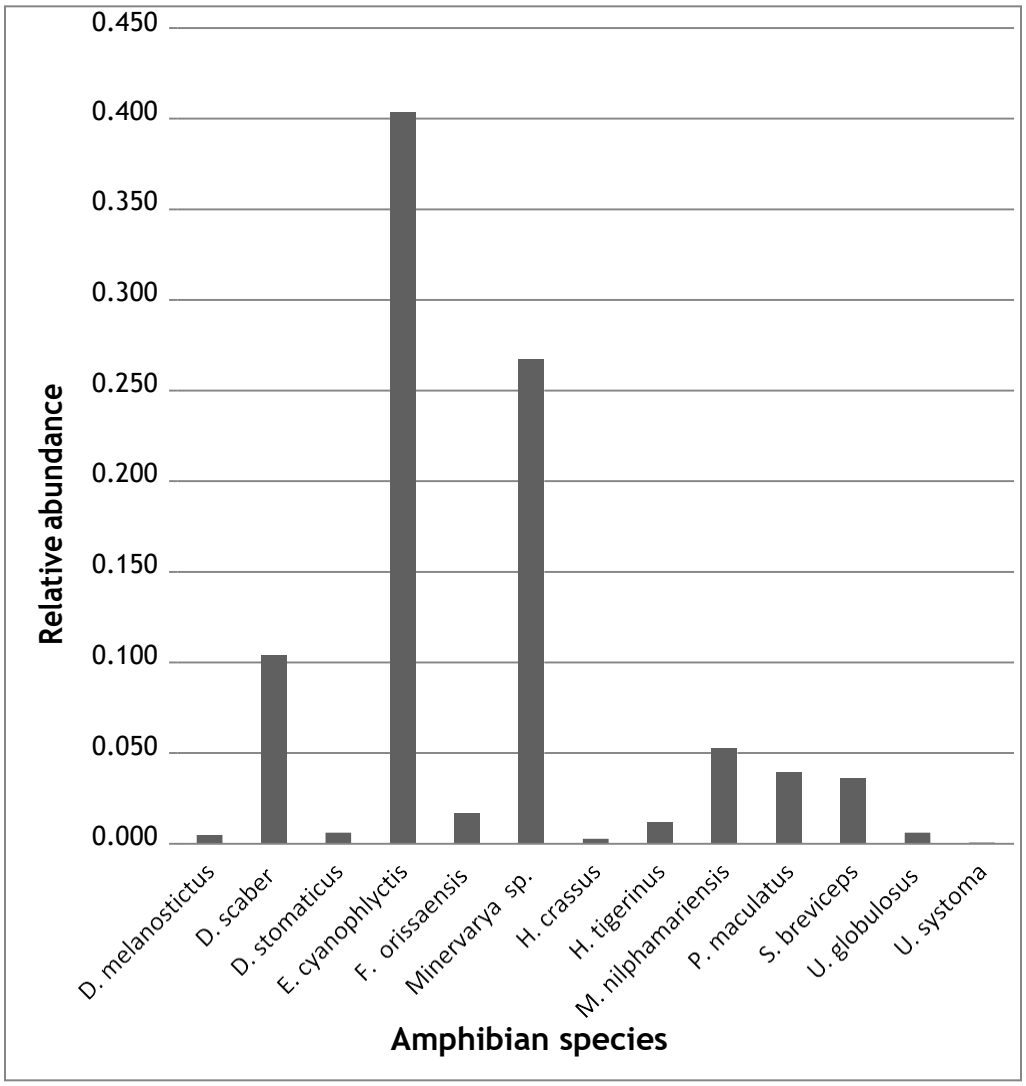

Figure 14: The relative abundance of amphibian species recorded during VES in the study.

has the highest relative abundance amongst amphibians followed by the Cricket frog (*Minervarya* sp.) and Ferguson's toad (*Duttaphrynus scaber*). The Marbled Balloon frog (*Uperodon systoma*) has the least relative abundance and recorded rare amongst amphibians in Panna Tiger Reserve (Figure 12).

Among reptiles, the relative abundance and encounter rate of Spotted house gecko (*Hemidactylus gleadowi*) was highest (Table 4) followed by Delhi rock gecko (*Cyrtopodion* cf *aravallensis*), Checkered Keelback snake (*Fowlea piscator*), Oriental Garden Lizard (*Calotes versicolor*), Bark Gecko (*Hemidactylus leschenaultii*), and Yellow-belly gecko (*Hemidactylus flaviviridis*).

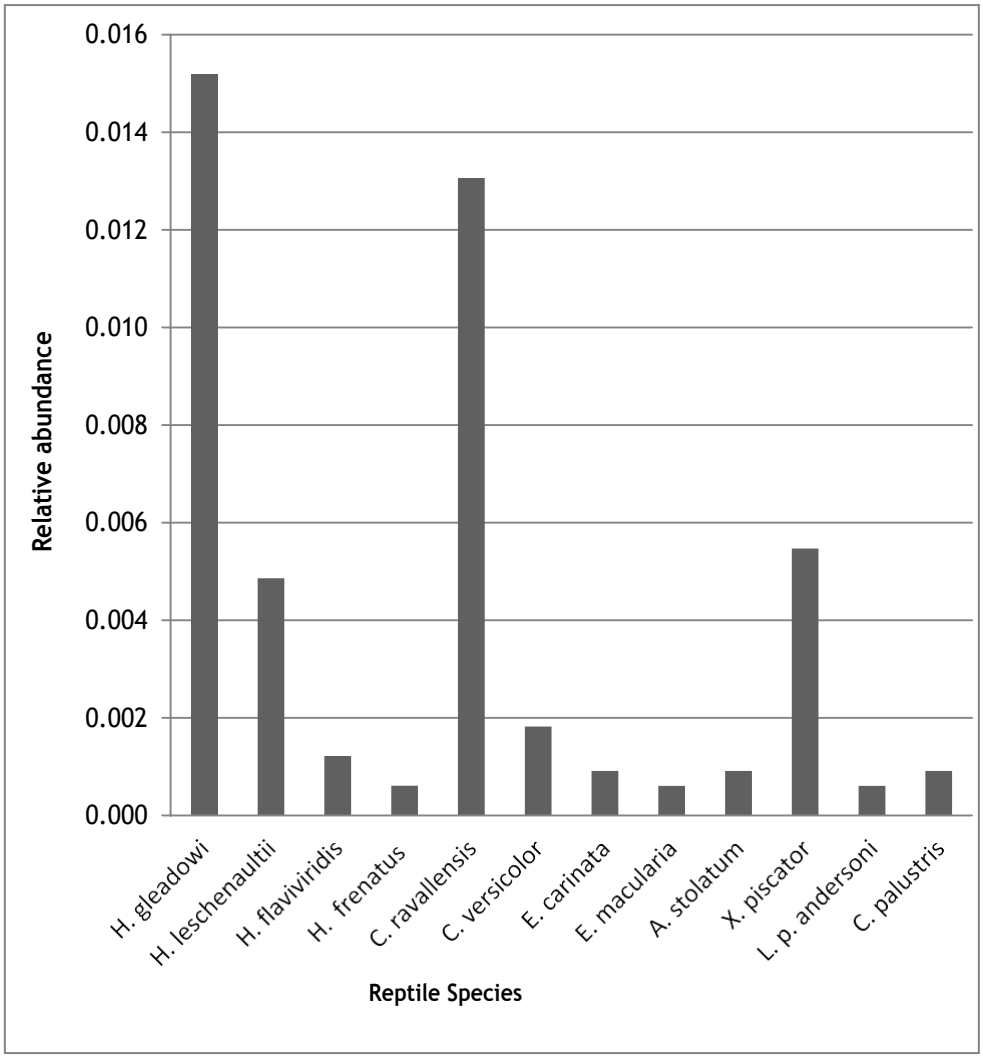

Figure 15: The relative abundance of reptile species recorded during VES in the study.

Table 4: Herpetofauna encounter rate (per hour/person) and relative abundance recorded in Panna Tiger Reserve:

S. no.	Herpetofauna Species	Encounter Rate / Hour	Relative Abundance
1	***Euphlyctis cyanophlyctis***	**7.73**	**0.404**
2	***Minervarya* sp.**	**5.12**	**0.267**
3	*Duttaphrynus scaber*	1.99	0.104
4	*Microhyla nilphamariensis*	1.01	0.053
5	*Polypedates maculatus*	0.76	0.039
6	*Sphaerotheca* cf *pashchima*	0.69	0.036
7	*Fejervarya orissaensis*	0.32	0.017
8	*Hoplobatrachus tigerinus*	0.22	0.012
9	*Duttaphrynus stomaticus*	0.12	0.006
10	*Uperodon globulosus*	0.12	0.006
11	*Duttaphrynus melanostictus*	0.09	0.005
12	*Hoplobatrachus crassus*	0.05	0.003
13	*Uperodon systoma*	0.01	0.001
14	***Hemidactylus gleadowi***	**0.29**	**0.015**
15	***Cyrtopodion* cf *aravallensis***	**0.25**	**0.013**
16	*Fowlea piscator*	0.10	0.005
17	*Hemidactylus leschenaultii*	0.09	0.005
18	*Calotes versicolor*	0.03	0.002
19	*Hemidactylus flaviviridis*	0.02	0.001
20	*Eutrops carinata*	0.02	0.001
21	*Amphiesma stolatum*	0.02	0.001
22	*Crocodylus palustris*	0.02	0.001
23	*Hemidactylus frenatus*	0.01	0.001
24	*Eutropis macularia*	0.01	0.001
25	*Lissemys punctate*	0.01	0.001
26	*Hemidactylus triedrus*	0.01	n/a
27	*Ophisops microlepis*	0.01	n/a
28	*Naja naja*	0.01	n/a
29	*Bungarus caeruleus*	0.01	n/a
30	*Daboia russelii*	0.01	n/a
31	*Oligodon arnensis*	0.01	n/a

4.3 Body mass distribution of anurans:

We collected body size and body weight data of 750 individuals belonging to of 13 species ofamphibians.

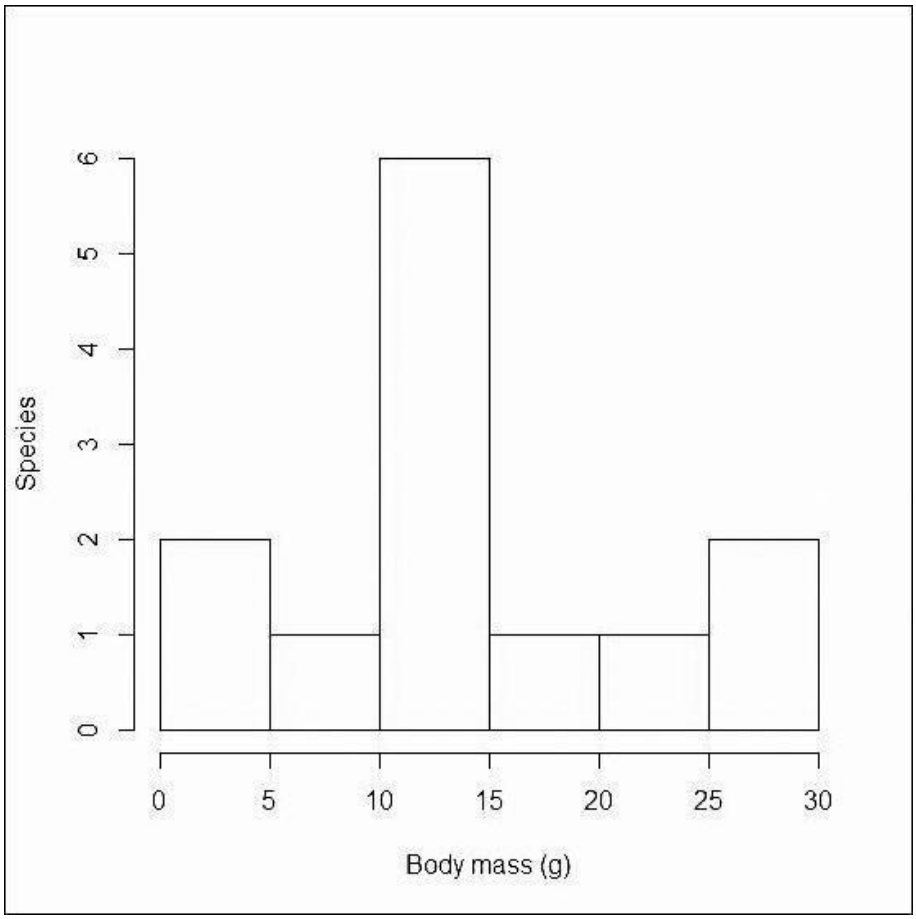

Figure 16: Histogram of body mass distribution of amphibians (frogs) in Panna Tiger Reserve

The highest numbers of species of frogs occurred in the mass range of 10 -15 grams (figure 15). Six species come under the 10 -15 grams range, two species come under the 0-5 gram range, two species come under 25-30 gram range and one species each comes under 5-10 gram, 15-20 grams and 20-25 grams range respectively. The species come in 10-15 grams categories are Marbled Toad (*D. stomaticus*), Indian Skipping Frog (*E. cyanophlyctis*), Orissa Frog (*F. orrisaensis*), Western Burrowing Frog (*S.* cf *pashchima*), Marbled Balloon Frog (*U. systoma*) and Indian Balloon Frog (*U. globulosus*).

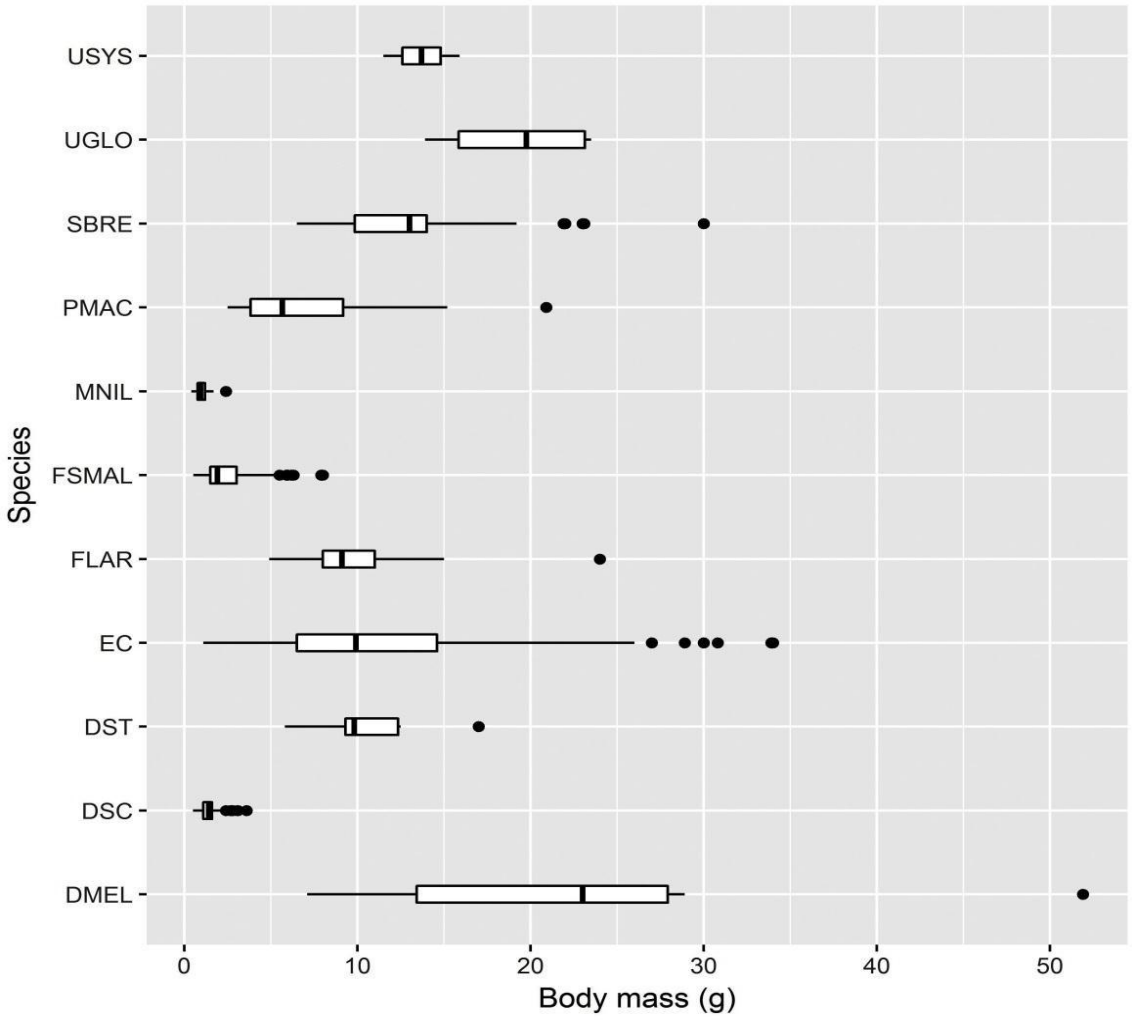

Figure 17: Box plots showing body mass distribution of 11 frogs of Panna Tiger Reserve. USYS- *Uperodon systoma*, UGLO- *Uperodon globulosus*, SBRE- *Sphaerotheca* cf *pashchima*, PMAC- *P. maculatus*, *M. nilphamariensis*, FSMAL- *Minervarya* sp., FLAR- *F. orissaensis,* EC- *E. cyanophlyctis*, DST- *D. stomaticus*, DSC- *D. scaber*, DMEL- *D. melanostictus*.

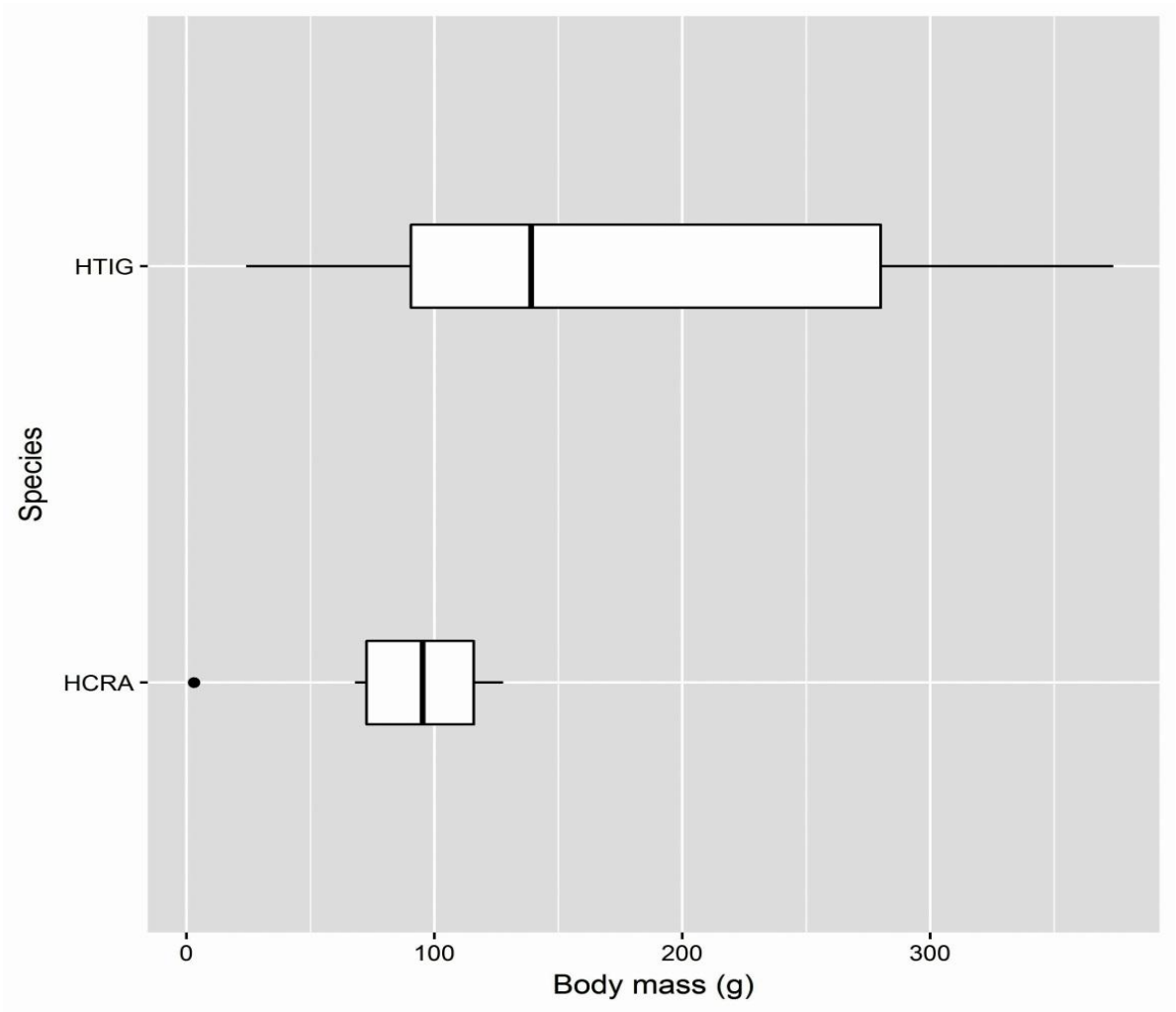

Figure 18: Box plots showing body mass distribution of frogs of Panna Tiger Reserve. HTIG-*Hoplobatrachus tigrinus*, HCRA- *H. crassus*.

4.4 Acoustic analysis and vocal behaviour of frogs:

We provide advertisement calls along with the quantitative description in brief of the vocalizations for the eight central Indian amphibian species: Common Indian Toad (*Duttaphrynus melanostictus*), Ferguson's Toad (*Duttaphrynus scaber*), Marbled Toad (*Duttaphrynus stomaticus*), Orissa Frog (*Fejervarya orissaensis*), Minervarya Frog (*Minervarya* sp.), Nilphamarai Narrow-mouthed Frog (*Microhyla nilphamariensis*), Common Indian Tree- frog (*Polypedates maculatus*), Western Burrowing Frog (*Sphaerotheca* cf *pashchima*), Indian Balloon Frog (*Uperodon globulosus*). Further, we provide quantified descriptions of seven temporal and one spectral acoustic properties measured for 5 calls per species (8 species) per individual.

Call character analysis:

1. **Ferguson's Toad (*Duttaphrynus scaber*):**
   The males were observed calling at the edge of ponds and puddles at night. The recorded males produced single type pulsatile calls. The calls were delivered continuously in mostly uniform intervals. The calls had mean duration of 187.80 ms (SD =2 ms) with 6.8 pulses delivered at the rate of 32.07 pulses/s. The mean rise time was 23.60 ms and mean fall time was 164.40ms. The mean dominant frequency was 3.23 kHz and mean peak power was96.72 dB, average inter-call interval was of 63.80 ms. The mean pulse duration was 12ms.

2. **Common Indian Toad (*Duttaphrynus melanostictus*):**
   The male individuals were heard making advertisement calls from the leaf litter at the edge of streams at night. They produced single type pulsatile calls at night. The calls were delivered continuously mostly in uniform intervals. The calls had mean duration of 53 ms (SD =13 ms) with 6 pulses delivered at rate of 117 pulses/s. The mean call rise time was 29 ms and mean call fall time was 23 ms. The mean dominant frequency was 1.7 kHz andmean peak power was 101 dB, average inter-call interval was of 39ms. The mean pulse duration was 10ms.

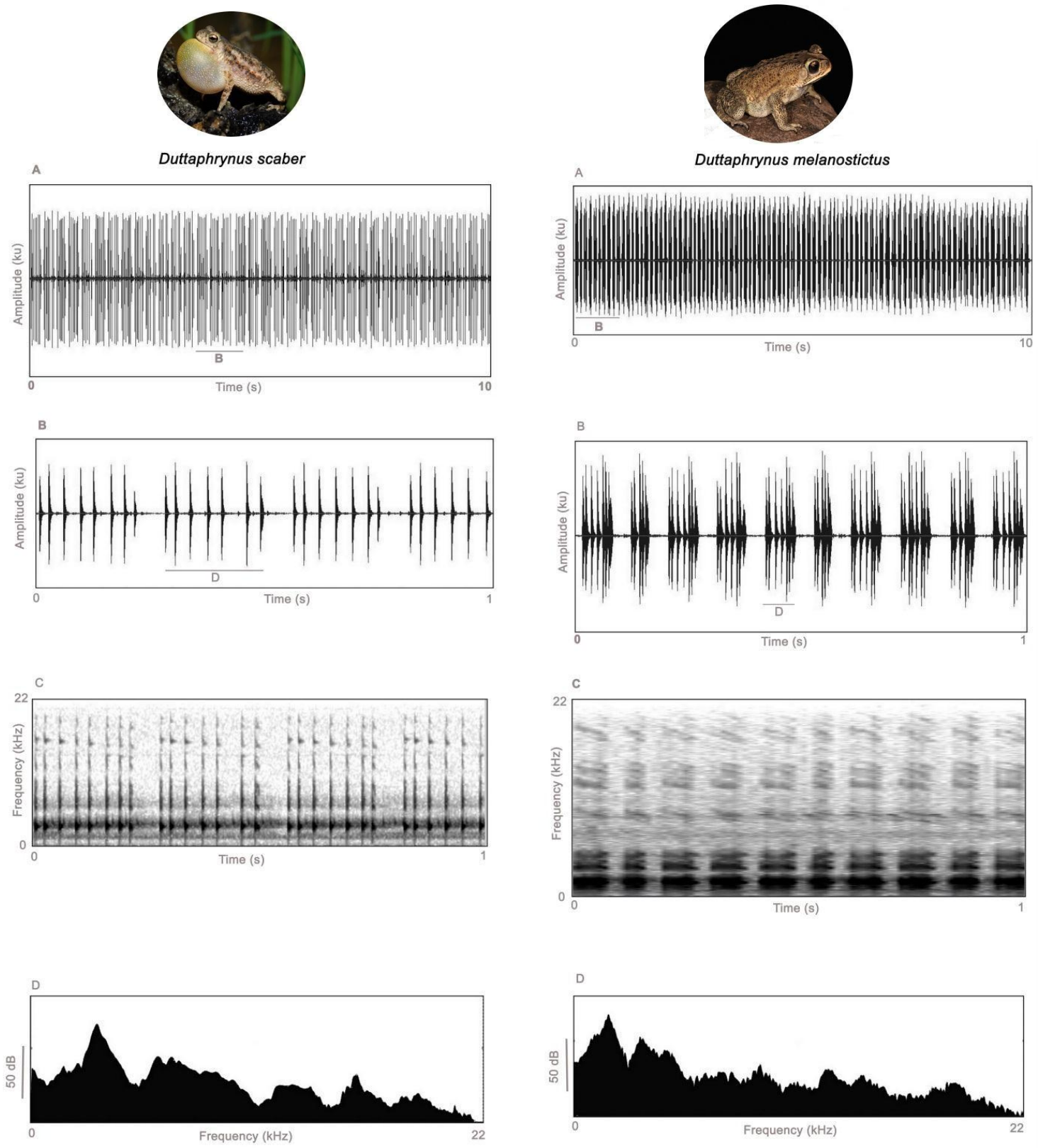

Figure 19: Advertisement calls of a male of **Ferguson's Toad (*Duttaphrynus scaber*)** and **Common Indian Toad (*Duttaphrynus melanostictus*).** A): 10 seconds oscillogram trace of a call by a single male. B): 1 second segment of call showing a number of calls and a single call

underlined in A. C):Spectrogram of the call/calls shown in B. (D) Power spectrum (1024 FFT size, Hanning window) of the call averaged over the duration of call depicted in B.

3. **Orissa Frog (*Fejervarya orissaensis*)**

   Males were heard calling at low pitch (compared with *Minervarya* sp.) in the night near the paddy fields. The calling males produced single type pulsatile calls. The calls had mean duration of 105ms (SD =2 ms) with 11 pulses delivered at rate of 105.7 pulses/s. The mean call rise time was 49ms and mean call fall time was 56ms. The mean dominant frequency was 2.6 kHz and mean peak power was 98.1 dB, average inter-call interval was of 453 ms. The mean pulse duration was 9 ms.

4. **Cricket Frog (*Minervarya* sp.)**

   The male of this species made calls in high pitch chorus, one male started and other males followed and increased the intensity of chorus while calling at night. They were commonly heard near all types of water bodies making mating calls during monsoon. Males produced single type pulsatile calls and increased the pitch gradually in the chorus as soon as other males picked up. The calls were produced in uniform and non uniform intervals both. The calls had mean duration of 55ms (SD =8 ms) with 12 pulses delivered at rate of 218.2 pulses/s. The mean call rise time was 32ms and mean call fall time was 24ms. The mean dominant frequency was 3.66 kHz and mean peak power was 99.4 dB, average inter-call interval was of 125 ms. The mean pulse duration was 4 ms.

5. **Indian Ballon Frog (*Uperodon globulosus*)**

   The male were heard calling in aggregations near roadside puddles after heavy rains in the night. The breeding advertisement calls were single type and pulsatile. The calls were delivered mostly in uniform intervals from the water bodies. The calls had mean duration of 153 ms (SD =7 ms) with 28 pulses delivered at rate of 197 pulses/s. The mean call rise time was 85 ms and mean call fall time was 67ms. The mean dominant frequency was 1.44 kHz and mean peak power was 98.1 dB, average inter-call interval was of 1583ms. The mean pulse duration was 4 ms.

6. **Nilphamarai Narrow-mouthed frog (*M. nilphamariensis*)**

   The calling males formed single type pulsatile call. The calls had uniform intervals. The calls had mean duration of 533ms (SD =46 ms) with 23pulses delivered at rate of 42.35 pulses/s. The mean call rise time was 373 ms and mean call fall time was 160ms. The mean dominant frequency was 1.37 kHz and mean peak power was 88.3 dB, average inter-call interval was of 1090ms. The mean pulse duration was 12 ms. In our calls, the mean call duration was longer and mean dominant frequency was lesser as compared with calls analysed by (Garg et. al. 2018) recorded from Western Ghats.

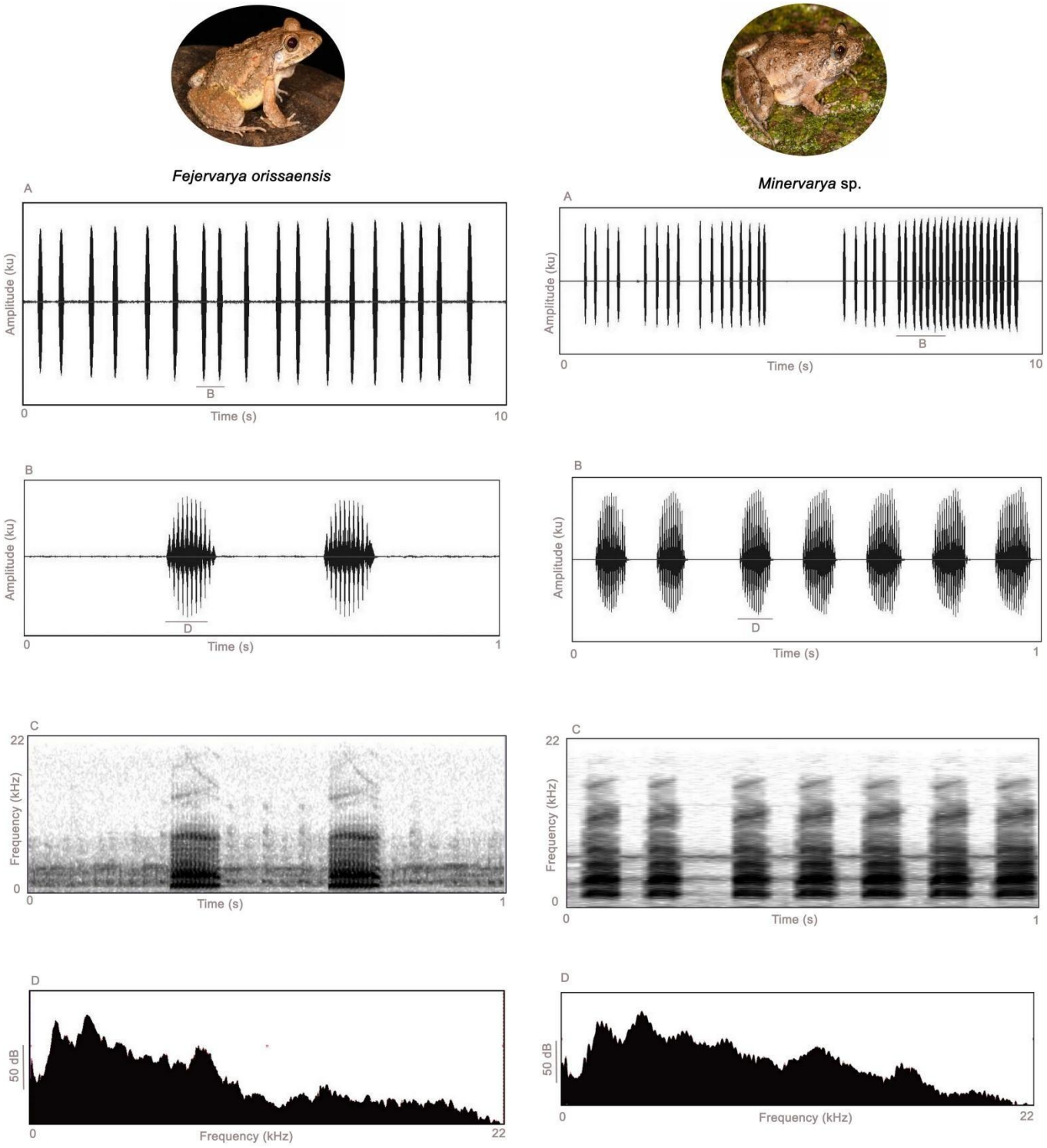

Figure 20: Advertisement calls of a male of **Orissa Frog (*Fejervarya orissaensis*)** and ***Minervarya* sp.** A): 10 seconds oscillogram trace of a call by a single male. B): 1 second segment of callshowing a number of calls and a single call underlinedinA. C): Spectrogram of the call/calls shown inB.(D) Power spectrum (1024 FFT size, Hanning window) of the call averaged over the duration of call depicted in B.

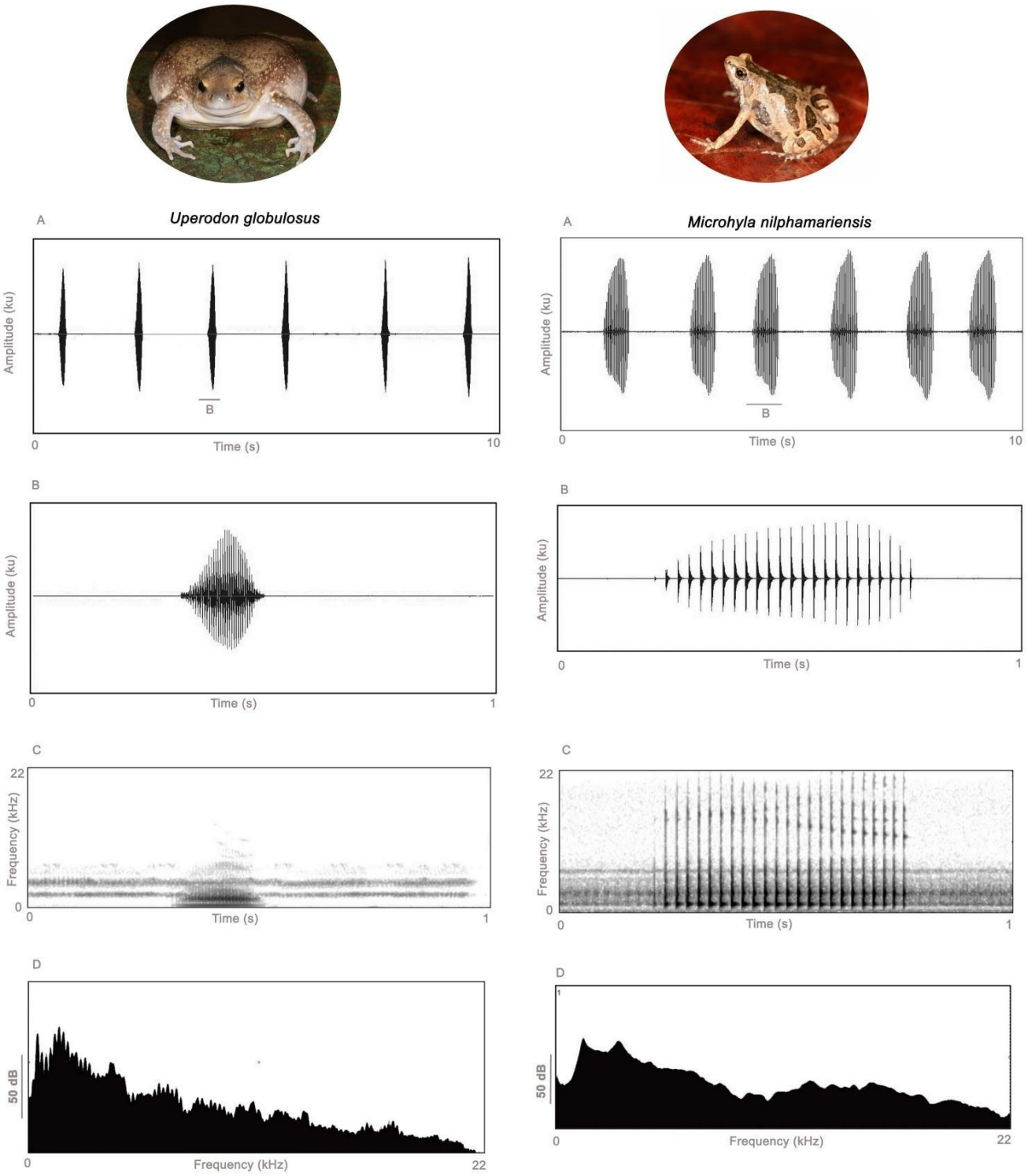

Figure 21: Advertisement calls of a male of **Indian Ballon Frog (*Uperodon globulosus*)** and **Nilphamarai Narrow-mouthed frog (*M. nilphamariensis*)**. A): 10 seconds oscillogram trace of a call by a single male. B): 1 second segment of call showing a number of calls and a single call underlined in A. C): Spectrogram of the call/calls shown in B. (D) Power spectrum (1024 FFT size, Hanning window) of the call averaged over the duration of call depicted in B.

7. Western Burrowing Frog (*Sphaerotheca* cf *pashchima*):

The male advertising calls started with onset of rains near puddles and streams in the night. They produced single type pulsatile calls. The calls were delivered in uniform intervals. The mean call duration was 384 ms (SD =11 ms) with 29 pulses delivered at rate of 75.37 pulses/s. The mean call rise time was 248 ms and mean call fall time was 137 ms. The mean dominant frequency was 0.99 kHz and mean peak power was 96.8 dB, average inter-call interval was of 285ms. The mean pulse duration was 10 ms.

8. Common Tree Frog (*Polypedates maculatus*)

The males were heard calling from bushes, trees and grasslands near puddles and streams during monsoon season in the night. The advertisement calls pulsatile and single type.The calls were delivered in non-uniform intervals. The calls had mean duration of 132ms(SD=19 ms) with 6 pulses delivered at rate of 38.13 pulses/s. The mean call rise time was 79ms and mean call fall time was 52ms. The mean dominant frequency was 0.82 kHz and mean peak power was 86.5 dB, average inter-call interval was of 349ms. The mean pulse duration was 4 ms.

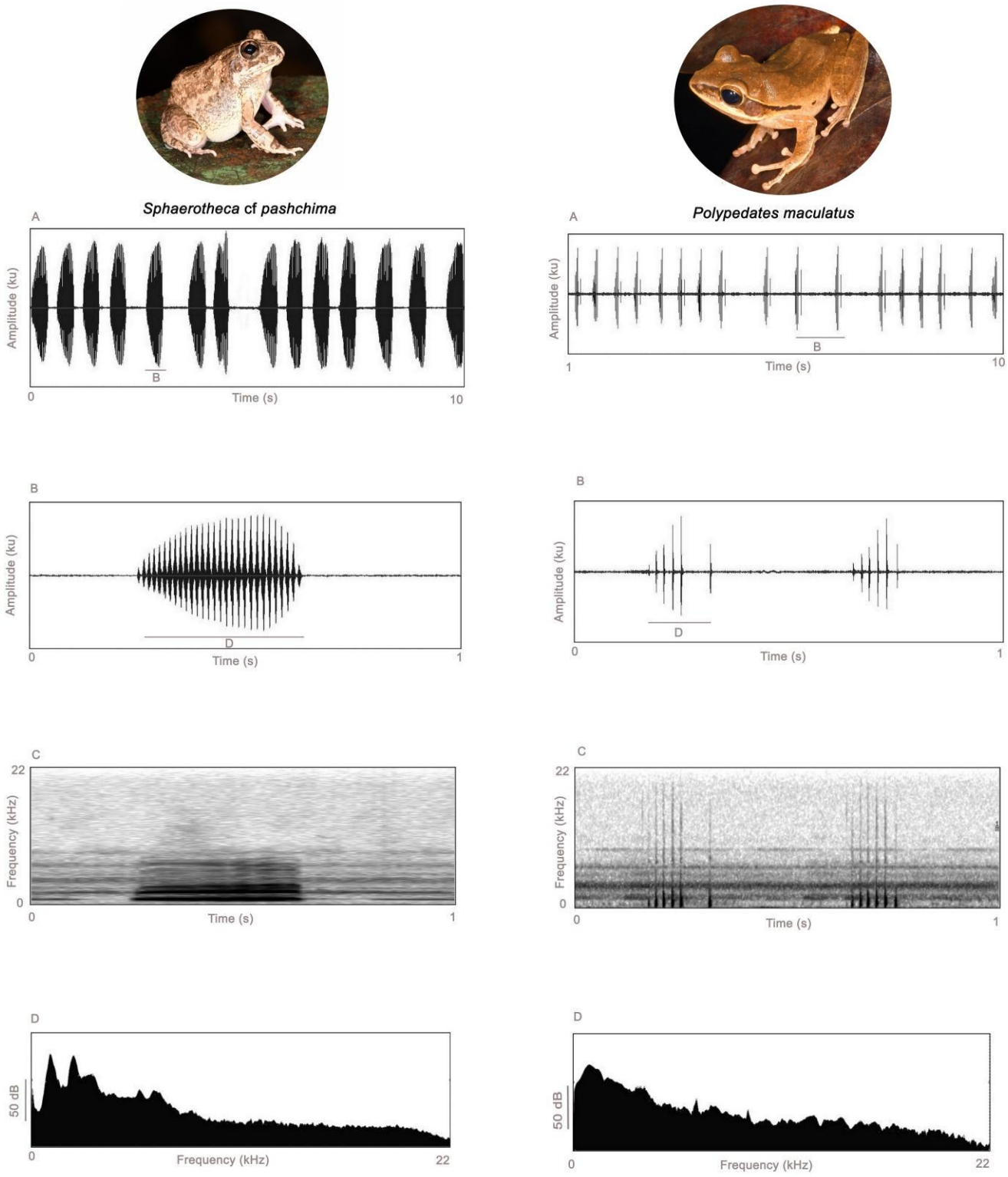

Figure 22: Advertisement calls of a male of **Western Burrowing Frog (*Sphaerotheca* cf. *pashchima*)** and **Common Tree Frog (*Polypedates maculatus*)**. A): 10 seconds oscillogram trace of a call by a single male. B): 1 second segment of call showing a number of calls and a single call underlined in A. C): Spectrogram of the call/calls shown in B. (D) Power spectrum (1024 FFT size, Hanning window) of the call averaged over the duration of call depicted in B.

Table 5. Descriptions of acoustic characters of eight anurans of PTR based on values determined from a sample of 5 calls from a males of each species:

S. no.	Species	Call Duration (ms)	Call rise time (ms)	Call fall time (ms)	Pulses per call (k)	Inter-call interval (ms)	Pulse rate (pulses/s)	Peak power (dB)	Dominant frequency (Hz)	Pulse duration (ms)
1	***D. scaber***	187.80±2.05	23.60±0.89	164.40±1.67	6.80±0.45	63.80±2.49	32.07±2.26	96.72±2.70	3230	12.40±1.34
2	***D. melanostictus***	52.60±12.54	29±13.25	23.40±4.28	5.80±1.10	39±1.58	117.03±13.39	101.42±1.97	1705.46±23.61	9±2.74
3	***F. orissaensis***	105.00±1.58	48.80±5.31	56±6.08	11	453±93.93	105.72±1.28	98.10±0.27	2635.70±19.23	9.20±0.45
4	***Minervarya* sp.**	55.20±6.79	31.80±8.33	23.60±2.73	12±1.41	125.40±28.47	218.25±6.42	99.42±1.00	3660.62±54.49	4.40±0.49
5	***S. cf. pashchima***	384.20±10.80	247.60±34.56	136.60±26.85	28.80±0.84	285.20±108.08	75.37±1.26	96.76±1.06	990.50	13±1.22
6	***U. globulosus***	151.60±7.27	85±5.05	66.60±2.97	28±1.58	1583.20±236.82	197±7.86	98.06±0.75	1447.06±23.61	4.20±0.45
7	***M. nilphamariensis***	533.40±46.26	373±30.21	160.20±29.68	23.40±1.95	1090±186.36	42.35±0.36	88.26±0.27	1378.10	11.60±0.55
8	***P. maculatus****	131.50±19.42	79.25±18.12	52±32.07	5.75±0.50	349±71.95	38.13±7.31	86.45±1.08	818.30	4±0.82

*Four calls were analysed from a single male. Data are presented as mean±SD.

4.5 Capacity building and awareness of herpetofauna

A major workshop for capacity building for the conservation of herpetofauna and Snake bite management was organised for the forest department staff of Panna Tiger Reserve and other local stakeholders. This training and capacity building workshop was conducted on 06.08.2018 in the presence of the Feld Director, Deputy Field Director, Assistant Field Director, Rangers, Beat guards and Shramiks. More than 100 participants participated in the training workshop and learnt snake handling skills to combat human wildlife conflict.

Figure 23: Awareness and capacity building programmes in Panna Tiger Reserve conducted during the project duration. A. & B. Major workshop on herpetofauna conservation and snake bite mitigation in Karnavati Madla, C. & D. Session and talk on herpetofauna conservation in Hinota conducted by project P.I. and researcher.

Also, a field training session and talk for awareness of herpetofauna was performed in Hinota with the participation of college students, visitors and locals. The session took place in the month of November 2017. Moreover, several talks (with pictorial presentation of species) with locals and villagers has been made in Hinota, Bador, Jaruapur villages for creating awareness and capacity building in local stakeholders for Herpetofauna conservation. We are in process of preparing a book in local language on the Herpetofauna of Panna Tiger Reserve for field staff and locals.

Grassland with rocky patches, a key gecko and agamid habitat

Photo plate: Reptiles

Hemidactylus gleadowi

Hemidactylus flaviviridis

Hemidactylus leschenaultii

Hemidactylus sahgali

Cyrtopodion* cf *aravallensis

Eublepharis satpuraensis

Eutropis carinata

Eutropis macularia

Lygosoma punctata

Ophisops microlepis

Varanus bengalensis

Lycodon aulicus **Non-venomous**

Lycodon striatus **Non-venomous**

Boiga forsteni **Mildly-venomous**

Boiga trigonata **Mildly-venomous**

Dendrelaphis tristis **Non-venomous**

Rhabdophis plumbicolor, **Adult Non-venomous**

Rhabdophis plumbicolor, **Juvenile**

Oligodon arnensis **Non-venomous**

Python molurus **Non-venomous**

Amphiesma stolatum **Non-venomous**

Grypotyphlops acutus **Non-venomous**

Eryx conicus **Non-venomous**

Coelognathus helena helena **Non-venomous**

Naja naja **(Venomous)**

Bungarus caeruleus **(Venomous)**

Daboia russelii **(Venomous)**

Echis carinatus **(Venomous)**

***Lissemys punctata,* Adult**

***Lissemys punctata*, Juvenile**

Pangshura tecta

Pangshura tentoria

Crocodylus palustris

Gavialis gangeticus

5. Discussion

1. This study documented 55 species of herpetofauna belonging to 41 genera and 21 families. 13 amphibians (9 genera and 4 families) and 42 reptiles (32 genera and 17 families) were recorded. Dicroglossidae is the dominant family (6 species) in amphibians followed by Bufonidae (3 species) and Microhylidae (3 species). Colubridae family of snakes has maximum diversity (11 species) in reptiles followed by Gekkonidae (6 species) family of geckos. *Fowlea piscator* was the most encountered snake and *Crocodylus palustris* was the most encountered crocodilian in PTR. *Eublepharis satpuraensis, Grypotyphlops acutus, Psammophilus* cf *blanfordanus, Argyrogena fasciolata, Lycodon striatus, Nilssonia* sp., *Pangshura tentoria* and *Gavialis gangeticus* were the rarest reptiles observed in our study. The spotlight of this study is the new records of *Fejervarya orissaensis*, *Hoplobatrachus crassus* and *Cyrtopodion* cf *aravallensis* in Madhya Pradesh state*. Eublepharis satpuraensis*, *Hemidactylus sahgali*, *Pangshura tecta*, *Pangshura tentoria* were first time recorded in PTR region. The reason of highest diversity and richness of amphibians in the Paddy field habitats may be due to management and retention of shallow water in paddy fields to grow paddy during the monsoon season. This provides breeding, foraging, and egg laying (oviposition) sites to several frogs. However, reptiles showed highest diversity and richness in Grassland habitats. This may be due the presence of rocky forest fence around Grasslands in Panna Tiger Reserve. The rocky crevices and outcrops provide ideal habitat to several lizards and snakes. This was the case in some of the locations we studied. The sightings of Muggers were highest from Magara Dabri to Judi in Madla (Figure 12). Most of the banks of Ken River (in PTR) have mostly rocky facets however during surveys we found some location such as Suda, Magra Dabri, Saksuma, Surajpura which have sandy banks which may be potential nesting site for Muggers and also for Gharials. Muggers were absent at some locations with disturbance (example Dodan village) due to fishing, farming and water pumping by electric motors etc. by local

villagers. A crocodile bite case was reported in Madla village in 2017 however bite cases are extremely rare in Ken River in PTR.

An individual (probably female) of Gharial (*Gavialis gangeticus*) was recorded from Muhare ghat in Ken Gharial Sanctuary in our study. Whitaker & Mahadev (1976) mentioned the sighting of few individuals by local fisherman near in Ken Gharial Sanctuary however according to Singh (1978) Gharials were extinct in the lower portion of the Ken River. An official report of forest department mentions the reintroduction of 142 *Gavialis gangeticus* (12 males, 48 females and 82 sex undetermined) 12 times since 1982 in Ken Gharial Sanctuary and Panna Tiger Reserve core area (Nair and Katdare, 2013). The only known mature adult male was last seen before the floods of 2005 by forest staff. At present, the record of only 1 individual (female) exists. The part of Ken River which flows through PTR and Ken Gharial Sanctuary has mostly rocky facets. The sandy segments and deep creeks which are prerequisite for the nesting of *Gavialis gangeticus* are inadequate and are not connected due to man-made barriers and disturbances. Based on these observations, the survival of a population of *Gavialis gangeticus* seems difficult and any future reintroduction plan of Gharial must be critically assessed.

2. The highest encounter rate and relative abundance was of Indian Skipping Frog (*Euphlyctis cyanophlyctis*) and *Minervarya* sp. amongst amphibians. This may be due to their adaptations to wide-ranging habitats and lack of suitable niches for other anurans in a dry deciduous forest. However, the Marbled Balloon frog (*Uperodon systoma*) has the least relative abundance and recorded rare amongst amphibians may be due to its secretive nature and very less activity period outside as it is a strong digger and goes deep in soil (Figure 12). In reptiles, Spotted house gecko (*Hemidactylus gleadowi*) has the highest relative abundance and encounter rate. With highest relative abundance and encounter rate Spotted house gecko (*Hemidactylus gleadowi*) was active in all season (except winters) in night and encountered easily. Delhi rock gecko (*Cyrtopodion* cf *aravallensis*) was another common gecko but active only in summers during the

breeding season. Yellow-belly gecko (*Hemidactylus flaviviridis*), Checkered Keelback snake (*Fowlea piscator*) and Oriental Garden Lizard (*Calotes versicolor*) were also common because of wide-ranging habitats. Sahgal's termite hill gecko (*Hemidactylus sahgali*), Satpura Eyelid Gecko (*Eublepharis satpuraensis*) were rare.

3. We used body mass as a surrogate to the body size. The body mass of anurans was analysed by plotting histogram of body mass for anurans. The highest number of species occurred in 10-15 grams range (Figure 15). The body mass distribution of frogs of PTR indicates a high species turnover in 10-15 grams range. It probably is an artifact of medium sized frog community in Panna Tiger Reserve (Harikrishnan et. al. 2014). The anuran community shows a significant difference in mass ratios of frogs from >5 grams to <270 grams in PTR and are not evenly spaced. The uneven distribution of body mass perhaps indicates to an improvised diversity of amphibians in PTR. The community structure of anurans shows all species needs to be intact. There should be no loss of species otherwise a gap will be created in ecosystem because anurans are an improvised community in PTR. We took this important data since body mass is a fundamental parameter in ecology, as it is related to several key ecological features and will be helpful in future studies. As an example, macroecological investigation has largely explored body mass variation along environmental biological trait in several taxa (Olson et al. 2009). The species which come in 10-15 grams range are Marbled Toad (*D. stomaticus*), Indian Skipping Frog (*E. cyanophlyctis*), Orissa Frog (*F. orrisaensis*), Western Burrowing Frog (*S.* cf *pashchima*), Marbled Balloon Frog (*U. systoma*) and Indian Balloon Frog (*U. globulosus*).
4. So far the bioacoustics technique was never used to describe and quantify the advertisement calls and breeding behaviour in this region of central India as the central Indian frogs and toads have always been overlooked due to their widespread distribution and being non endemic and non charismatic as compared to species found across biodiversity hotspot regions such as Western Ghats. However, bioacoustics

technique is useful in rapid species identification, systematics, monitoring and conservation of the species. During this study, we studied vocalisation and advertisement calls of 9 species of frogs and toads from Panna Tiger Reserve. This pioneer work study provides an important reference and tool to monitor and conserve frog species in Panna landscape. In case of Nilphamarai Narrow-mouthed frog (*M. nilphamariensis*), we found that in our calls, the mean call duration was longer and mean dominant frequency was lesser as compared with calls analysed by (Garg et. al. 2018) of *M. nilphamariensis* recorded in Amboli Western Ghats. Also, the temporal and spectral acoustic properties of two *Fejervarya* (one recently revised to *Minervarya*) species were distinct during our analysis. This indicates they are two different cryptic species and bioacoustics technique is effective in separating the cryptic species.

5. We observed eye anomaly and tumor on the inner hind limb in *Hoplobatrachus tigrinus* in Hinta village near polluted drain of mining area in September 2017, noticed ectrodactyly in limbs of *Minervarya* sp. and on two occasions and we witnessed abnormality in the mid-dorsal stripe and swollen dorsal of *Minervarya* sp. in paddy fields of Jaruapur. This bodily abnormality and infections may indicate use of pesticide and contamination of water due to pollution (Henle and Dubois 2017).

6. Among the recorded reptiles, Ga*vialis gangeticus* is categorized as Critically Endangered, *Crocodylus palustris* is Vulnerable, *Python molurus* is near threat of IUCN red data list. The *Varanus bengalensis, Python molurus, Pengshura tecta, Lissemys punctata, Crocodylus palustris, Gavialis gangeticus* and *Nilssonia* sp. are under Schedule I and *Ptyas mucosa* and *Fowlea piscator* are listed in Schedule II, all other recorded snakes are listed in Schedule IV of Wildlife Protection Act, 1972 of India. Eleven species recorded in our study are listed in CITES: *Gavialis gangeticus, Crocodylus palustris, Python molurus, Varanus bengalensis, Pangshura tecta, Nilssonia* sp., are listed in Appendix –I;*Ptyas mucosus, Naja naja* and an amphibian *Hoplobatrachus tigerinus* are

listed in Appendi –II; *Fowlea piscator, Daboia russelii* are listed in Appendix –III. All other recorded snakes are under Sch. IV of IWPA.

7. The species accumulation graphs reveal that in case of amphibians, the asymptote is achieved after the visual encounter surveys of approximately 60 sites. However, in case of reptiles, the species richness showed covert diversity even after the visual encounter surveys of 86 sites. This signifies that this present study has mostly recorded the amphibian richness in Panna Tiger Reserve. However, in case of reptiles, the species richness showed covert diversity even after the visual encounter surveys of 86 sites. It specifies further field investigations may bring additional reptile species in Panna Tiger Reserve. The species which are not recorded but have distribution or known from nearby areas in previous studies are *Uperodon taprobanicus*, *Microhyla rubra*, *Uperodon variegatus, Euphlyctis hexadactylus, Sitana* sp., *Hemidactylus chipkali, Sibynophis subpunctatus, Ahaetulla nasuta, Lycodon travancoricus, Ferania sieboldi, Bungarus sindanus walli, Bungarus fasciatus, Chamaeleo zeylanicus, Cyrtodactylus nebulosus, Cyrtodactylus varadgirii, Eutropis dissimilis, Eutropis trivittata, Lygosoma guentheri, Nilssonia gangetica* and *Nilssonia hurum.* Subsequent field surveys may yield more species.

   Future direction: The two years of field surveys in PTR revealed a cryptic hitherto unknown diversity of herpetofauna. However, a few taxonomic species remain to be identified. We are conducting further research to determine their scientific identity. At the same time, crucial ecological breeding information needs to be collected in more detailed manner. More surveys will help populate the distribution data of herpetofauna in PTR. Thus, further research in taxonomic distribution, natural history will help us repair detailed conservation action plan.

6. Summary

This was an extensive study focused on distribution, diversity and ecology of herpetofaunal assemblage in Panna Tiger Reserve and adjoining areas. This study represents the first time systematic inventory using various methods and techniques to effectively document the complete herpetofauna species richness and diversity not only in Panna Tiger Reserve but also for any protected areas such as a Tiger Reserve in Central India. It sets a standard protocol for any future herpetofauna study for central Indian dry deciduous forest landscape.

The study highlights are the rigorous and active searches of more than 200 potential habitats of herpetofauna with 55 species of reptiles and amphibians recorded in the period of two years. The study discovers the 3 new state herpetofauna records for Madhya Pradesh and 4 new regional records. Most importantly, as a result of this study, a new species of lizard from Panna Tiger Reserve is going to be described soon under this study. This study chiefly showcases the species distribution, diversity, richness, bodymass distribution of herpetofauna in PTR. The body mass distribution reveals the uneven distribution which perhaps indicates to an improvised diversity of amphibians in PTR. This study provides first time acoustic characteristics and call descriptions of eight frog species from central India. One Critically Endangered, one Vulnerable, one Near Threat on IUCN redlist, 7 species under Schedule – I of Wildlife Protection Act, 1972 of India, 11 species under CITES are recorded in present study. Moreover, the result reveals that Paddy field habitat have the highest diversity and richness of amphibians and Grassland habitat have the highest diversity and richness of reptiles in Panna Tiger Reserve. The Indian Skipping Frog (*Euphlyctis cyanophlyctis*), Minervarya Frog (*Minervarya* sp.), Spotted House Gecko (*Hemidactylus gleadowi*) and Delhi rock gecko (*Cyrtopodion* cf *aravallensis*) were the species with highest encounter rate and relatively most abundant. This report also discusses about species natural history with major emphasis on distribution of threatened and rare species such as Mugger and Gharial and suggests a more detailed crocodilians study is needed. The study also discusses about threats to the local species. The species accumulation curvature for amphibians reaches asymptote however reptiles have shown covert diversity and additional surveys are suggested to obtain complete reptile richness. We hope that the information provided in this report will be useful for further studies and conservation strategies for the herpetofauna in this landscape.

Photo Plate : Reproductive information of Amphibians

Duttaphrynus scaber, **Calling Male**

Duttaphrynus scaber, **Amplecting pair**

Duttaphrynus scaber, **Toadlet**

Duttaphrynus stomaticus**, Calling male**

Duttaphrynus stomaticus, **Amplecting pair**

Euphlyctis cyanophlyctis**, Calling male**

***Fejervarya orissaensis*, Calling male**

***Fejervarya orissaensis, A*mplecting pair**

***Minervarya* sp.**

***Minervarya* sp., Calling male**

***Minervarya* sp., Amplecting pair and female laying eggs**

***Minervarya* sp. tadpole**

***Microhyla nilphamariensis,* Amplecting pair**

***Microhyla nilphamariensis*, Tadpole**

***Polypedates maculatus* ,Foam nest**

***Polypedates maculatus* , Tadpole**

***Sphaerotheca* cf *pashchima,* Amplecting pair**

***Sphaerotheca* sp., Froglet**

Uperodon globulosus

***Uperodon* sp., eggs on water surface**

References:

1. **Aengals, R., V.M.S. Kumar & M.J. Palot (2011).** Updated Checklist of Indian Reptiles. Zoological Survey of India; http://zsi.gov.in/checklist/Checklist/Reptles.pdf. Accessed on 11 March 2019.
2. **Agrawal, H.P. (1976)** Fauna of Kanha National park, Reptilia Newsletter of the Zoological Survey of India 2 (6), 247- 249.
3. **Agarwal, I., Mirza, Z. A., Pal, S., Maddock, S. T., Mishra, A., & Bauer, A. M. (2016).** A new species of the *Cyrtodactylus* (*Geckoella*) *collegalensis* (Beddome, 1870) complex (Squamata: Gekkonidae) from Western India. *Zootaxa*, *4170*(2), 339-354.
4. **Allan, J. R., Watson, J. E., Di Marco, M., O'Bryan, C. J., Possingham, H. P., Atkinson, S. C., & Venter, O. (2019).** Hotspots of human impact on threatened terrestrial vertebrates. *PLoS biology*, *17*(3), e3000158.
5. **Alroy, J.(2015).** Current extinction rates of reptiles and amphibians. *Proceedings of the National Academy of Sciences*, *112*(42), 13003-13008.
6. **AmphibiaWeb. 2019.**<https://amphibiaweb.org> University of California, Berkeley, CA, USA. Accessed 23 Mar 2019.
7. **Bhandarkar, W. R., Paliwal, G. T., Bhandarkar, S. V., & Kali, A. A. 2012).**Herpetofaunal diversity at Navegaon national park, Distt. Gondia Maharashtra. *International Journal for Environmental Rehabilitation and Conservation*, *3*(1), 42-49.
8. **Böhm M, et al. (2013).** The conservation status of the world's reptiles. Biological Conservation 157: 372–385.
9. **Chandra, K., &Gajbe, P. U. (2005).** An inventory of herpetofauna of Madhya Pradesh and Chhattisgarh. *Zoos' Print Journal*, *20*(3), 1812-1819.
10. **Chundawat, R. S., Gogate, N., & Johnsingh, A. J. T. (1999)**. Tigers in Panna: preliminary results from an Indian tropical dry forest. *Riding the tiger: tiger conservation in human-dominated landscapes*, 123-129.
11. **Crump, M.L. and Scott, Jr. N.J. (1994).** Visual encounter surveys. In Heyer, W.R., Donnelly, M.A., Mcdiarmid, R.W., Hayek, L.C. and Foster, M.S. (Eds). Measuring and

monitoring biological diversity:standard methods for amphibians. Smithsonian Institution Press, Washington DC: 84–92.

12. **Dahanukar, N., Sulakhe, S., & Padhye, A. (2017).** Identity of *Sphaerotheca pluvialis* (Jerdon, 1853) and other available names among the burrowing frogs (Anura: Dicroglossidae) of South Asia. *Journal of Threatened Taxa*, *9*(6), 10269-10285.
13. **Das, A., & Das, I. (2017).** *A Naturalist's Guide to the Reptiles of South Asia: India, Bangladesh, Bhutan, Nepal, Pakistan, Sri Lanka and the Maldives*. John Beaufoy Publishing Limited.
14. **Das, A., Basu, D., Converse, L., &Choudhury, S. R. C. (2012)**. Herpetofauna of Katerniaghat Wildlife Sanctuary, Uttar Pradesh, India. *Journal of Threatened Taxa*, *4*(5), 2553-2568.
15. **Dandge, P. H., &Tiple, A. D. (2015).**A new species of rupicolus gecko of the genus *Hemidactylus* Oken, 1817 (reptilia: squamata: Gekkonidae) from Maharashtra, central India. *Russian Journal of Herpetology*, *22*(3).
16. **Deichmann JL, Duellman WE, Bruce Williamson G (2008).** Predicting biomass from snout–vent length in new world frogs. *Journal of Herpetology* 42, 238–45.
17. **Dinesh, K. P., Kulkarni, N. U., Swamy, P., & Deepak, P. (2017).** A new species of Fejervarya Bolkay, 1915 from the lateritic plateaus of the Goa parts of the Western Ghats. *Records of the Zoological Survey of India*, *117*(4), 301-314.
18. **Dodd Jr, C. K., & Smith, L. L. (2003).** Habitat destruction and alteration. Historical trends and future prospects for amphibians.
19. **Dutta, S. K. (2015).** Anuran fauna of Bastar Division of Chhattisgarh state, India. *Ambient Science*, *2*(2), 31-38
20. **Dutta, S. K. (1997).** A new species of *Limnonectes* (Anura: Ranidae) from Orissa, India. Hamadryad. Madras 22: 1–8.
21. **Dutta, S. K. (2009).** Amphibians and Reptiles of Similipal Biosphere Reserve. Regional Plant Resource Centre.
22. **Enge, K.M. (2001).** The pitfalls of pitfall traps. *Journal of Herpetology* 35(3): 467–478; http://doi.org/10.2307/1565965
23. **Frost, Darrel R. (2019)**. Amphibian Species of the World: an Online Reference. Version 6.0 (Date of access). Electronic Database accessible at

http://research.amnh.org/herpetology/amphibia/index.html. American Museum of Natural History, New York, USA.

24. **Garg, S., Das, A., Kamei, R. G., &Biju, S. D. (2018b).** Delineating *Microhyla ornata* (Anura, Microhylidae): mitochondrial DNA barcodes resolve century-old taxonomic misidentification. *Mitochondrial DNA Part B*, *3*(2), 856-861.
25. **Garg, S., Suyesh, R., Das, A., Jiang, J., Wijayathilaka, N., Amarasinghe, A. T., & Meegaskumbura11, M. (2019).** Systematic revision of *Microhyla* (Microhylidae) frogs of South Asia: a molecular, morphological, and acoustic assessment.
26. **Gibbons, J.W., D.E. Scot, T.J. Ryan, T.D. Buhlmann, B.S. Mets, J.L. Greene, T. Mills, Y. Leiden, S. Poppy & C.T. Winne (2000).** The global decline of reptiles, déjà vu amphibians. *BioScience* 50: 653–666;htp:// doi.org/10.1641/0006-3568(2000)050 [0653: TGDORD]2.0.CO;2
27. **Harikrishnan S., KarthikeyanVasudevan, Abhijit Das, B. C. Choudhary, S.K. Dutta and Indraneil Das (2014).**Macroecology of terrestrial herpetofauna in Andaman and Nicobar Archipelago. Final Report. Wildlife Institute of India. Dehradun, India
28. **Henle, K., & Dubois, A. (2017).** Studies on Anomalies in Natural Populations of Amphibians. *Mertensiella*, *25*, 185-242.
29. **Hoffmann M, et al. (2010).** The impact of conservation on the status of the world's vertebrates. *Science* 330(6010):1503–1509.
30. **Jayapal, R., Qureshi, Q., & Chellam, R. (2007).** Developing a spatial conservation protocol for Central Indian Highlands through a biogeographical analysis of birds and existing Protected Area network: a Geographical Information Systems approach. *Research report No. RR 07/001*.
31. **Kareiva, P., & Marvier, M. (2003).** Conserving biodiversity coldspots: Recent calls to direct conservation funding to the world's biodiversity hotspots may be bad investment advice. *American Scientist*, *91*(4), 344-351.
32. **Lajmi, A., Giri, V. B., & Karanth, K. P. (2016).** Molecular data in conjunction with morphology help resolve the *Hemidactylus brookii* complex (Squamata: Gekkonidae). *Organisms Diversity & Evolution*, *16*(3), 659-677.

33. **Manhas, A., Raina, R., & Wanganeo, A. (2018).** Reptilian diversity of the Bhopal Region in the State of Madhya Pradesh in central India. *IRCF Reptiles & Amphibians*, *25*(2), 104-114
34. **Mc Menamin, S. K., Hadly, E. A., & Wright, C. K. (2008).** Climatic change and wetland desiccation cause amphibian decline in Yellowstone National Park. *Proceedings of the national Academy of Sciences*, *105*(44), 16988-16993.
35. **Mirza, Z. A., & Raju, D. (2017).** A new rupicolous species of gecko of the genus *Hemidactylus* Oken, 1817 from the Satpura Hills, Central India. *Amphibian & Reptile Conservation*, *11*(1), 51-71.
36. **Mirza, Z. A., Sanap, R. V., Raju, D., Gawai, A., & Ghadekar, P. (2014).** A new species of lizard of the genus *Eublepharis* (Squamata: Eublepharidae) from India. *Phyllomedusa: Journal of Herpetology*, *13*(2), 75-90.
37. **Mirza, Z. A., Gowande, G. G., Patil, R., Ambekar, M., & Patel, H. (2018).** First appearance deceives many: disentangling the *Hemidactylus triedrus* species complex using an integrated approach. *PeerJ*, *6*, e5341.
38. **Mohapatra, P.P., Mahapatra, C., Dutta, S. K. (2017).** Studies on Amphibians of Odisha: An Overview. (IN) Das, A. (Ed.) Diversity and Ecology of Amphibians of India. ENVIS bulletin: Wildlife & protected Areas. Vol. 19. Wildlife Institute of India, Dehradun 248001, India, 11-31pp.
39. **Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GA, Kent J (2000)**. Biodiversity hotspots for conservation priorities. Nature 403:853–858.
40. **Nair, T., & Katdare, S. (2013).** Dry-season assessment of gharials (*Gavialis gangeticus*) in the Betwa, Ken and Son Rivers, India. *Crocodiles*, 53.
41. **Nowakowski, A. J., Watling, J. I., Thompson, M. E., Brusch IV, G. A., Catenazzi, A., Whitfield, S. M., & Todd, B. D. (2018).** Thermal biology mediates responses of amphibians and reptiles to habitat modification. *Ecology letters*, *21*(3), 345-355.
42. **Olson, V. A., Davies, R. G., Orme, C. D. L., Thomas, G. H., Meiri, S., Blackburn, T. M., & Bennett, P. M. (2009).** Global biogeography and ecology of body size in birds. *Ecology Letters*, 12(3), 249-259.
43. **Padhye, A., R. Pandit, R. Patil, S. Gaikwad, N. ukar& Y. Shouche (2013).** Range extension of Ferguson's Toad *Duttaphrynusscaber* (Schneider) (Amphibia: Anura:

Bufonidae) up to the northern most limit of Western Ghats, with its advertisement call analysis. *Journal of Threatened Taxa* 5 (11): 4579–4585; http://dx.doi.org/10.11609/JoTT. o3345.4579-85.

44. **Padhye, A., Dahanukar, N., Sulakhe, S., Dandekar, N., Limaye, S., & Jamdade, K. (2017).** *Sphaerotheca pashchima*, a new species of burrowing frog (Anura: Dicroglossidae) from western India. *Journal of Threatened Taxa*, *9*(6), 10286-10296.
45. **Pasha, M. K. S., G. Areendran, K. Sankar and Q. Qureshi (2000):** A preliminary checklist of snakes of Pench Tiger Reserve, Madhya Pradesh Cobra 40. 5-8.
46. **Pounds, J.A., M.R. Bustamante, L.A. Coloma, J.A. Consuegra, M.P.L. Fogden, P.N. Foster, E.L. Marca, K.L. Masters, A. Merino-Viteri, R. Puschendorf, S.R. Ron, G.A. Sanchez-Azofeifa, C.J. Stll& B.E. Young (2006).** Widespread amphibian extinctions from epidemic disease driven by global warming. *Nature* 439: 161–167; htp://doi.org/10.1038/nature04246.
47. **Prasad, V.K., A. Verma & G. Shahabuddin (2018).** An annotated checklist of the herpetofauna of the Rashtrapati Bhawan Estates, New Delhi, India*. Journal of Threatened Taxa* 10(2): 11295–11302; http://doi.org/10.11609/jott.3235.10.2.11295-11302
48. **Prasad, V., Dinesh, K., Das, A., Swami, P., Shinde, A., Jadhav, V.B. (2019).** A new species of *Sphaerotheca* Gunther, 1859 (Anura: Dicroglossidae) from the Eastern Plain, hot subhumid (moist) ecoregion of India. *Records of the Zoological Survey of India* (Accepted).
49. **Raj, P., Dinesh, K. P., Das, A., Dutta, S. K., Kar, N. B., & Mohapatra, P. P. (2018).** Two new species of cricket frogs of the genus *Fejervarya* Bolkay, 1915 (Anura: Dicroglossidae) from the Peninsular India. *Records of the Zoological Survey of India*, *118*(1), 1-21.
50. **Sanchez, E., Kurabayashi, A., Biju, S. D., Islam, M. M., & Hasan, M. (2018).** Phylogeny and classification of fejervaryan frogs (Anura: Dicroglossidae). *Salamandra* 109–116
51. **Sanyal, D.P. and G. Dasgupta (1990).** On the collection of reptiles from Baster District –Madhya Pradesh, Central India, *Hamadryad* 15(1): 18-20.
52. **Schleich, H. H., Kästle, W., &Kabisch, K. (1996).** *Amphibians and reptiles of North Africa* (Vol. 63). Germany: Koeltz scientific books, Koenigstein.

53. **Smith, M. A. (1931).** The fauna of British India, Ceylon and Burma: Amphibia and Reptilia, Vol. I. - Loricata, Testudines. Taylor and Francis Ltd., London. 185 pp.
54. **Smith M. A. (1935).***The Fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Vol. II. Sauria,* Taylor and Francis, London.
55. **Smith M. A. (1943).***The Fauna of British India, Ceylon, and Burma, including the whole of the Indo-Chinese subregion. Reptilia and Amphibia. Vol. III. Serpentes*, Taylor and Francis, London.
56. **Sodhi, N.S., D. Bickford, A.C. Diesmos, T.M. Lee, L.P. Koh, B.W. Brook, C.H. Sekercioglu & C.J.A. Bradshaw (2008).** Measuring the meltdown: drivers of global amphibian extinction and decline. PLoS ONE 3: e1636; htp://doi.org/10.1371/journal.pone.0001636
57. **Stuart, S. N., Chanson, J. S., Cox, N. A., Young, B. E., Rodrigues, A. S., Fischman, D. L., & Waller, R. W. (2004).** Status and trends of amphibian declines and extinctions worldwide. *Science*, *306*(5702), 1783-1786.
58. **Thakur, S. (2011).** A note on snakes of Kanha National Park and surrounding areas. *Reptile Rap*, *11*, 2-5.
59. **Todd, B.D., C.T. Winne, J.D. Willson& J.W. Gibbons (2007).** Getting the drift: examining the effects of timing, trap type and taxon on herpetofaunal drift fence surveys. *The American Midland Naturalist* 158(2): 292–305
60. **Thomas, A. & S.D. Biju (2015).** Tadpole consumption is a direct threat to the endangered Purple Frog, *Nasikabatrachus sahyadrensis*. *Salamandra* 51(3): 252–258.
61. **Uetz, P. 2019.** The reptile database, http://www.reptile-database.org. Accessed: 23 March 2019.
62. **Whitaker R. and Captain A. (2004).***Snakes of India: the Field Guide*, Draco books, Chennai, India.
63. **Whitfield, S. M., Bell, K. E., Philippi, T., Sasa, M., Bolaños, F., Chaves, G., & Donnelly, M. A. (2007).** Amphibian and reptile declines over 35 years at La Selva, Costa Rica. *Proceedings of the National Academy of Sciences*, *104*(20), 8352-8356.

Annexure

Table 5: Conservation status of herpetofauna recorded during the present study. IWPA: Indian Wildlife Protection Act, IUCN: International Union for Conservation of Nature and Natural Resources, CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora.

S. no.	Common Name	Species Name	Conservation Status
	Reptiles		
1	Yellow-belly gecko	*Hemidactylus flaviviridis*	Not Evaluated
2	Common house gecko	*Hemidactylus frenatus*	Least Concern (IUCN)
3	Spotted House Gecko	*Hemidactylus gleadowi*	Not Evaluated
4	Bark Gecko	*Hemidactylus leschenaultii*	Not Evaluated
5	Sahgal's termite hill gecko	*Hemidactylus sahgali*	Not Evaluated
6	Delhi rock gecko	*Cyrtopodion* cf *aravallensis*	Not Evaluated
7	Satpura Eyelid Gecko	*Eublepharis satpuraensis*	Not Evaluated
8	Oriental Garden Lizard	*Calotes versicolor*	Not Evaluated
9	Blanfords Rock Agama	*Psammophilus* cf *blanfordanus*	Least Concern (IUCN)
10	Common skink	*Eutropis carinata*	Least Concern (IUCN)
11	Bronze Skink	*Eutropis macularia*	Not Evaluated
12	Punctate supple skink	*Lygosoma punctata*	Not Evaluated
13	White-spotted Supple Skink	*Lygosoma albopunctatum*	Not Evaluated
14	Small-scaled lacerta	*Ophisops microlepis*	Least Concern (IUCN)
15	Common Indian monitor	*Varanus bengalensis*	Least Concern (IUCN), Sch I (IWPA), Appendix 1 (CITES)
16	Common Sand Boa	*Eryx conicus*	Sch IV (IWPA)
17	Red Sand Boa	*Eryx johnii*	Sch IV (IWPA)
18	Buff Striped Keelback	*Amphiesma stolatum*	Sch IV (IWPA)
19	Banded Racer	*Argyrogena fasciolata*	Sch IV (IWPA)
20	Forsten's Cat Snake	*Boiga forsteni*	Least Concern (IUCN), Sch IV (IWPA)
21	Common Cat Snake	*Boiga trigonata*	Least Concern (IUCN), Sch IV (IWPA)
22	Trinket Snake	*Coelognathus helena helena*	Sch IV (IWPA)
23	Common Bronzeback Tree Snake	*Dendrelaphis* cf *tristis*	Sch IV (IWPA)
24	Common Wolf Snake	*Lycodon aulicus*	Sch IV (IWPA)
25	Barred Wolf Snake	*Lycodon striatus*	Sch IV (IWPA)
26	Green Keelback	*Rhabdophis plumbicolor*	Sch IV (IWPA)

S. no.	Common Name	Species Name	Conservation Status
27	Common Kukri Snake	*Oligodon arnensis*	Sch IV (IWPA)
28	Indian Rat snake	*Ptyas mucosa*	Sch II (IWPA), Appendix 1 (CITES)
29	Checkered Keelback	*Fowlea piscator*	Sch II (IWPA), Appendix III (CITES)
30	Common krait	*Bungarus caeruleus*	Sch IV (IWPA)
31	Indian spectacled cobra	*Naja naja*	Appendix II (CITES), Sch IV (IWPA)
32	Indian Rock Python	*Python molurus*	Near Threat (IUCN), Sch I (IWPA), Appendix I (CITES)
33	Beaked Worm Snake	*Grypotyphlops acutus*	Least Concern (IUCN),Sch IV (IWPA)
34	Brahminy blind snake	*Indotyphlops braminus*	Sch IV (IWPA)
35	Russell's viper	*Daboia russelii*	Appendix III (CITES),Sch IV (IWPA)
36	Indian saw-scaled viper	*Echis carinatus*	Sch IV (IWPA)
37	Indian roofed turtle	*Pangshura tecta*	Sch I (IWPA), Appendix 1 (CITES)
38	Indian tent turtle	*Pangshura tentoria*	Not Evaluated
39	Indian flapshell turtle	*Lissemys punctata*	Least Concern (IUCN), Sch I (IWPA)
40	Softshell turtle	*Nilssonia sp.* Unknown	Sch I (IWPA), Appendix 1 (CITES)
41	Mugger crocodile	*Crocodylus palustris*	Vulnerable (IUCN), Sch I (IWPA), Appendix 1 (CITES)
42	Gharial	*Gavialis gangeticus*	Critically Endangered (IUCN), Sch I (IWPA), Appendix 1 (CITES)
	Amphibians		
1	Common Indian Toad	*Duttaphrynus melanostictus*	Least Concern (IUCN)
2	Ferguson's Toad	*Duttaphrynus scaber*	Least Concern (IUCN)
3	Marbled Toad	*Duttaphrynus stomaticus*	Least Concern (IUCN)
4	Indian Skipping Frog	*Euphlyctis cyanophlyctis*	Least Concern (IUCN)
5	Orissa Frog	*Fejervarya orissaensis*	Least Concern (IUCN)
6	Minervarya Frog	*Minervarya sp.*	Not Evaluated
7	Jerdon’s Bull Frog	*Hoplobatrachus crassus*	Least Concern (IUCN)
8	Indian Bull Frog	*Hoplobatrachus tigerinus*	Least Concern (IUCN), Appendix II (CITES)
9	Nilphamarai Narrow-mouthed Frog	*Microhyla nilphamariensis*	Not Evaluated
10	Common Indian Tree-frog	*Polypedates maculatus*	Least Concern (IUCN)
11	Western Burrowing Frog	*Sphaerotheca* cf *pashchima*	Not Evaluated
12	Indian Balloon Frog	*Uperodon globulosus*	Least Concern (IUCN)
13	Marbled Balloon Frog	*Uperodon systoma*	Least Concern (IUCN)

Wildlife Institute of India
P. O. Box. 18
Chandrabani, Dehradun – 248001
Uttarakhand