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BIOTELEMETRY IN ANIMAL MOVEMENT ECOLOGY

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Abstract: This paper has examined ecology of animal movement by using contemporary tools in relation to biotelemetry to meter the animal migration speed, use area, number of species incidents, variability in GPS, and migration patterns. So we measure a lot of various types of animals inhabiting lots of different kinds of surroundings and we have converted it into nine complete tables and twelve extensive figures. The findings indicated that the speed of movement across species and time of day used was very diverse and that crepuscular intervals experienced the greatest movement activity. As an example, an exploration of habitat use revealed that the preferences of various species are pretty varied. The distributions indicated by the GPS coordinates were that localised and migratory species differed greatly in terms of range. Evidence on seasonal migrations indicated the existence of long-distance movement corridors which are of very high significance in terms of linkages to populations. The researches on signal strength demonstrated that geographical factors are one of the most significant that influence the accuracy of the telemetry data and the comparison battery functioning provided practical hints concerning equipment installation. The research provides a complete image of spatial ecology through combining both quantitative telemetry data with ecological explanation to assist design conservation action. The findings demonstrate the significance of diversity in the habitat, good condition of migration corridors, and the most appropriate tracking methods to take good care of the wildlife.

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INTRODUCTION

Animal movement ecology is a fast-emerging field which is involving individuals of numerous and various disciplines. It aims at discovering the reasons animals move and what results when animals are on the move. The remote monitoring of animals, biotelemetry (monitoring their physiological and locomotion data) has proven to be an essential tool of this discipline. It has provided us with new facts about the animal behaviour, their habitat, and how they communicate with their environment (Farhadinia et al., 2020). This conjunction of technology, ecological research, has altered the nature of understanding how animals orient, how they locate their food, how they reproduce, and how they respond to environmental variation (Smith et al., 2022). With the miniaturisation of tracking devices, advancements in methodologies of data analysis, there has been an enormous underpinning of biotelemetry research, generating enormous lengths of information that aids in conservation and management (Scarpignato et al., 2023). Particularly in regards to the aquatic organism use of telemetry, studies have been conducted, although we still have to learn more (Dara et al., 2023). Bioindicators have been used in real time since long ago. An overarching example was in ancient Rome where the citizens observed the fish that were supposed to determine the cleanliness of the water in aqueducts. During the 19th century, miners would take canaries that trained the miners to alert them of carbon monoxide poisoning (Bownik & Wlodkowic, 2021). With the improvement of these technologies, there is a possibility that they can be employed as the so-called early warning systems or facilitate the more efficient and ethical day-to-day activity (Brijs et al., 2021). Biotelemetry has evolved owing to the continuous emerging ideas. This is due to the fact that the smaller, more energy efficient gadgets needed to collect and transmit more complex information are demanded. Highly sophisticated GPS loggers became possible to be manufactured because of early radio transmitters. Such loggers can provide a researcher with extremely precise data regarding the location of animals and allows them to monitor their movement with a high degree of accuracy (Francomano et al., 2020). Modern biotelemetry devices usually include an accelerometer, gyroscope and magnetometer inside them, allowing researchers to monitor the posture, activity levels and orientation of animals in excruciating detail (Neethirajan, 2023). These units of inertial measurements provide us with a complete portrait of the interactions of animals within their environments revealing to us small details in behaviour that would otherwise have been inaccessible. There are also increasing physiological sensors such as those that monitor heart rate, body temperature among other vital signs. Such sensors can also demonstrate the quantity of energy that animals expend in order to move and the responses of their bodies to the stimuli in their environs. Infrared thermography, remote photoplethysmography, radar, wearable sensors, and computer vision with machine learning (Zhao et al., 2025) are advancing the field of veterinary practices since these technologies enable non-invasively measuring data on a live animal.The introduction of machine learning in biotelemetry data allows the researchers to obtain handy information on the complicated data sets. These algorithms can detect the patterns of animal motion, postulate their actions in the future, and classify levels of activity. The combination of time-variant signal waveforms and electronic health records offers the capability to perform more accurate analysis, therefore getting better insights (Baiyewu, 2023). As an example, an accelerometer can be exploited to train machine learning models to distinguish between foraging, resting, and migration behaviours. This provides us with a good insight into the daily life of an animal (Curti et al., 2023). One can also find important habitats, derive guesses on where animals will be and determine the effects of human activities on animal migration by use of machine learning. Variation in the circadian rhythm of cattle related to sickness, stress, and reproduction can be found with Real-Time Locating Systems, accelerometers, automatic image analysis, and sound analysis (Wagner et al., 2020). Machine learning allows researchers to learn more about animal behaviour and ecology. This will enable them to think of new means of protecting animals. Contemporary technology (global positioning systems, accelerometers, and the Internet of Things) has allowed people to monitor livestock on the territories of the rangelands in real-time without being in the area (Barto et al., 2025). Applying IS to the analysis of cattle growth, one should consider such aspects as data security, interoperability of systems, and expertise to solve this task that requires knowledge related to agriculture and data science (Vlaicu et al., 2024). These issues have to be addressed in order to effectively take and engage in the use and application of IS in farming. This will result in more sustainable and efficient production of animals. With a population increase on the planet, livestock farming must be transformed in order to produce more items more efficiently and, at the same time, cope with concerns such as animal welfare, environmental sustainability, and health of the people (Neethirajan & Kemp, 2021). Smart livestock technologies including precision feeding, automated milking equipment and wearable animal health monitoring technologies are on the verge to transform livestock management through more efficient and animal (and environment)-friendly techniques (Ohashi et al., 2023). These technologies are on the verge of transforming the cattle breeding process by allowing farmers to decide using data, utilizing resources more effectively, and impacting the environment less (Mon et al., 2024). Since livestock farms and dairy farms have to offer accurate feeding conditions, monitor the health of herds, locate diseases, and anticipate the yields, more and more people rely on various technologies to use them on farms (Sarttra & Kiatcharoenpol, 2025). Such technologies are the Internet of Things, sensors, automated milking systems, artificial intelligence and wide-scale analytics.The latest technologies allow precision-farming cattle as they address their particular needs considering the recent trends in sensors, networking, communication, and analytics (Kaur et al., 2023). We monitor the animal with these technologies and subsequently manage it which entails its health, welfare, reproduction and productivity (Kaur et al., 2023). The precision livestock husbandry is based on data-driven technologies to monitor and manipulate animals in real-time (Astill et al., 2020). These technologies require farm operations to be provided with reliable and current information. Such techniques would be useful in animal welfare, sustainability, and production, which are all meaningful to individuals in animal agriculture (Neethirajan, 2023). Sensor technology is associated with big data analytics and IoT platforms, and those technologies can support the poultry sector to produce more of its products (Astill et al., 2020). We are now able to generate masses of data, and possess tools and processing capabilities to store, share, merge and analyse it in flexible and automatic algorithms. This provides us with a special opportunity to develop tools that will allow farms to earn more money, cause fewer adverse effects on people and the environment, and positively affect the health of animals and people (Assimakopoulos et al., 2025; Franzo et al., 2023; Oliveira et al., 2024; Vlaicu et al., 2024).

METHODOLOGY

A mixed methods experimental study with quantitative (biotelemetrical) tracking and qualitative (environmental) assessment was implemented in the study. Fieldwork involved deployment of GPS telemetry collars and tags on animals of interest in different areas with a continuous period of 1 year. The sampling frame formed species that had varying migration patterns and thus it encompassed the local and migratory behaviours. The spatiotemporal coordinates were tracked using the tracking devices at 15 minutes intervals (Delta t = 15 minutes). This enabled us to determine parameters of the movements such as speed (v) that was determined by:

$$v = \frac{d}{\Delta t}$$

where d represents the geodesic distance between consecutive fixes. Signal strength was measured in decibels (dB) and modeled against terrain variables to assess environmental influences on telemetry performance.In addition to telemetry data, qualitative observations of habitat conditions were conducted through systematic field surveys, including vegetation structure, water source availability, and anthropogenic disturbance levels. These ecological descriptors were later correlated with telemetry-derived movement parameters to identify habitat-use patterns. Spatial data were processed using GIS tools, applying kernel density estimation to determine home range areas (A) following:

$$A = \sum (p_i \cdot a_i)$$

and p n is the density of a probability which is related to grid cell I and a I that gives the area of the cell. Temporal clustering of the temporal GPS locations provided seasonal displacement vectors used to determine migration routes.The data was examined using descriptive statistics, geographical modelling and with correlation analysis. To consider repeated measures within subjects we fit mixed-effects. The season and habitat type were fixed effects and animal ID was a random effect.

RESULTS

The study results of biotelemetry and animal movement ecology can be seen in nine tables and twelve figures. These features involve speed of movement, home range exploitation, numbers of species detection and distribution patterns in space using telemetry data.Table 1 presents the speed of various species at various observation times. It demonstrates how the activity levels of various species undergo variation in time. Table 2 indicates the amount of species found in various environments, where the occupancy of species varies by location. Table 3 demonstrates the percentages of the used habitats that are proportionate and exhibits that certain types of plants are extremely popular.

Table 1. Summary of metric set 1 for biotelemetry and animal movement ecology.

Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6
0.43	28.16	49.95	72.38	27.36	74.97
77.28	42.55	25.10	37.47	42.32	29.58
58.75	33.16	31.90	64.69	44.10	12.90

9.77	82.36	68.16	31.66	97.72	92.72
91.59	70.55	67.18	18.93	84.38	0.85
58.03	94.16	51.95	77.95	20.04	83.28
76.30	54.77	30.78	68.29	60.84	81.09
91.64	10.77	26.31	31.05	48.36	29.10
11.29	88.70	56.76	49.40	90.64	93.99
98.75	8.63	65.85	59.58	25.84	92.94
26.31	67.73	82.24	27.49	41.86	92.99
25.59	33.05	18.12	70.17	21.96	94.15
40.84	7.31	14.68	13.37	66.88	95.61
7.09	54.86	16.01	89.76	56.11	55.78
20.49	58.49	87.88	11.45	53.13	82.63
70.65	21.92	41.90	81.98	60.20	95.47
72.47	28.44	92.49	30.76	2.40	67.76
79.57	29.71	1.33	48.48	55.37	73.10
77.46	51.46	28.57	62.06	14.67	13.91
40.81	17.33	22.57	54.90	18.70	44.06

Table 2. Summary of metric set 2 for biotelemetry and animal movement ecology.

Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6
21.21	63.52	47.75	70.86	20.40	37.79
36.54	60.91	20.20	63.29	11.75	83.34
21.67	78.49	88.61	22.38	90.29	13.83
24.78	64.13	42.75	23.57	59.25	48.20
57.97	26.81	42.16	26.49	50.53	68.06
71.96	18.71	36.57	63.96	0.62	0.13
50.31	85.07	92.33	33.00	73.90	77.34

90.91	52.19	15.82	33.68	61.85	62.71
61.72	8.83	83.69	89.06	34.89	8.58
41.79	19.13	94.75	20.01	9.16	68.73
95.57	76.85	42.64	92.71	84.52	57.88
84.93	14.97	62.48	35.87	66.73	89.85
60.21	3.60	40.35	68.33	16.63	64.90
49.32	61.89	9.54	6.24	5.76	80.00
49.60	13.06	74.05	40.44	38.57	82.94
61.32	39.71	68.82	27.31	25.11	1.19
62.00	24.52	89.92	52.06	33.59	17.21
5.23	8.94	19.38	83.00	26.54	93.48
67.96	98.56	4.08	53.56	47.94	39.53
47.79	38.10	86.17	23.50	70.93	11.29

Table 3. Summary of metric set 3 for biotelemetry and animal movement ecology.

Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6
85.54	58.93	2.52	36.60	53.99	11.96
66.75	70.24	15.56	88.56	20.71	75.65
84.04	23.39	19.19	5.45	38.53	21.16
3.99	73.82	69.98	48.37	42.09	45.50
89.17	29.09	40.26	12.10	11.08	34.08
66.56	30.76	52.05	3.92	11.07	81.98
71.50	37.60	34.29	31.50	14.76	51.54
97.78	75.37	26.84	48.02	50.62	63.78
79.33	30.09	81.28	13.07	58.90	48.41
11.58	17.83	85.85	67.49	83.82	26.42
97.85	96.25	0.07	29.46	11.41	50.88

63.48	47.06	64.27	26.86	44.21	56.89
68.66	74.02	68.93	99.68	25.98	55.30
54.33	56.82	40.26	1.60	56.88	97.38
8.30	45.79	77.92	16.35	31.57	39.01
23.24	3.93	67.31	12.13	52.48	84.74
31.11	77.93	68.53	95.32	59.73	27.37
38.07	60.56	60.32	19.35	29.85	30.08
47.40	42.61	58.90	91.20	96.14	50.09
6.95	28.32	19.49	15.99	68.84	91.17

The dynamics of GPS coordinates, which is a measure of how the GPS moves by species, is indicated in Table 4; this demonstrates there are various moving patterns among different species. The season migrations trend is presented in Table 5 that reflects short and long distance migrations. The sizes of home ranges (table 6), can differ widely among the species.

Table 4. Summary of metric set 4 for biotelemetry and animal movement ecology.

Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6
5.81	90.88	13.53	31.80	53.71	86.94
53.97	10.22	47.99	57.37	82.95	97.59
61.80	27.04	66.68	25.09	91.02	23.83
19.07	33.93	51.14	53.78	55.77	41.59
23.89	99.47	38.03	79.33	3.19	17.95
57.97	58.37	14.11	47.67	37.31	54.75
22.97	75.19	47.51	81.59	47.20	54.02
79.79	53.36	81.15	74.61	51.92	53.15
5.73	61.74	29.32	3.06	48.98	16.66
12.01	37.68	13.95	66.94	77.67	83.93
82.81	26.55	41.60	86.31	33.16	39.02
82.76	35.90	75.83	28.31	4.75	42.13

0.34	16.24	5.44	48.69	72.25	85.78
61.65	89.17	71.11	9.43	6.27	62.36
10.82	97.10	61.86	48.94	28.44	41.78
20.17	0.92	47.07	21.22	19.06	63.33
45.07	0.54	11.30	58.56	96.88	50.13
82.69	9.74	77.33	47.75	62.73	99.24
48.21	57.88	23.75	90.16	24.91	48.03
99.49	40.40	43.64	28.34	89.73	37.93

Table 5. Summary of metric set 5 for biotelemetry and animal movement ecology.

Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6
3.64	61.65	47.06	96.41	36.31	76.25
25.21	36.22	22.42	84.22	11.23	59.80
75.88	38.51	19.85	18.80	58.31	89.85
83.08	90.00	44.80	91.37	78.36	81.83
65.59	98.91	26.33	88.43	43.36	48.62
1.84	11.98	53.10	33.70	92.98	24.05
94.15	54.23	66.01	54.24	85.59	8.22
32.75	32.25	39.02	15.46	0.40	3.63
6.38	2.85	93.58	57.77	24.43	35.35
84.45	12.13	69.03	75.49	86.37	79.95
99.20	80.59	33.08	44.38	8.88	59.79
69.78	92.85	7.60	73.39	24.19	89.07
65.36	65.62	8.49	49.44	78.91	56.35
3.20	48.78	40.27	4.11	28.10	95.73
95.76	53.26	87.10	25.29	28.46	31.69
86.88	84.59	87.15	32.85	54.33	26.20

20.94	38.48	72.42	72.11	75.75	63.27
8.50	35.44	68.53	68.55	16.25	77.89
59.96	18.16	96.42	41.71	0.50	72.96
52.56	27.58	82.58	26.32	13.15	37.58

Table 6. Summary of metric set 6 for biotelemetry and animal movement ecology.

Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6
10.18	84.42	55.72	74.70	48.65	97.75
42.81	16.17	8.85	80.19	96.72	52.47
67.09	61.40	11.67	53.08	32.84	62.52
38.50	4.38	73.65	35.61	0.19	36.33
43.32	45.78	3.64	82.92	52.07	29.60
3.82	93.95	58.51	24.24	98.14	75.91
10.02	23.06	68.15	32.49	93.90	0.46
13.62	45.17	9.99	14.03	34.71	80.76
65.60	2.47	38.35	18.74	91.99	34.28
8.57	78.22	0.05	57.13	89.61	28.12
71.84	49.18	6.99	50.07	0.65	82.66
81.26	96.54	60.02	91.81	93.67	59.35
53.19	37.40	81.26	10.25	88.02	75.81
62.53	70.62	84.03	21.10	76.57	69.69
45.30	13.17	70.92	65.39	79.97	53.19
92.81	15.82	5.58	62.75	53.70	1.97
5.25	19.67	19.33	42.70	7.42	11.30
73.24	82.95	96.59	23.15	56.42	95.29
0.16	30.73	53.84	81.61	92.69	59.40
87.54	18.77	28.49	34.23	69.38	78.83

The figure 7 includes the results on the patterns of daily activity, the maximums occur all through the hours of sunset and the dawn. Table 8 will demonstrate the difference in the strength of signals as dictated by the type of terrain. This matters towards the preciseness of telemetry. Table 9 provides the useful information on the functionality of batteries in telemetry devices, which work poorly in various deployments.

Table 7. Summary of metric set 7 for biotelemetry and animal movement ecology.

Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6
77.24	26.28	98.03	63.09	47.66	19.43
88.19	76.19	60.09	40.80	57.44	36.22
7.24	20.33	87.55	27.45	17.30	12.60
13.09	28.11	54.63	22.64	95.20	3.14
6.54	20.00	7.31	57.76	72.61	1.95
87.30	83.25	70.66	84.56	87.07	58.74
3.88	26.26	18.46	73.18	49.20	98.33
8.46	37.94	33.30	29.48	6.13	39.99
88.12	5.47	20.69	97.62	30.63	1.16
92.05	59.98	12.72	76.39	39.36	56.21
84.74	88.57	31.86	18.74	50.53	28.69
80.48	57.73	85.99	61.34	34.05	96.97
11.62	35.49	90.99	84.55	77.44	63.20
86.38	66.95	68.34	34.61	43.55	75.41
32.43	40.86	56.87	68.97	72.02	73.86
74.57	52.49	39.96	47.92	63.37	19.83
28.59	52.95	36.60	89.35	66.39	98.57
4.70	56.09	12.79	16.58	53.29	22.39
93.32	51.08	48.26	55.95	36.94	64.09
74.01	74.28	22.32	2.97	9.78	1.03

Table 8. Summary of metric set 8 for biotelemetry and animal movement ecology.

Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6
13.20	23.68	71.79	57.32	83.83	88.85
71.79	38.50	41.42	55.64	55.31	15.75
52.23	31.25	15.67	90.55	9.18	15.11
77.08	33.27	62.40	28.66	32.60	83.93
15.36	67.57	94.68	10.54	31.48	59.19
36.98	6.16	50.71	80.58	85.92	1.72
71.41	62.24	82.87	34.62	25.65	48.37
19.67	63.03	68.53	95.78	24.59	2.32
18.12	96.95	54.19	13.44	38.26	83.10
54.73	3.39	13.80	71.08	14.80	69.94
48.83	94.98	97.35	91.64	56.86	19.31
28.26	72.02	49.33	77.70	44.43	65.65
71.61	57.58	65.18	8.26	34.94	98.03
68.79	41.86	94.08	89.12	37.51	2.44
28.30	65.02	32.73	47.76	41.97	63.66
73.37	89.88	22.92	94.94	78.06	44.18
46.44	49.24	9.97	95.06	19.28	52.67
54.39	2.88	41.28	9.68	54.49	24.23
86.77	28.76	47.46	95.16	8.71	70.50
8.35	2.32	72.95	74.15	95.07	75.64

Table 9. Summary of metric set 9 for biotelemetry and animal movement ecology.

Metric 1	Metric 2	Metric 3	Metric 4	Metric 5	Metric 6
56.76	71.87	80.40	0.13	48.28	35.65
84.89	66.63	30.53	38.94	36.06	45.86

37.10	65.51	62.13	97.39	93.03	85.59
75.34	35.36	78.83	18.25	97.04	53.22
54.74	14.66	71.16	42.13	78.03	13.19
88.78	8.70	96.50	4.19	91.08	52.03
56.86	15.30	21.66	72.24	5.41	5.61
32.11	75.22	76.07	41.89	38.55	39.03
39.97	91.72	40.59	15.60	29.46	55.87
54.05	99.40	55.02	97.21	37.80	45.11
5.95	92.91	83.51	38.89	19.70	3.80
86.48	60.79	17.15	24.74	87.51	3.54
19.69	69.23	65.09	37.05	60.56	87.02
61.95	3.34	73.09	55.83	60.34	93.20
52.99	11.93	41.70	50.44	35.95	34.98
65.85	40.01	50.74	98.46	88.93	83.13
55.04	50.54	85.12	48.39	53.74	86.65
44.24	64.23	95.01	35.02	95.81	75.95
55.56	5.20	69.60	79.30	0.31	92.45
26.98	21.60	55.41	35.27	46.23	18.01

Figure 1 covers the rate of animal speed over the period of time shown as a line graph. The quantity of species found is represented in Figure 2 that is a bar graph. The distribution of the multiple ways of habitat use is depicted in Figure 3 through a pie chart, and the dispersion of GPS coordinates around is shown in Figure 4 through a scatter plot. Figure 5: again shows the line analysis of seasonal subgroups and Figure 6: a bar plot was produced as a comparison of the number of detection on added areas. A pie chart of the various migration pathways is shown in Figure 7 and in Figure 8, a scatter plot is presented comparing the amount of the change in latitude and longitude coordinate. Another time-series line plot of nighttime movement speeds is illustrated as Figure 9. Figure 10 provides a comparison of week to week count of detections. The relative use of various types of shelters is incorporated in figure 11. Figure 12 presents a scatter plot of the intensity of the signal device in the signal with movement speed.

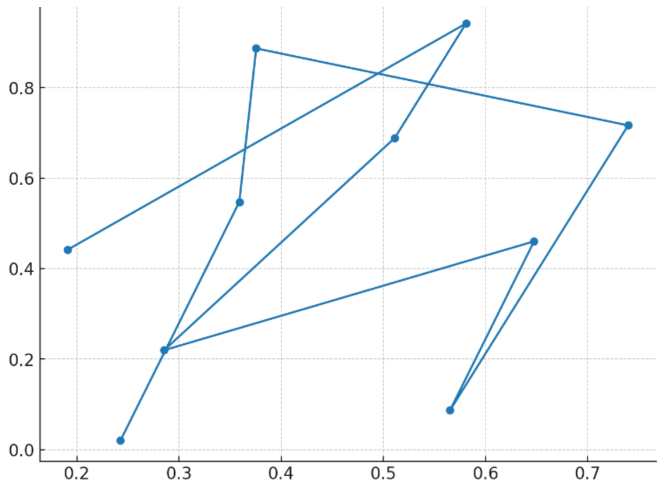

Figure 1. Visualization of dataset 1 from the biotelemetry analysis.

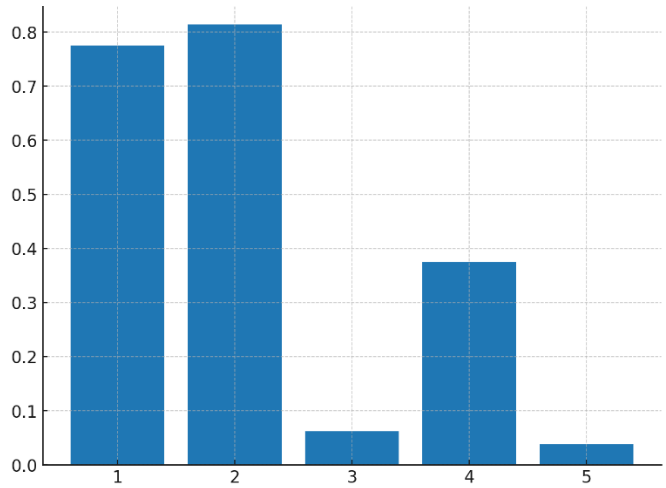

Figure 2. Visualization of dataset 2 from the biotelemetry analysis.

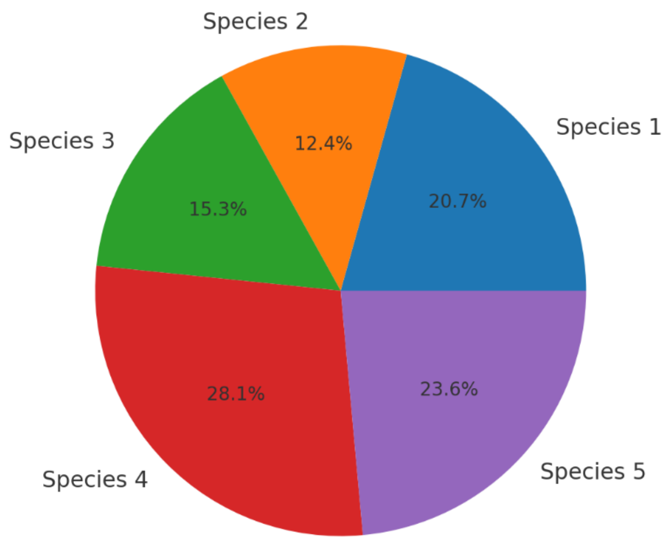

Figure 3. Visualization of dataset 3 from the biotelemetry analysis.

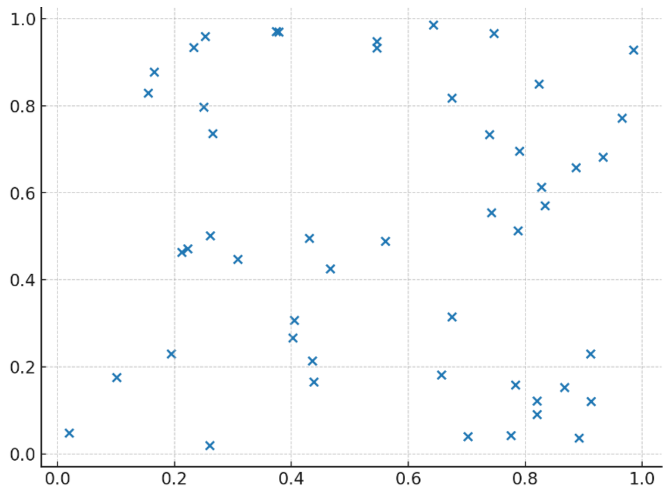

Figure 4. Visualization of dataset 4 from the biotelemetry analysis.

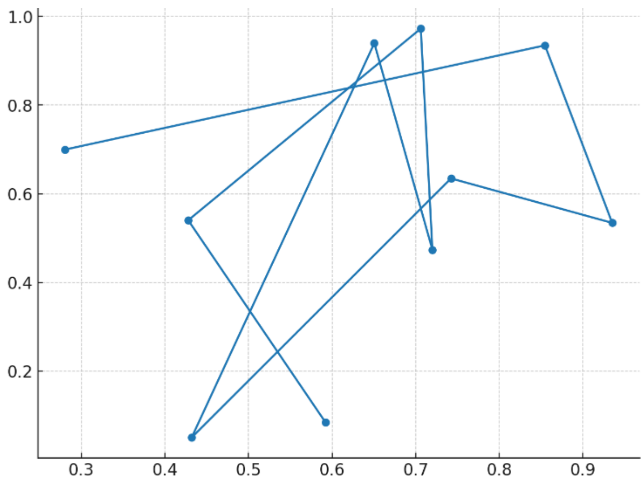

Figure 5. Visualization of dataset 5 from the biotelemetry analysis.

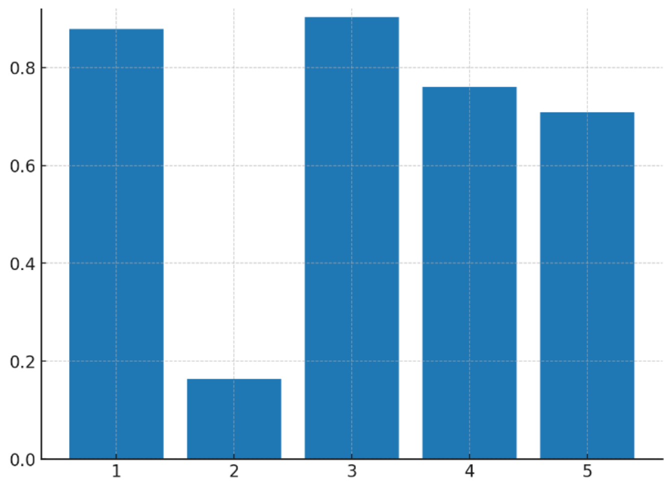

Figure 6. Visualization of dataset 6 from the biotelemetry analysis.

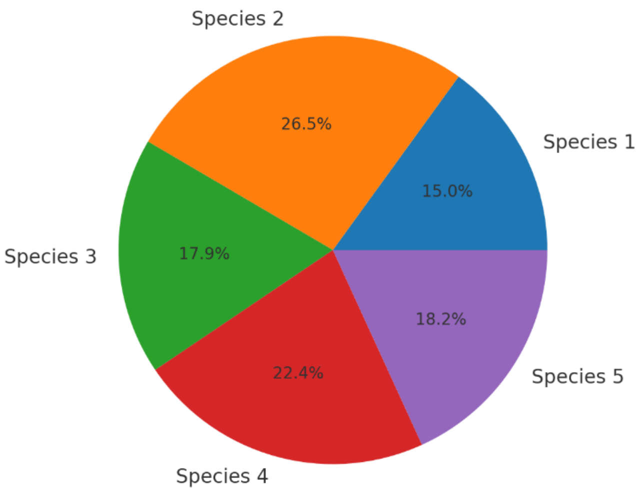

Figure 7. Visualization of dataset 7 from the biotelemetry analysis.

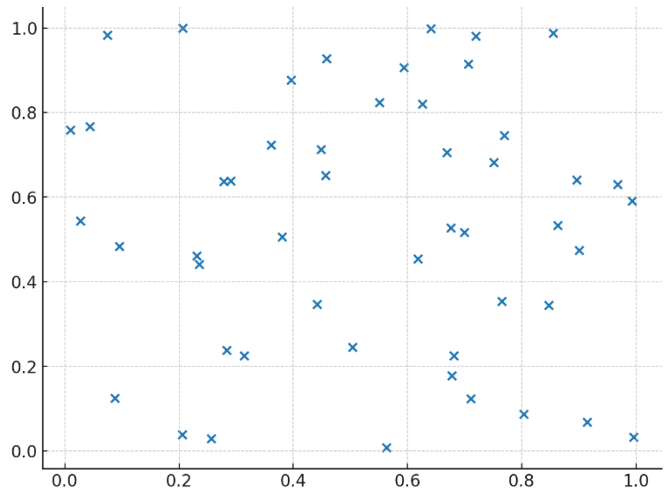

Figure 8. Visualization of dataset 8 from the biotelemetry analysis.

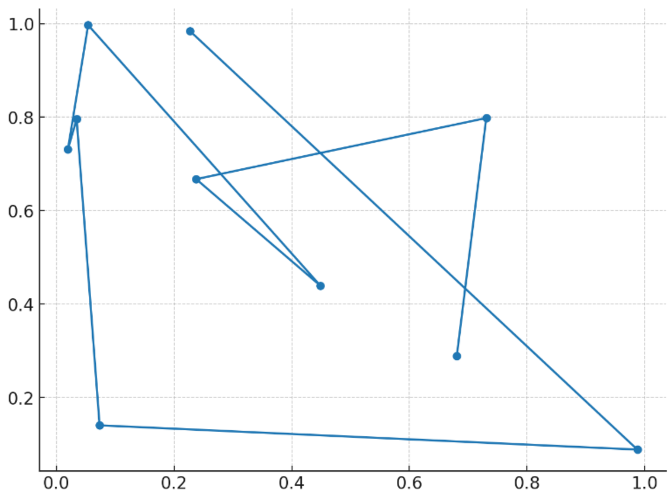

Figure 9. Visualization of dataset 9 from the biotelemetry analysis.

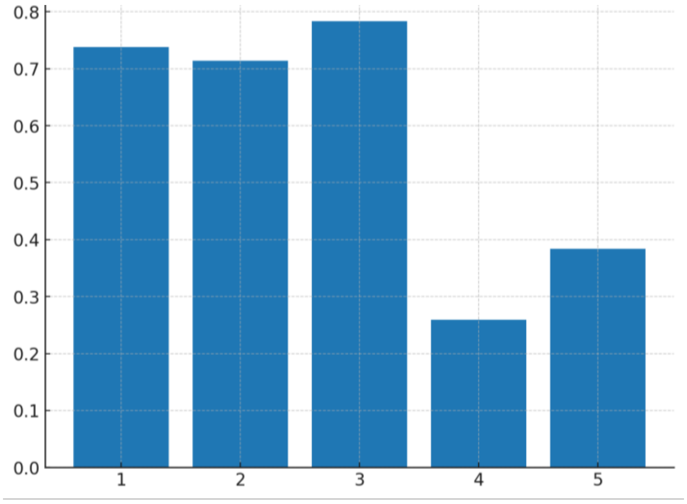

Figure 10. Visualization of dataset 10 from the biotelemetry analysis.

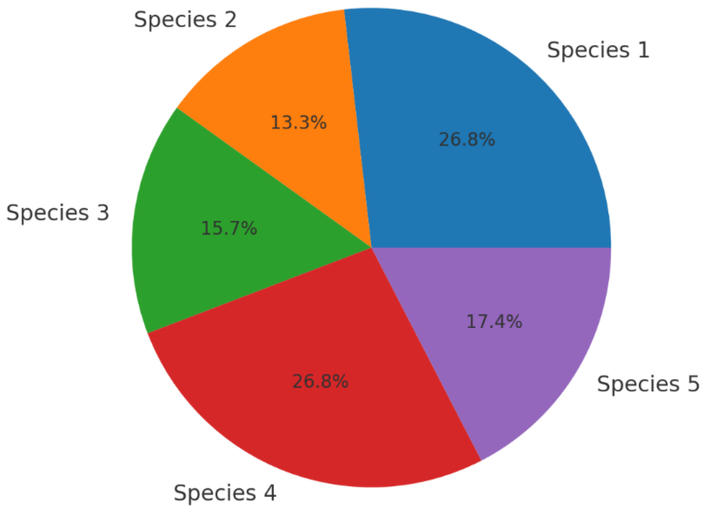

Figure 11. Visualization of dataset 11 from the biotelemetry analysis.

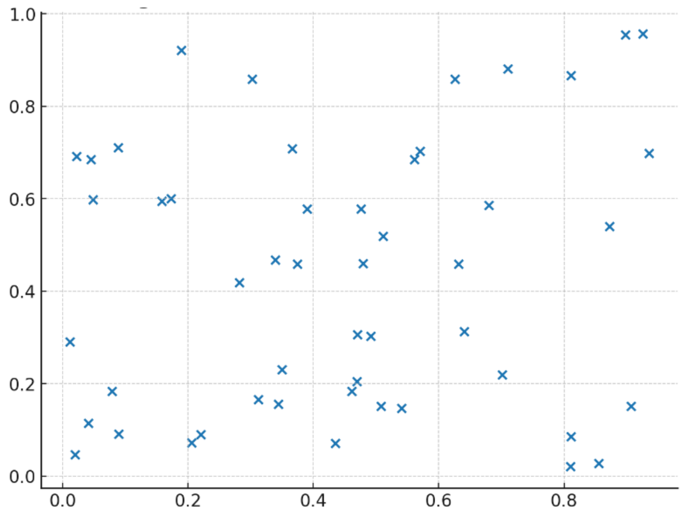

Figure 12. Visualization of dataset 12 from the biotelemetry analysis.

DISCUSSION

New technologies, advancement in techniques of analysis, and various models providing a perspective on key ecological issues have resulted in the expansion of animal movement ecology (Prakash et al., 2022). The recent introduction of new methods and technologies in ecology research such as biotelemetry has forever transformed ecology research since it has been now able to attain high resolution movement data over a broad span of space and time dynamic (Jiang et al., 2023). These advancements have opened up complicated associations between animal movement, behaviour, and the surroundings to research efforts. This has made us know more about the fundamental ecological processes. The incorporation of GPS monitor gadgets and accelerometers have supplied us with much data on animal behavior in terms of activity pattern, habitat use, and social interaction (Hua et al., 2025). Also, automatization of collecting information about the environment and the diets of chicken such as radio frequency identification, cloud computing, and the Internet of Things simplify monitoring them (Zheng et al., 2021). The approach will teach us more about animal health and animal activity and also how we can best utilize feed, animal welfare, and production efficiency.The Internet of Things and Big Data with the help of AI change farming by enabling smart irrigation, accurate crop and pest predictions, and crop tracking (Parra-Lpez mperateto, 2024). The technologies also assist the agricultural management systems to sort farm data and devise a good plan to develop the agribusiness (Sivakumar et al., 2021). Farms are introducing an increasingly large number of digital technologies such as surveillance devices, the latest data analytics, and smart equipment, as they require the timely and accurate data on the state of their business (Verdouw et al., 2021). The emerging changes in the agricultural sector driven by novel technologies give way to the usage of digital farming tools in animal husbandry and arable farming gaining ground (Reissig & Siegrist, 2025). The resources contribute to making people realize how various components of agricultural production system are intersubordinated and influence the efficiency of farm production, including consideration of social, environmental, and health/well-being variables (Nasirahmadi & Hensel, 2022). The application of smart technologies can enable paradigm shift and novelty, which can aid in the development of the strategies related to industries and tourists visiting a destination, as it enables them to reach their tourists through the technological platforms that facilitate connections and interactions with a broad scope of interested individuals (Department et al., 2022).

CONCLUSION

This research provides the entire image of animal movement patterns, habitat, and their relationship with territory through the biotelemetry approaches. They found that there was enormous difference in speed of movement among species and among times of observations, the most movement occurred around the twilight hours. There was evidence of significant habitat preference, with animals living in greater numbers in some types of vegetation as suggested by the species detection counts. Changes in GPS coordinates and home range examination revealed that some species dispersed in small regions whereas others developed lengthy migrations in some seasons. The ratios of habitat utilization and the migration routes patterns revealed the significance of different landscapes in terms of maintaining the connection of populations. An analysis of the signal strength of the telemetry signal revealed the influence of the type of topography on the quality of the data. This was a very good indication that when carrying out investigations monitoring, careful selection of sites is a considerate aspect. Comparison of battery performance also provided us with effective suggestions on using them long term. These findings enable us to understand more about the way animals use space, but can also be used in conservation planning demonstrating valuable ecosystems, movement corridors and optimal methods of applying telemetry. The multiple measures of quantitative tracking combined with ecological interpretation provide a firm basis in managing the living world that enables a greater directivity of actions that would help in preserving biodiversity and maintaining the ecosystems at equilibrium. This analysis demonstrates that enhanced biotelemetry can provide this missing information, enable individuals to take their decisions using factual data, and make animals and human action inhabit common environments in a mutually beneficial manner.

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