ENVIRONMENTAL AND ECOLOGICAL SURVEY ESPECIALLY FOR SPIDER RESEARCH IN EASTERN REGION OF RAJASTHAN AND ITS CATCHMENT AREA

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***ABSTRACT*: Spiders have been regarded as good indicators of habitat quality due to higher sensitivity to change in their environment. Spiders are attractive because of their intriguing biology and they can be easily collected and maintained in laboratory. This survey research was carried out between July 2012 – Dec.2016 in Eastern Region of Rajasthan lies between 27°2170 North Latitude and 77° 4895 East Longitude. The present study was attempted to accomplish the following objectives: The major objective of the present Survey research was to make a situation analysis and review of the Environmental and Arachnological studies undertaken in and around the Eastern Region of Rajasthan, explore the research gaps, and plan futuristic strategy. This included reviewing the present scenario in and around the Eastern Region of Rajasthan, revisiting the completed Arachnological investigation on Eastern Region of Rajasthan and its catchment, collecting and collating the findings of published and unpublished documents, and analyzing the data for examining decadal changes in several ecological variables.**

***Keywords*- Spider, Survey research, Research Gap, Eastern Rajasthan.**

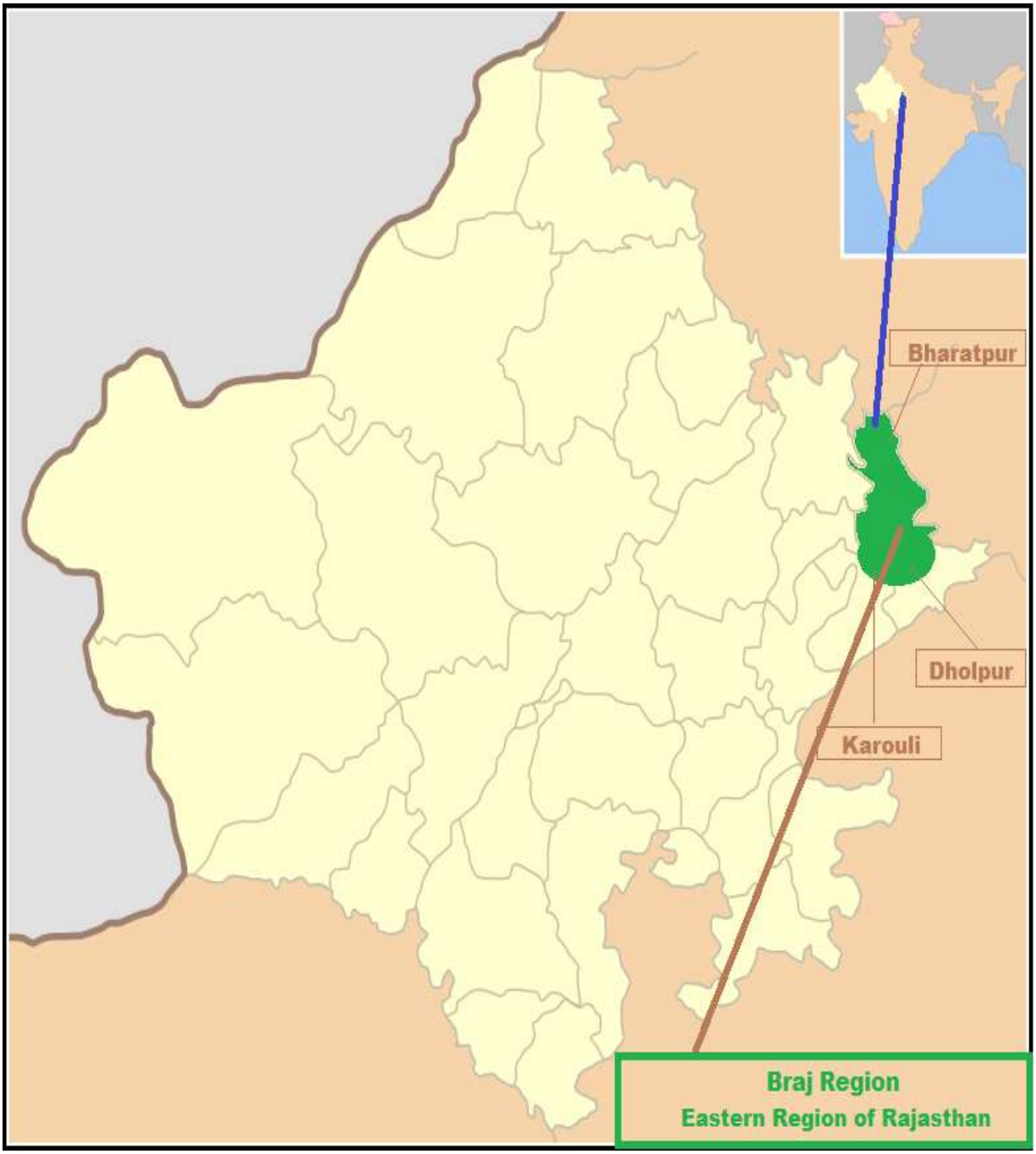
1. INTRODUCTION

Spiders can survive in most environments and are polypagous; therefore, they have great biodiversity. Although spider diversity in temperate regions has been well studied, tropical areas however, have received relatively little attention. Spiders are the most diverse and abundant invertebrate predators in terrestrial ecosystems (Wise 1993; Nyffeler 2000). They regulate the terrestrial arthropod population (Riechrt and Bishop, 1990; Coddington and levi, 1991). The global list of spider fauna is approximately 39,882 species belonging to 3676 genera and 108 families. (Platnick 2011). Tikader (1987) published the first comprehensive list of Indian spiders which included 1067 species belonging to 249 genera in 43 families. Rajasthan state has not been studied extensively for its spider diversity, fragmentary reports however, are available (Bastawade and Khandal 2006; Saini *et. al* 2012). Scanty reports are available on spider and its diversity in and around this region. (Lawania et.al 2013 a, b, c, d, e, f). This study is focused on the neglected diversity of spider fauna and providing base line information for further studies. The present work was carried out in forest and agriculture fields from Eastern region of Rajasthan (India). This Region locally known as Braj, is a mosaic of grasslands, woodlands, woodland swamps and wetlands. These diverse habitats are home to approximately 375 avian species including 140 species of waterfowl, 372 species of plants, 34 species of mammals, 57 species of fish, 14 species of snakes, 5 species of lizards, 3 species of Geckos, 7 species of turtles, 8 species of amphibians, 71 species of butterflies, more than 16 species of dragonflies and 51 species of spiders. The said area assumes ornithological significance in two respects - firstly because of its strategic location as a staging ground for migratory waterfowl arriving in the Indian subcontinent before dispersing to various regions. It is also a site where waterfowl converge before departing to breeding grounds in the western Palaearctic region. In addition, the wetland is a wintering area for massive congregations of waterfowl. Secondly it used to be the only regular wintering area in India for the central population of the rare and endangered Siberian crane. This region has been considered as a structural entity on the basis of topography and socio-cultural profile. The forest and vegetation of Eastern Rajasthan has been broadly classified and categorised in to three types depending upon three major zones: Semi-arid type, Subtropical humid type, and Tropical savana (Summer-dry type forest). These forests provide sufficient vegetation diversity and rich environment conditions for the spider fauna.

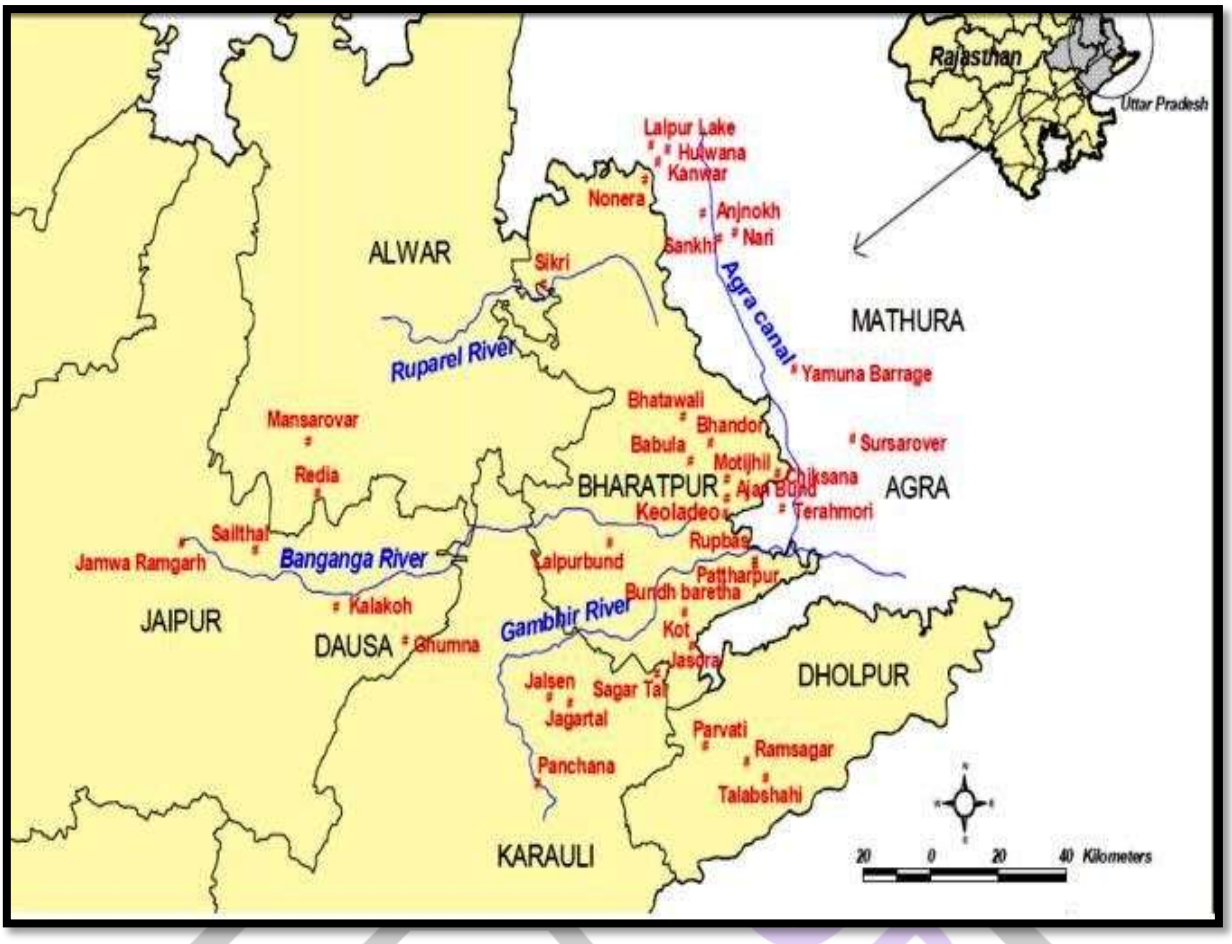
2. MATERIAL AND METHODS

2.1 Study area- The present work has been carried out in forest and agriculture fields of Eastern region of Rajasthan (India). The Eastern region of Rajasthan (Map-1) covers mainly Bharatpur district and some micro habitat areas of Dholpur and Karoli district (27.2170°N 77.4895°E) in Rajasthan. It was earlier known as "Braj". This dense forest region has wide diversity of habitats ranging from marshes, grasslands, woodlands, scrublands. South-West monsoon brings rainfall during the month of June to September. The average monthly temperature is 4 ^{O} C in December and 42 ^{O} C in June. The humidity in winter season is as low as 42% in the month of February and as high as 89% in the month of August. Eastern Region of Rajasthan lies at the confluence of the Gambhir and Banganga rivers. The area lies between 27°2170 North Latitude and 77° 4895 East Longitude. It is a low

lying area in the floodplains of river Banganga and Gambhir which are tributaries of river Yamuna covering an area of about 5099 sq. km. It is situated 180 km from Delhi, along the Delhi – Jaipur Highway, 50 km from Agra.



Map – 1- Location Map of Eastern region of Rajasthan



Map – 1- High value biodiversity areas (HVBA) of Eastern region of Rajasthan

2.2 Approaches

Macro level approach- Details of the research works undertaken in and around Eastern Region of Rajasthan was collected; Efforts were made to collect the available information from the following sources:
Newspaper reports/articles, Research articles published in scientific journals, Research reports and dissertations from academic and research institutions, Information available online, Records from various line departments of Government of Rajasthan, Government of India and other relevant sources such as Department of Forest and Wildlife, Agriculture, Irrigation, Rural Development, State Pollution Control, Board, Directorate of Economics and Statistics, State Ground Water Board, and Regional Census Office, Jaipur, India Meteorology Department (IMD), Jaipur. The collected information were collated and sorted out into a temporal scale of 5 years and as appropriate based on the availability of datasets to analyze the annual/decadal changes
Micro level approach- To gain basic understanding about the perception and opinion about ground scenario and the changes occurring over time, discussions were held with stakeholders.
Following approaches were adopted: Customized questionnaire survey and interaction with naturalists, armature bird watcher and Arachnologists.

2.3 Methods of collection (Especially spiders)

In total 24 study sites were chosen. Spiders were collected and counted by the two quantitative methods viz- Transect method (50 m x 10 m transects, with two transects per site) and quadrate method (20 m x 10 m quadrate, with 5-5 quadrate in per site and 10-10 quadrates in 15th & 16th sites.

(a) Field Methods: Well standard sampling protocols were adopted for spider collection in different sites of sampling. The detailed descriptions of this collection techniques are-

(i) Sweep Netting- this method is used to collect the foliage spiders is collated by this sampling method from herbs shrubs and low level vegetation (up to 2 m in height). The sweep net consists of a 90 cm handle; 40 cm ring.

(ii) Ground Hand Collecting- Knee level spider samples collected from this collection method. This method of sampling is used to collect the spiders, in the ground, litter, in broken logs, rocks which are found to be visible.

(iii) Aerial Hand Collecting- This collection method involved the collection of species of spiders from knee level to arm length level. This method accessed free-living and web-building spiders on the stems of living or dead shrubs, high herbs, foliage and tree trunks etc.

(iv)Vegetation Beating- This method is used to accesses spiders living in the shrub, high herb vegetation, bushes, branches and small trees. In this method spiders were collected on a cloth (1 m by 1.2 m) by beating high herbs vegetation, dead shrubs and high herbs with a stick.

(v) Litter sampling- Specimen were collected by hand. Litter sampling involved sorting of spiders from the litter collection tray.

(vi) Pitfall sampling- Wet pitfall trap method was used to study the ground dwelling spiders. The pitfall traps consisted of a 9 cm wide by 16 cm deep plastic jar, two-third filled with 70% ethyl alcohol and a few drops of liquid soap/detergent. The pitfall traps were left open for a period of three days. The distance between two adjacent jars was 5 meter.

3. RESULT AND DISCUSSION

The study was performed on 24 study sites of the said region. Spiders were collected and counted by most of the two quantitative methods viz- Transect method (with two transects per site and 50 m x 10 m transects,) and quadrate method (20 m x 10 m quadrates, with 5-5 quadrate per site and 10-10 quadrates in 15th & 16th site. These transect and quadrates were treated as our basic sampling units. Transects and quadrates were placed randomly within stratified habitat types. Sampling was carried out between July 2012 – Dec.2016. Spiders were sampled along these transects and quadrates using six sampling techniques (semi-quantitative sampling and pitfall traps). The main purpose of this sampling design was to produce a relatively complete species list and associated abundance data for a representative example of each habitat type in the region, and of the region as a whole.

Table-1 - Area of the site Compartments of Eastern Region of Rajasthan

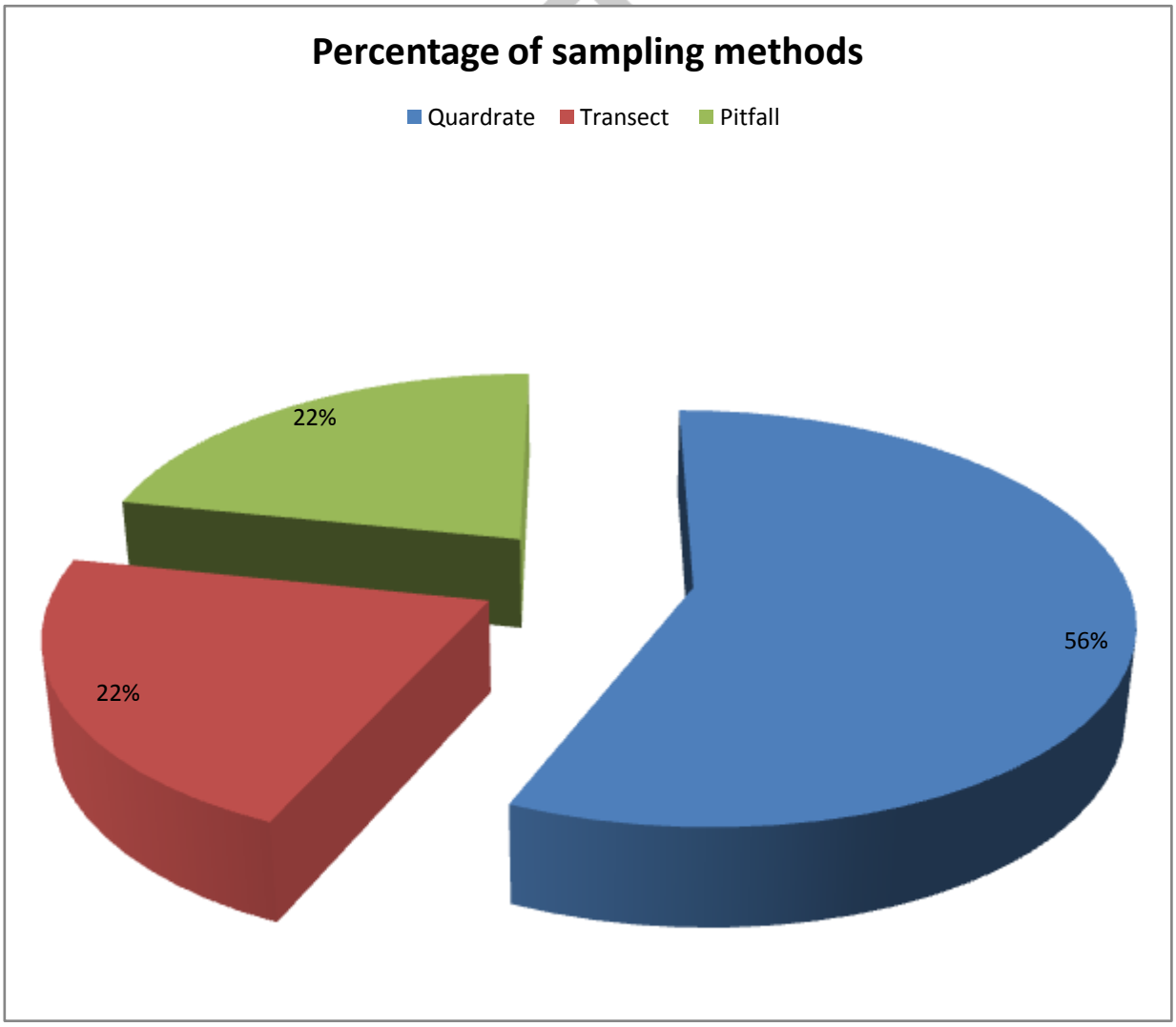
Site.No.	Area (km2)	Perimeter (km)	Habitat type
1	0.6792940	4.430	Woodland & Grassland
2	1.3163100	5.520	Woodland & Wetland
3	0.5567616	4.430	Woodland & Grassland
4	1.3884040	4.810	Wetland
5	1.5599370	5.390	Wetland
6	1.5107260	6.100	Wetland
7	0.8303809	3.760	Wetland
8	0.3989488	2.650	Woodland & Wetland
9	0.3283468	2.500	Woodland & Wetland
10	1.9087720	6.490	Woodland & Grassland
11	1.2857160	4.990	Woodland & Grassland
12	1.0107250	4.230	Woodland & Grassland
13	1.1976270	5.840	Woodland & Grassland
14	0.6597537	3.840	Woodland, Grassland & Wetland
15	1.7518300	7.890	Woodland & Grassland
16	1.5964930	5.350	Woodland & Grassland
17	0.5334135	3.830	Woodland & Grassland

18	2.2817700	5.970	Wetland
19	3.0626720	7.560	Wetland & Woodland
20	1.4475590	5.870	Wetland, Woodland & Grassland
21	1.0358230	5.260	Woodland
22	0.7166310	4.550	Woodland
23	0.6553409	3.610	Wetland
24	1.3382760	7.080	Woodland, Grassland & Wetland

Table-2- Showing no. of sampling method & sampling site with GPS range with special references to habitat type of Eastern Region

S.N of Site	Sampling Methods	No. of sampling points			Habitat type	GPS range
		Quadrate (Q)	Transect (T)	Pitfall (P)		
1	**Q, T & P**	**5**	**2**	**2**	Woodland & Grassland	26°-44’47” to 26°-52’36” N 76°-30’36” to 76°-50’58” E
2	**Q, T & P**	**5**	**2**	**2**	Woodland & Wetland	27°-10’08” to 27°-11’15” N 77°-31’58” to 77°-30’33” E
3	**Q, T & P**	**5**	**2**	**2**	Woodland & Grassland	27°-10’54” to 27°-10’15” N 77°-31’49” to 77°-32’12” E
4	**Q, T & P**	**5**	**2**	**2**	Wetland	27°-10’12” to 27°-09’56” N 77°-32’11” to 77°-31’30” E
5	**Q, T & P**	**5**	**2**	**2**	Wetland	27°-10’08” to 27°-09’31” N 77°-31’59” to 77°-36’07” E
6	**Q, T & P**	**5**	**2**	**2**	Wetland	27°-09’47” to 27°-09’24” N 77°-32’24” to 77°-31’54” E
7	**Q, T & P**	**5**	**2**	**2**	Wetland	27°-09’41” to 27°-09’20” N 77°-32’20” to 77°-31’51” E
8	**Q, T & P**	**5**	**2**	**2**	Woodland & Wetland	27°-09’17” to 27°-09’06” N 77°-31’48” to 77°-31’26” E
9	**Q, T & P**	**5**	**2**	**2**	Woodland & Wetland	27°-09’14” to 27°-09’16” N 77°-31’38” to 77°-31’13” E
10	**Q, T & P**	**5**	**2**	**2**	Woodland & Grassland	27°-08’31” to 27°-09’09” N 77°-33’13” to 77°-33’32” E
11	**Q, T & P**	**5**	**2**	**2**	Woodland & Grassland	27°-09’00” to 27°-08’28” N 77°-33’36” to 77°-35’32” E
12	**Q, T & P**	**5**	**2**	**2**	Woodland & Grassland	27°-08’15” to 27°-08’57” N 77°-33’12” to 77°-31’53” E
13	**Q, T & P**	**5**	**2**	**2**	Woodland & Grassland	27°-08’31” to 27°-09’09” N 77°-33’13” to 77°-33’32” E
14	**Q, T & P**	**5**	**2**	**2**	Woodland, Grassland& Wetland	27°-09’03” to 27°-08’26” N 77°-31’34” to 77°-31’01” E
15	**Q, T & P**	**10**	**3**	**3**	Woodland & Grassland	27°-08’14” to 27°-07’59” N 77°-33’37” to 77°-32’04” E
16	**Q, T & P**	**5**	**2**	**2**	Woodland & Grassland	27°-09’07” to 27°-09’17” N 77°-30’27” to 77°-30’13” E
17	**Q, T & P**	**5**	**2**	**2**	Woodland & Grassland	27°-09’08” to 27°-09’20” N 77°-30’27” to 77°-30’13” E
18	**Q, T & P**	**5**	**2**	**2**	Wetland	27°-09’34” to 27°-10’03” N 77°-31’19” to 77°-31’26” E

19	**Q, T & P**	**5**	**2**	**2**	Wetland & Woodland	27°-10'10" to 27°-09'39" N 77°-30'54" to 77°-30'33" E
20	**Q, T & P**	**5**	**2**	**2**	Wetland, Woodland & Grassland	27°-09'32" to 27°-09'07" N 77°-30'33" to 77°-30'20" E
21	**Q, T & P**	**5**	**2**	**2**	Woodland	27°-09'26" to 27°-10'07" N 77°-30'11" to 77°-30'07" E
22	**Q, T & P**	**5**	**2**	**2**	Woodland	27°-09'30" to 27°-10'42" N 77°-30'10" to 77°-30'03" E
23	**Q, T & P**	**5**	**2**	**2**	Wetland	27°-11'09" to 27°-09'39" N 77°-03'50" to 77°-30'37" E
24	**Q, T & P**	**10**	**3**	**3**	Woodland, Grassland & Wetland	27°-38'56" to 27°-50'32" N 77°-30'24" to 77°-40'03" E
Total		**130**	**50**	**50**	**Total GPS Range 26°44" to 27°50" North latitude 76° 53' to 77° 40 east longitude**	
		Total sampling points 230				



Graph-1- Showing sampling methods and its percentage in study area.

4. CONCLUSION AND RECOMMENDATIONS

Present compilation – A bibliography with 456 reports (both published and unpublished), research articles, conference proceedings, dissertations and theses, and books and booklets, Helped in identifying spider and other Environmental research gaps and priority areas that need to be studied to help maintaining the ecological integrity of Eastern region of Rajasthan, its surrounding ecosystems, and catchment areas. Research matrix was prepared, and accordingly, the research areas are divided in

two major heads: those required to be undertaken for the first time and those that require a revisit and comparison with earlier reported findings.

1. Research gaps: initial assessments-

i. Seed-bank for Eastern region of Rajasthan: Investigate the carrying capacity and minimum ecological requirement of seeds of both flora and fauna (especially spiders) of the region.

ii. Assessment of health of satellite wood lands, grasslands and wetlands in Eastern region of Rajasthan and their suitability as alternate habitats for both resident and migratory spiders.

iii. Flow regime and Environmental flow: Examine the flow regime of rivers supplying water to Eastern region of Rajasthan, and assess the environmental flow as an aid in decision-making process.

iv. Nutrient and contaminant budgeting in the upstream areas of Eastern region of Rajasthan especially in the catchment areas of the rivers need to be examined. It is expected that sub-surface flow must be inducing the spatial movement of agro-chemical residues in the region.

v. Assessment of quality of inflow water from alternate sources such as Chambal river and Govardhan drain.

vi. Investigate the co-existence and resources partitioning of major herbivores such as nilgai, sambar, chital, and feral cattle that would provide information which could help the management of habitat and population of these species in Eastern region of Rajasthan in the present context.

vii. Examine the changes in vegetation pattern and soil quality due to ongoing invasive species eradication programme. Investigate the role of Eastern region of Rajasthan in carbon sequestration.

viii. Cumulative Impact Assessment on land use changes, intensification of agriculture, hydrology and water regime, infrastructure development, ground water extraction, increase in visitors, etc.,

ix. Identification of indicator spider species and its ecology needs to be studied for the long term conservation of the region.

x. Assessment of Ecosystem services of Eastern region of Rajasthan and its economic evaluation.

xi. Creation of research database and analysis on research-management interface.

2. Research gaps: revisit and comparison

i. Study the land use changes in the region focusing on both urbanization and agriculture,

ii. Revisit the vegetation cover of Eastern region of Rajasthan and prepare a revised vegetation map for the region.

iii. Review the scenario on agriculture: intensification of agriculture, and use of organic fertilizers.

iv. Assessment of levels of agrochemical residues in various environmental compartments across trophic levels.

v. Regular monitoring of water quality and pollutants levels in the region is to be carried out to monitor the health of aquatic ecosystem.

vi. Assessment of ground water quality and impact of agrochemical inputs on aquifers and around Eastern region of Rajasthan,

vii. Comprehensive Environmental Assessment and Monitoring for the Eastern region of Rajasthan ecosystem and the adjoining areas with respect to biophysical and socioeconomic aspects. This would help the PA Management to take corrective measures.

viii. Periodic monitoring of status of spider population and their habitats for their long term conservation in the region.

ix. Bird migration study: Since thousands of migratory birds visit Eastern region of Rajasthan, it provides ample opportunity for bird ringing and monitoring. Through such attempt it would be easy to examine spatial movement of contaminants through organisms such as birds,

x. Climate change and avian influenza: Study the impact of global climate change, avian influenza etc. on global bird communities and their migration to and from Eastern region of Rajasthan. This also provides an opportunity to study the epidemiology of avian influenza in India.

xi . Aquatic-terrestrial habitat relationship: Due to changing climate and land use pattern the habitat relationship between aquatic and terrestrial ecosystems of the region needs to be studied.

xii. Evaluation of the catchment area to understand the land use pattern and its impact on the region environment.

xiii. Socio-economic assessments and economic evaluation need to be undertaken for the surrounding areas of Eastern region of Rajasthan.

5. ACKNOWLEDGEMENT

We would like to thank Prof. G.N. Vankhede, Ex- Professor and Head, P.G. Dept. of Zoology, S.G.B. Amravati University, for supporting us during the past 3 years. Our deep sense of gratitude goes to Dr. M.S. Malhotra, Senior Deputy Director, ICMR, New Delhi, who had supported us continuously with all kinds of his moral support.

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