International Journal for Research in Environment
Published by: **Green Publications**
Article Type: **Research**
DOI:**10.53555/env.v1i1.2575**
Volume 01 Issue 01 March 2026

Deciphering Global Mammal Diversity Through Trophic and Environmental Gradients

Dr Anamika Singh

Professor, Department of Geography, Vasanta College of Women, KFI, Rajghat, Varanasi, Email Id: dr.anamikasghvew@gmail.com, Orcid Id: https://orcid.org/0009-0008-8775-971X
***Corresponding Author:** Dr Anamika Singh , dr.anamikasghvew@gmail.com*

Received:- 06/02/2026, Revised:- 07/03/2026, Accepted:- 14/03/2026, Published:- 21/03/2026

ABSTRACT

The diversity of mammals at a global scale is influenced by trophic organisation, climatic energy, water availability and geography. To carry out a quantitative macroecological assessment, 1,912 species of terrestrial mammals were selected for which a complete information on trophic, environmental and spatial aspects was available. Species were categorized as either herbivores, omnivores, or carnivores, and the midpoints of their ranges were used to assign them to the ten-degree geographical cells. The concentration of species, richness of families, richness of orders, richness of trophic groups and Shannon diversity of the trophic groups were examined as a function of temperature, precipitation, absolute latitude, actual evapotranspiration, and potential evapotranspiration. The herbivores accounted for 36.87% of the analyzed species, the omnivores accounted for 34.47% and the carnivores accounted for 28.66%. Species concentration increased in the positive direction with temperature, precipitation, and both measures of evapotranspiration and trophic diversity, and decreased in the negative direction with absolute latitude. The multivariable model accounted for 25.6% of observed variation, but none of the individual predictors were significant after simultaneous adjustment. There was no general trend in the median geographical range for the omnivores, but this was the largest for the carnivores in the wettest and most productive environments. The results suggest a mosaic, with overlapping environmental and trophic gradients, as the structure of global mammalian diversity. Reservations should focus on warm productive, trophically complex areas, and be aware of range-midpoint concentration, but not necessarily interpreted as confirmed local occupancy.

Key words: mammal diversity, trophic guilds, environmental gradients, evapotranspiration, species richness, macroecology

1. Introduction

Mammals are found in almost all terrestrial biomes and have a significant impact on vegetation dynamics, seed dispersal, predation, nutrient cycling, and food-web stability. The number of living mammal species is continually updated as new species are discovered and others are revised into different species, as taxonomic, nomenclatural and geographic knowledge improves, and the inventory is not static but always changing (Burgin et al., 2025). But there is more to mammalian diversity than numbers of species. Communities vary in feeding strategy, diet breadth, geographic distribution, climate tolerances, and history, such that comparable richness values can represent different community structures. The quantification of how these dimensions change along environmental gradients is therefore a key goal of macroecology and conservation planning.

Climatic patterns are significant in shaping global diversity patterns and are geographically complex. Productivity and habitat suitability are influenced by temperature, precipitation, water availability, and energy supply; latitude is a combination of the climatic and historical factors. Broad-scale comparisons suggest a contribution of the geography of climate to variation in species richness on a worldwide scale, but with regional and taxonomic differences in the extent to which it does so (Coelho et al., 2023). Land-based vertebrate gradients also exhibit a higher degree of diversification in low latitudes and low altitudes; these differences are linked to ecology, size and regional history (Raz et al., 2024). The actual and potential evapotranspiration of water and energy provides an interpretation of global variation for mammals.

A trophic organisation level is added because herbivores, omnivores and carnivores rely on different resources and have different positions in food webs. Herbivores are associated with plant productivity, carnivores are dependent on their prey and they need large ranges, while omnivores may have more diversity in their food sources. Ecological strategies are not only linked to diet, but also to the timing of activity, and there is a broad mammalian trait space in terms of activity timing, with activities being ecologically differentiated (Cox et al. 2021). However, loss of biodiversity is likely to not occur uniformly and ecological strategies may be lost in some areas while still being present in others (Cooke et al., 2019). Trophic diversity should thus be considered in addition to the taxonomic richness, not as a side effect.

Current patterns of diversity also are shaped by historical and evolutionary processes. Past climatic change and evolutionary history have left signatures on the distribution of genetic diversity in terrestrial mammals (Theodoridis et al., 2020). Biogeography, life history and climate affect genetic variation across animal and plant populations around the world (De Kort et al., 2021). The barrier-related biodiversity is at such a deep level that the vertebrate communities are divergent, and cannot be accounted for by current climate (Williams et al., 2024). Hence, bivariate relationships with richness could exist with environmental predictors but not be as strong when analysed simultaneously, as climatic, spatial, and historical gradients are interlinked.

As mammals are facing habitat conversion, exploitation, climatic change and other pressures, the need to understand these patterns has grown. Land use change, direct exploitation, climate change, pollution and invasive species were all identified as drivers of ecological decline in the global biodiversity assessment (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2019). The Intergovernmental Panel on Climate Change (2022) predicts changes in species distribution, ecosystem structure, and extinction risk in terrestrial environments due to climate-related risks. The consequences of mammalian loss are important because recovery of evolutionary diversity after the present crisis may take millions of years (Davis et al., 2018). Furthermore, the uneven distribution of rare mammals, and the fact that the distribution of species of conservation value may not provide adequate representation of ecologically rare species (Loiseau et al., 2020).

Although climate and biodiversity have been extensively studied, trophic composition and climatic-energy gradients are frequently determined independently and many global studies focus on richness and do not look at major feeding groups. Geographical summaries also summarize the species level ranges, not occurrence. Thus, records generated by analysis of ranges' midpoints must be viewed as a geographical representation of species distribution rather than as an inventory of all mammals found within each range. This distinction is significant if it is desired to compare richness with latitude, temperature, precipitation and evapotranspiration.

Based on this background the present study looks at a complete case sample of terrestrial mammalian species distributed all over the world. It describes taxonomic and trophic composition, compares environmental conditions between herbivores, omnivores and carnivores, and assesses the relationship between range-midpoint species concentration and temperature,

precipitation, actual evapotranspiration, potential evapotranspiration, absolute latitude and trophic Shannon diversity. It examines the differences in climatic relationships between trophic groups. The study combines trophic organisation, water–energy and latitudinal gradients to better understand which environmental dimensions match the global diversity of mammals, while considering that contemporary patterns are the result of historical, geographical and anthropogenic processes.

The objectives of the study are:

1. To characterise the global taxonomic and trophic composition of terrestrial mammals, with emphasis on herbivores, omnivores, and carnivores.
2. To examine how mammalian range-midpoint species concentration varies across temperature, precipitation, actual and potential evapotranspiration, and absolute-latitude gradients.
3. To determine the combined influence of environmental conditions and trophic diversity on mammalian species concentration and assess whether climatic relationships differ among trophic groups.

2. Materials and Methods

2.1 Research Design

The macroecological, cross-sectional, quantitative design was employed to investigate the relationship between trophic characteristics and environmental factors and mammal diversity around the world. The investigation was based on species level secondary data and not repeated field observations and/or population counts. One primary record represented each species of mammal, and each ten-degree geographical cell was based on the midpoint of the range and was used to model mammal richness. The design allowed comparison of trophic groups, assessment of environmental gradients and an estimation of the contribution of climatic energy, latitude and trophic diversity to the concentration of mammalian species.

2.2 Source and Taxonomic Scope

Species-level data was retrieved from PANTHERIA, a database that contains mammalian taxonomy, ecology, geography, climate and life-history traits. In the original source there were 5,416 records of mammals which were recorded under the recognised orders and families. To describe global composition, the taxonomic fields order, family, genus and scientific name were kept. Marine-related groups were excluded in order to focus on a terrestrial theme. Taxa Cetacea, Sirenia, Phocidae, Otariidae and Odobenidae were therefore removed prior to further processing. The remaining records were examined and all necessary measurements of trophos, geographical, and environmental data for the comparisons planned were completed.

2.3 Record Selection and Preparation

An undefined value was used for the missing-value code of −999 prior to screening. Only records were kept when the following data were available: trophic level, mean temperature, precipitation, actual evapotranspiration, potential evapotranspiration, range-midpoint latitude and range-midpoint longitude. Initial 5416 records were reduced to 1912 terrestrial mammal species in this complete case procedure. Absolute latitude was calculated by subtracting range-midpoint latitude, geographical range area was retained for comparison among the different guilds. Before analysing the data, implausible values were checked in the continuous measurements; and coding of the taxonomic and ecological fields was checked for consistency.

2.4 Trophic and Ecological Variables

Trophic level was considered as an ecological categorical predictor and divided into 3 groups: herbivores, omnivores, and carnivores. Number of food categories used (dietary breadth) was kept as a descriptive ecological characteristic. Environmental variables consisted of mean temperature, precipitation, actual evapotranspiration, potential evapotranspiration and absolute latitude. The geographical range area was analysed separately, to compare the spatial occupancy of the trophic groups. The measures enabled the results to describe the trophozoon, the climatic association, the energetic conditions, the dietary generalism and the species-range extent differences in the entire terrestrial sample.

2.5 Spatial Aggregation and Diversity Measures

A ten-degree geographical cell (mid latitude and mid longitude) was used to assign species. Because each species was represented in only one cell, this procedure estimated species

concentration using the range midpoint instead of species richness in a local area. Multivariable modelling was performed on 95 analytical cells, with cells with <5 species excluded. Species richness, family richness, order richness, and trophic-group richness was determined for each retained cell. In addition, trophic Shannon diversity was calculated based on the proportion of herbivores, omnivores and carnivores as an index of trophic evenness and complexity.

2.6 Descriptive and Comparative Analysis

The representation of trophic groups, mammalian orders, climatic categories and latitude bands was summarized with frequencies and percentages. Means, medians, and ranges were used to summarise the continuous environmental and ecological characteristics. Environmental data were also segmented into descriptive categories that were easy to interpret, such as temperature, precipitation, evapotranspiration, and absolute latitude. Several variables were not normally distributed, so they were compared to trophic groups with Kruskal–Wallis tests for temperature, precipitation, evapotranspiration, latitude, dietary breadth and range area. The values of epsilon squared were obtained to measure the size of the significant difference, and the significance was measured as $p<0.05$.

2.7 Correlation and Regression Modelling

Bivariate correlation between species richness at the cell level and mean temperature, precipitation, AET, PET, absolute latitude, and trophic Shannon diversity were examined using Spearman rank correlations. Data on species richness was transformed with log(1 + richness) prior to regression to allow for the reduction of the positive skew. All predictors were standardized and ordinary least-squares regression was used to estimate the simultaneous contribution of these predictors in the 95 remaining cells. The goodness of fit of the model was determined by R^2, adjusted R2, F statistic and probability values associated with F. To detect problematic multicollinearity among the predictors, variance inflation factors were tested.

2.8 Interaction, Reliability, and Ethics

A secondary regression was performed to determine if differences in temperature and precipitation relationship by herbivore, omnivore and carnivore richness were found via trophic-group interaction terms. Selected for strengthening reliability were complete-case selection, exclusion of explicitly marine taxa, minimum cell size, predictor standardisation and

multicollinearity checks. Results were interpreted as association and range mid-point concentration were not necessarily equated with confirmed local occupancy. The investigation did not involve any direct human or live animal interaction or cause any individual-level ethical risk because it utilized open ecological data.

3. Results

3.1 Characteristics of the Analysed Mammal Records

PanTHERIA comprised 5,416 species level records from 29 orders, 153 families and 1,230 genera. One thousand, nine hundred and twelve species were left after discarding the code for missing values, excluding the explicitly marine taxa and requiring complete information for trophic, climatic, evapotranspiration and range-midpoint data. A total of 27 orders, 129 families and 781 genera constitute the analytical sample, while 3504 records (64.70%) were excluded because at least one of the required fields was missing. Median abs lat was 15.48°. Mean precip was 119.18 mm, mean AET was 986.39 mm. The species retained have a median precipitation of 108.83 mm. The main characteristics of the terrestrial mammal sample retained are summarised in Table 1.

Table 1. Characteristics of the analytical mammal sample

Characteristic	Value
Initial mammal records	5,416
Initial taxonomic coverage	29 orders, 153 families, 1,230 genera
Terrestrial species retained	1,912
Records excluded	3,504 (64.70%)
Final taxonomic coverage	27 orders, 129 families, 781 genera
Mean temperature, °C	18.61 ± 7.55
Mean precipitation, mm	119.18 ± 73.53
Mean actual evapotranspiration, mm	986.39 ± 444.91
Mean potential evapotranspiration, mm	1,357.67 ± 359.70
Median absolute latitude, degrees	15.48 (IQR: 5.90–29.34)
Mean dietary breadth, food categories	2.59 ± 1.61

Note. Values are presented as number, number and percentage, mean ± standard deviation, or median and interquartile range.

3.2 Global Taxonomic and Trophic Diversity

The herbivores made up the highest numbers of species with 705 species (36.87%), next were the omnivores with 659 species (34.47%) and then the carnivores with 548 species (28.66%).

Rodentia contributed 579 species (30.28%), Chiroptera 416 (21.76%), Carnivora 189 (9.88%), Primates 169 (8.84%), and Artiodactyla 151 (7.90%). Together, Rodentia and Chiroptera represented 52.04% of the analytical sample. The median and mean dietary breadth is 2.00 and 2.59 food categories, respectively. The omnivores had the widest diet (4.00 categories median), followed by herbivores (2.00 categories median) and carnivores (1.00 categories median). The five most prevalent orders represented 1,504 species, or 78.66% of the analytical sample retained. Table 2 shows the taxonomic and trophic composition of the material. The relative abundance of the three trophic guilds is shown in Figure 1.

Table 2. Taxonomic and trophic composition of terrestrial mammal species

Dimension	**Category**	**Species, n**	**Percentage**
Trophic guild	Herbivore	705	36.87
	Omnivore	659	34.47
	Carnivore	548	28.66
Mammalian order	Rodentia	579	30.28
	Chiroptera	416	21.76
	Carnivora	189	9.88
	Primates	169	8.84
	Artiodactyla	151	7.90
Top five orders combined	—	1,504	78.66

Note. Percentages for trophic guilds are calculated from the complete analytical sample of 1,912 species. Rodentia and Chiroptera jointly represented 52.04% of the sample.

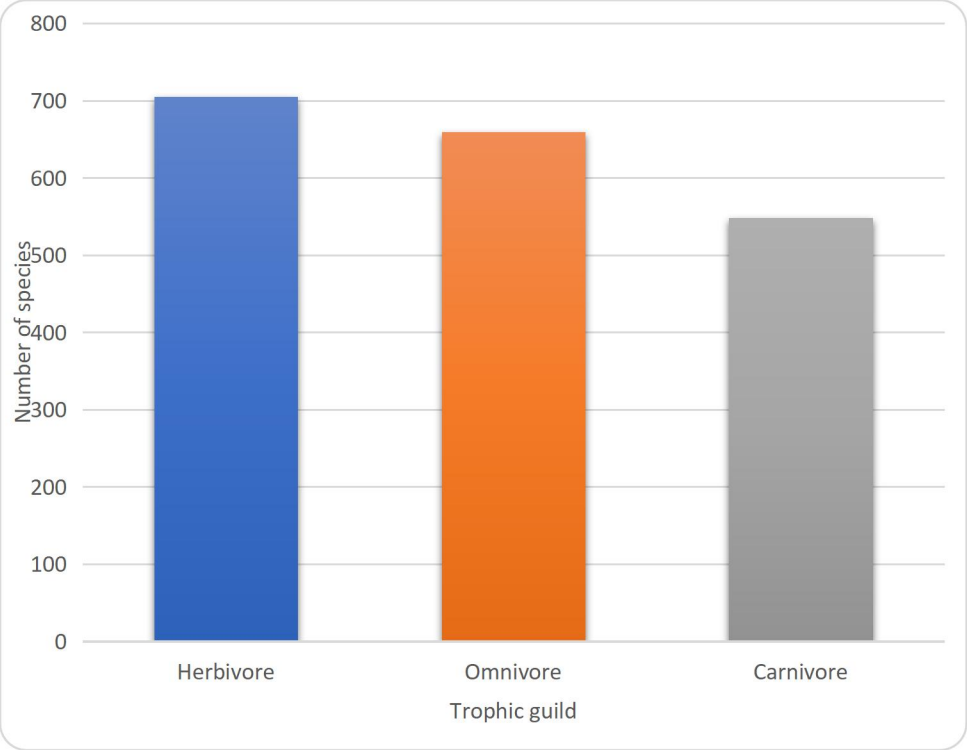

Figure 1. Trophic composition of the analytical mammal sample

3.3 Mammal Diversity Across Environmental Gradients

Warm range conditions above 20°C contained 1,122 species (58.68%), compared with 483 species (25.26%) at 10–20°C and 307 (16.06%) below 10°C. Intermediate precipitation of 50–150 mm contained 917 species (47.96%), while wet conditions above 150 mm contained 609 (31.85%) and dry conditions below 50 mm contained 386 (20.19%). Tropical range midpoints held 1,276 species (66.74%), temperate midpoints 585 (30.60%), and high-latitude midpoints 51 (2.67%). High actual evapotranspiration (>1,000 mm) contained 975 species (50.99%) and each environmental category kept all three trophic groups. The overall pattern of concentration was the same in the case of family and order richness, as in the case of family and order size.The overall pattern of concentration was the same as in the case of family and order size for family and order richness. The abundance of species by family and order is provided for each of the environmental categories in Table 3. The distribution of species in warmer and tropical conditions and in high evapotranspiration is illustrated in Figure 2.

Table 3. Distribution of mammal species across environmental gradients

Gradient	Category	Species, n	Percentage	Families	Orders	Guilds
Temperature	Cold, <10°C	307	16.06	41	14	3
	Moderate, 10–20°C	483	25.26	76	19	3
	Warm, >20°C	1,122	58.68	109	26	3
Precipitation	Dry, <50 mm	386	20.19	59	18	3
	Intermediate, 50–150 mm	917	47.96	107	24	3
	Wet, >150 mm	609	31.85	85	23	3
Absolute latitude	Tropical, <23.5°	1,276	66.74	112	25	3
	Temperate, 23.5–50°	585	30.60	74	21	3
	High latitude, >50°	51	2.67	17	7	3
Actual evapotranspiration	Low, <500 mm	382	19.98	58	18	3
	Moderate, 500–1,000 mm	555	29.03	86	23	3
	High, >1,000 mm	975	50.99	99	24	3

Note. Each environmental gradient represents a separate classification of the same 1,912 species. Counts should therefore be summed only within each three-category gradient, not across all rows.

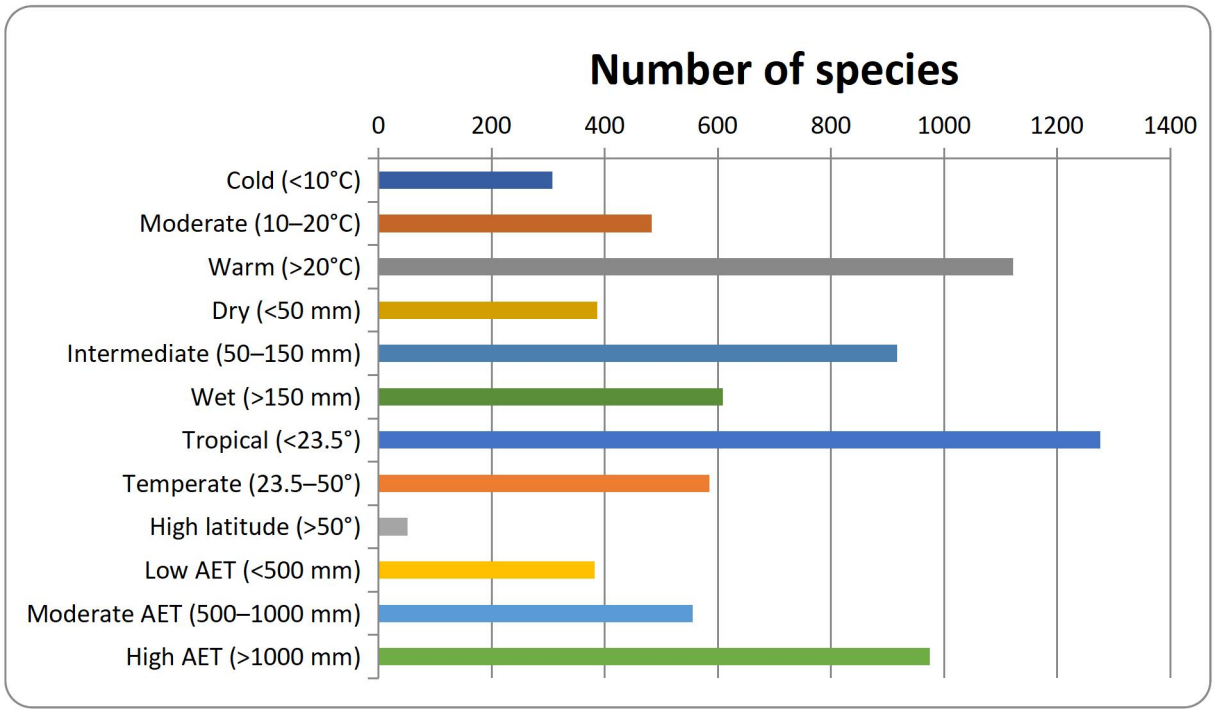

Figure 2. Mammal species distribution across environmental gradients

3.4 Environmental Differences Among Trophic Guilds

The omnivores had the highest medians of precipitation (126.58 mm) and actual evapotranspiration (1,116.69 mm); for carnivores the medians of precipitation and actual evapotranspiration were 106.72 and 991.28 mm, respectively; and for herbivores, 99.95 and 947.32 mm, respectively. Guild differences were significant for temperature ($H = 9.071$, $p = 0.010724$), precipitation ($H = 14.663$, $p = 0.000655$), and actual evapotranspiration ($H = 13.063$, $p = 0.001457$), although effect sizes were small. There was no significant difference in potential evapotranspiration and absolute latitude. The median range area was significantly different ($H = 61.838$, $p < 0.000001$), with carnivores having the largest median range of 1.30 million km². Epsilon square values for the climates varied between 0.0037 and 0.0066. Table 4 shows median values, interquartile ranges, Kruskal–Wallis statistics and effect size for complete trophic-guild comparisons.

Table 4. Environmental and ecological differences among trophic guilds

Variable	Herbivores, median (IQR)	Omnivores, median (IQR)	Carnivores, median (IQR)	H	p	ε²
Temperature, °C	21.08 (14.63–24.03)	22.42 (15.36–24.36)	21.73 (15.43–23.91)	9.071	.011	.0037
Precipitation, mm	99.95 (51.16–165.45)	126.58 (65.74–174.99)	106.72 (58.22–152.55)	14.663	<.001	.0066
Actual evapotranspiration, mm	947.32 (548.67–1,340.95)	1,116.69 (663.82–1,388.46)	991.28 (610.71–1,283.54)	13.063	.001	.0058
Potential evapotranspiration, mm	1,483.25 (1,157.10–1,608.15)	1,510.91 (1,146.15–1,607.97)	1,474.71 (1,146.77–1,586.55)	2.984	.225	.0005
Absolute latitude, degrees	16.61 (6.32–29.35)	13.44 (5.43–29.72)	16.58 (6.46–28.02)	4.464	.107	.0013
Range area, million km²	0.431 (0.076–1.964)	0.718 (0.132–3.142)	1.297 (0.202–6.313)	61.838	<.001	.0313
Dietary breadth, categories	2.00 (1.00–3.00)	4.00 (3.00–5.00)	1.00 (1.00–1.00)	1,171.580	<.001	.6127

Note. H denotes the Kruskal–Wallis statistic; ε² denotes epsilon-squared effect size. Guild sample sizes were 705 herbivores, 659 omnivores, and 548 carnivores. Climatic differences were statistically significant but had very small effect sizes. Dietary breadth showed the largest effect.

3.5 Combined Predictors of Mammal Diversity

Across 95 ten-degree range-midpoint cells containing at least five species, richness correlated positively with temperature ($\rho = 0.303$, $p = 0.002869$), precipitation ($\rho = 0.401$, $p = 0.000055$), actual evapotranspiration ($\rho = 0.450$, $p = 0.000005$), potential evapotranspiration ($\rho = 0.376$, $p = 0.000176$), and trophic diversity ($\rho = 0.317$, $p = 0.001725$), but negatively with absolute latitude ($\rho = -0.430$, $p = 0.000014$). The complete regression was significant ($R^2 = 0.256$, adjusted $R^2 = 0.214$, $F(5,89) = 6.109$, $p = 0.000066$). None of the predictors was significant after simultaneous adjustment, but trophic diversity was close to being significant ($\beta = 0.120$, $p = 0.077$). There were no significant interactions between trophic groups and temperature or precipitation. The correlation coefficients, the multivariable regression estimates, the multicollinearity diagnostics and the trophic interaction terms are presented in Table 5. These bivariate relationships are shown in Figure 3 in terms of direction and magnitude.

Table 5. Cell-level correlations and multivariable predictors of mammal species concentration

Panel A. Spearman rank correlations

Predictor	ρ	p
Temperature	.303	.003
Precipitation	.401	<.001
Actual evapotranspiration	.450	<.001
Potential evapotranspiration	.376	<.001
Absolute latitude	−.430	<.001
Trophic Shannon diversity	.317	.002

Panel B. Five-predictor ordinary least-squares regression

Predictor	b	SE	t	p	95% CI	VIF
Temperature	−0.0588	0.138	−0.428	.670	−0.332, 0.215	5.21
Precipitation	0.0484	0.186	0.260	.795	−0.321, 0.418	9.51
Actual evapotranspiration	0.0855	0.224	0.382	.703	−0.359, 0.530	13.78
Absolute latitude	−0.2104	0.155	−1.356	.178	−0.519, 0.098	6.62
Trophic Shannon diversity	0.1198	0.067	1.789	.077	−0.013, 0.253	1.23

Model statistics: N = 95 cells; R^2 = .256; adjusted R^2 = .214; $F(5, 89) = 6.109$; $p < .001$.

Panel C. Trophic-guild interaction terms

Interaction	b	p
Temperature × Herbivore richness	−0.0418	.735
Temperature × Omnivore richness	−0.0395	.749
Precipitation × Herbivore richness	−0.1099	.374
Precipitation × Omnivore richness	0.0436	.724

Note. The dependent variable in Panel B was log-transformed range-midpoint species concentration. Continuous predictors were standardised; therefore, b represents the expected change in log-transformed concentration for a one-standard-deviation change in the predictor. Carnivores formed the reference trophic group in Panel C. Potential evapotranspiration was included in the bivariate correlation assessment but not in the five-predictor regression model.

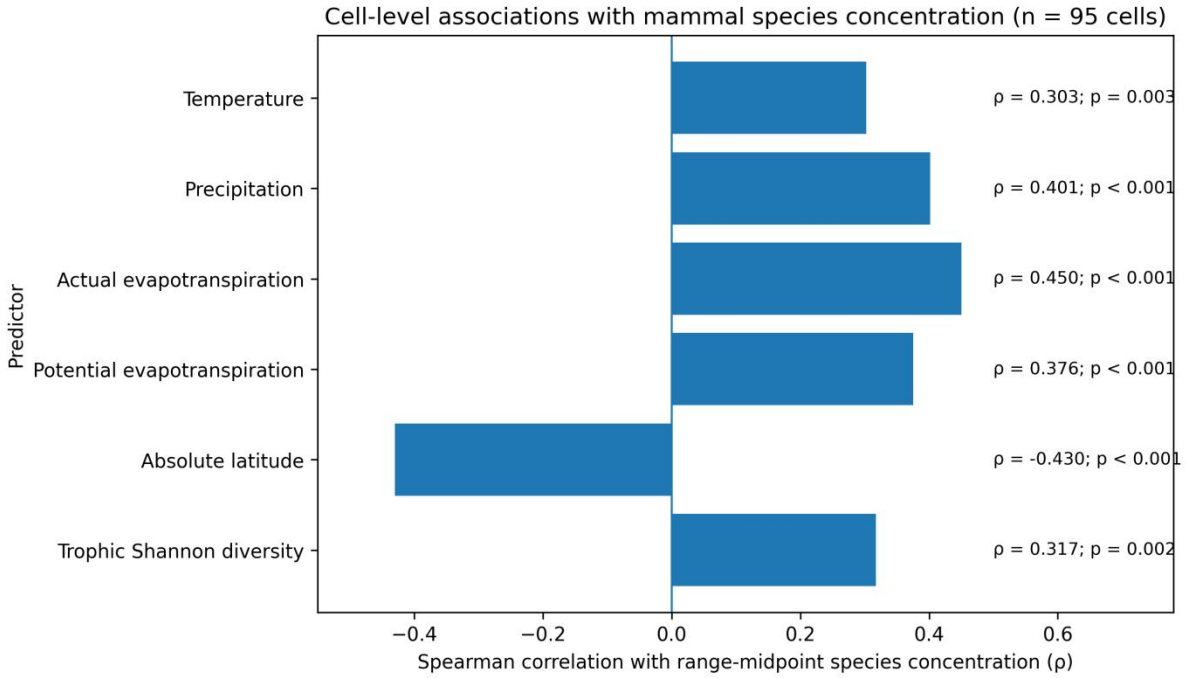

Figure 3. Associations between environmental predictors and species concentration

4. Discussion

The analysis showed a concentration of terrestrial mammal diversity in warmer, wetter, lower-latitude, and high-energy environments. Among 1,912 complete species records, herbivores were the largest trophic group, followed by omnivores and carnivores. More than half of the species occurred in ranges averaging above 20°C, while tropical range midpoints contained approximately two-thirds of the sample. Species concentration increased with temperature, precipitation, actual and potential evapotranspiration, and trophic diversity, but declined with absolute latitude. These patterns are consistent with evidence that environmental change and human pressures have already reshaped global mammalian diversity and may intensify future losses (Andermann et al., 2020).

The predominance of herbivores and omnivores suggests that resource availability and dietary flexibility are central to mammalian organisation. Omnivores occupied the wettest and most productive ranges and displayed the broadest dietary breadth, indicating that access to multiple food categories may support persistence across heterogeneous conditions. Carnivores had the largest median geographical ranges, possibly because they must locate dispersed prey and satisfy higher energetic demands. Mammalian home-range size is similarly influenced by environmental

productivity and trophic ecology (Broekman et al., 2024). Omnivorous flexibility may therefore broaden climatic tolerance, whereas carnivore distributions may be constrained by prey availability and habitat continuity.

Precipitation and actual evapotranspiration produced the strongest bivariate associations with species concentration, supporting the importance of water–energy availability. Moist, productive environments can sustain greater plant biomass, invertebrate abundance, and prey resources, thereby accommodating more trophic roles. Research likewise shows that climate, habitat, and anthropogenic gradients jointly structure terrestrial mammal diversity (Fernández-Cabello et al., 2025). However, environmental differences among trophic guilds had small effect sizes, meaning that broad dietary categories explained little of their climatic occupancy. Adaptations such as burrowing may also permit survival under harsh and variable climates, weakening simple climate–diversity relationships (Pinkert et al., 2025).

Although the overall regression was significant, its adjusted explanatory power remained modest, and no individual environmental predictor retained significance after simultaneous adjustment. This indicates substantial overlap among temperature, precipitation, evapotranspiration, and latitude. Trophic Shannon diversity approached significance but was not independently decisive. Moreover, nonsignificant interactions between trophic-group richness and temperature or precipitation did not support the hypothesis that guild richness responds differently to these gradients. Nevertheless, mammalian responses to disturbance can vary substantially by trophic group at finer landscape scales (Burton et al., 2024), while temporal niche shifts may alter exposure to human activity and contribute to uneven declines (Cox et al., 2023).

The findings also demonstrate why conservation should extend beyond species counts. High-concentration cells contained substantial taxonomic and trophic complexity, yet protecting species-rich areas alone may not preserve distinctive ecological strategies. Phylogenetic diversity does not reliably represent functional diversity, requiring both dimensions to be evaluated directly (Mazel et al., 2018). Threatened vertebrate extinctions can also cause geographically uneven functional losses (Toussaint et al., 2021), while mammalian conservation priorities differ when evolutionary distinctiveness is considered alongside richness (Robuchon et al., 2021). Wildlife trade creates additional pressure on regions containing exceptional functional and phylogenetic diversity (Hughes et al., 2023).

Effective protection therefore requires limiting land conversion, livestock pressure, fragmentation, and overexploitation. Habitat availability has changed unevenly according to species traits and human land use (Pacifici et al., 2023), and projected range contractions indicate continuing exposure across mammalian groups (Beyer & Manica, 2020). Protected areas can reduce range loss and local extinction when coverage, connectivity, and management are adequate (Cristiano et al., 2025). Interpretation remains cautious because complete-case selection may favour well-documented species, ten-degree cells conceal local habitat variation, and range-midpoint concentration is not equivalent to verified local richness. Cross-sectional associations cannot establish causation, while omitted vegetation, land-use, and evolutionary variables may explain the modest regression performance.

5. Conclusion

The diversity of mammals was found to be greatest in warm, moist, productive, and lower latitude climates, and was shown to be closely related to how much energy is available in the climate and how much water is available in the region, as well as the geographical distribution of terrestrial mammals. The herbivores were the most numerous trophic group, the omnivores had the widest diet and environmental breadths, and the carnivores had the widest median geographical ranges. Species concentration was related to temperature, precipitation, ACT, PET, and trophic diversity, but these relationships were not as strong when measured in combination. This means that overlapping climatic, spatial, trophic, historical and ecological factors are responsible for mammalian diversity rather than any one factor. Lack of significant trophic-interactions further indicates that there might exist similar responses to broad climatic gradients at the global level, although there might be finer regional differences. Therefore, not only species-rich areas should be safeguarded, but also trophically complex communities and ecologically unique mammals. Special care must be taken in tropical and high energy areas where there is the highest diversity and anthropogenic pressures are also high. The value of range midpoints as indicators of confirmed local occupancy and the potentially biasing effect of complete case selection should be taken into account when designing future studies and using them to advance the understanding of global mammal diversity.

References

1. Andermann, T., Faurby, S., Turvey, S. T., Antonelli, A., & Silvestro, D. (2020). The past and future human impact on mammalian diversity. Science Advances, 6(36), Article eabb2313. https://doi.org/10.1126/sciadv.abb2313

2. Beyer, R. M., & Manica, A. (2020). Historical and projected future range sizes of the world's mammals, birds, and amphibians. Nature Communications, 11, Article 5633. https://doi.org/10.1038/s41467-020-19455-9

3. Broekman, M. J. E., Hilbers, J. P., Hoeks, S., Huijbregts, M. A. J., Schipper, A. M., & Tucker, M. A. (2024). Environmental drivers of global variation in home range size of terrestrial and marine mammals. Journal of Animal Ecology, 93, 488–500. https://doi.org/10.1111/1365-2656.14073

4. Burgin, C. J., Zijlstra, J. S., Becker, M. A., Handika, H., Alston, J. M., Widness, J., Liphardt, S., Huckaby, D. G., & Upham, N. S. (2025). How many mammal species are there now? Updates and trends in taxonomic, nomenclatural, and geographic knowledge. Journal of Mammalogy, 106(5), 1082–1117. https://doi.org/10.1093/jmammal/gyaf047

5. Burton, A. C., Beirne, C., Gaynor, K. M., Sun, C., Granados, A., Allen, M. L., Alston, J. M., Alvarenga, G. C., Calderón, F. S. Á., Amir, Z., Anhalt-Depies, C., Appel, C., Arroyo-Arce, S., Balme, G., Bar-Massada, A., Barcelos, D., Barr, E., Barthelmess, E. L., Baruzzi, C., … Kays, R. (2024). Mammal responses to global changes in human activity vary by trophic group and landscape. Nature Ecology & Evolution, 8(5), 924–935. https://doi.org/10.1038/s41559-024-02363-2

6. Coelho, M. T. P., Barreto, E., Rangel, T. F., Diniz-Filho, J. A. F., Wüest, R. O., Bach, W., Skeels, A., McFadden, I. R., Roberts, D. W., Pellissier, L., Zimmermann, N. E., & Graham, C. H. (2023). The geography of climate and the global patterns of species diversity. Nature, 622, 537–544. https://doi.org/10.1038/s41586-023-06577-5

7. Cooke, R. S. C., Eigenbrod, F., & Bates, A. E. (2019). Projected losses of global mammal and bird ecological strategies. Nature Communications, 10, Article 2279. https://doi.org/10.1038/s41467-019-10284-z

8. Cox, D. T. C., Gardner, A. S., & Gaston, K. J. (2021). Diel niche variation in mammals associated with expanded trait space. Nature Communications, 12, Article 1753. https://doi.org/10.1038/s41467-021-22023-4

9. Cox, D. T. C., Gardner, A. S., & Gaston, K. J. (2023). Diel niche variation in mammalian declines in the Anthropocene. Scientific Reports, 13, Article 1031. https://doi.org/10.1038/s41598-023-28104-2

10. Cristiano, A., Pillay, R., Ramírez-Delgado, J. P., Watson, J. E. M., Venter, O., & Pacifici, M. (2025). Role of protected areas in mitigating range loss and local extinctions of terrestrial mammals. Conservation Biology, 39(6), Article e70092. https://doi.org/10.1111/cobi.70092

11. Davis, M., Faurby, S., & Svenning, J.-C. (2018). Mammal diversity will take millions of years to recover from the current biodiversity crisis. Proceedings of the National Academy of Sciences of the United States of America, 115(44), 11262–11267. https://doi.org/10.1073/pnas.1804906115

12. De Kort, H., Prunier, J. G., Ducatez, S., Honnay, O., Baguette, M., Stevens, V. M., & Blanchet, S. (2021). Life history, climate and biogeography interactively affect worldwide genetic diversity of plant and animal populations. Nature Communications, 12, Article 516. https://doi.org/10.1038/s41467-021-20958-2

13. Fernández-Cabello, I., Franch, M., Vilella, M., Fernandez-Arrieta, N., Rota, M., Sanglas, A., Baqué-Díaz, E., Gallardet, M., Federico, P., Peris, A., Serratosa, E., Real, J., Sayol, F., & Puig-Gironès, R. (2025). Assessing the role of habitat, climate, and anthropization gradients on terrestrial mammal diversity in the western Mediterranean basin. Integrative Zoology, 20(3), 485–503. https://doi.org/10.1111/1749-4877.12866

14. Hughes, L. J., Massam, M. R., Morton, O., Edwards, F. A., Scheffers, B. R., & Edwards, D. P. (2023). Global hotspots of traded phylogenetic and functional diversity. Nature, 620, 351–357. https://doi.org/10.1038/s41586-023-06371-3

15. Intergovernmental Panel on Climate Change. (2022). Climate change 2022: Impacts, adaptation and vulnerability: Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama, Eds.). Cambridge University Press. https://doi.org/10.1017/9781009325844

16. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (E. S. Brondízio, J. Settele, S. Díaz, & H. T. Ngo, Eds.). IPBES Secretariat. https://doi.org/10.5281/zenodo.3831673

17. Loiseau, N., Mouquet, N., Casajus, N., Grenié, M., Guéguen, M., Maitner, B., Mouillot, D., Ostling, A., Renaud, J., Tucker, C., Velez, L., Thuiller, W., & Violle, C. (2020). Global distribution and conservation status of ecologically rare mammal and bird species. Nature Communications, 11, Article 5071. https://doi.org/10.1038/s41467-020-18779-w

18. Mazel, F., Pennell, M. W., Cadotte, M. W., Díaz, S., Dalla Riva, G. V., Grenyer, R., Leprieur, F., Mooers, A. O., Mouillot, D., Tucker, C. M., & Pearse, W. D. (2018). Prioritizing phylogenetic diversity captures functional diversity unreliably. Nature Communications, 9, Article 2888. https://doi.org/10.1038/s41467-018-05126-3

19. Pacifici, M., Cristiano, A., Lumbierres, M., Lucherini, M., Mallon, D., Meijaard, E., Solari, S., Tognelli, M. F., Belant, J. L., Butynski, T. M., Cronin, D., d'Huart, J.-P., Da Re, D., de Jong, Y. A., Dheer, A., Fei, L., Gallina, S., Goodrich, J. M., Harihar, A., … Wiesel, I. (2023). Drivers of habitat availability for terrestrial mammals: Unravelling the role of livestock, land conversion and intrinsic traits in the past 50 years. Global Change Biology, 29(24), 6900–6911. https://doi.org/10.1111/gcb.16964

20. Pinkert, S., Reuber, V., Krug, L.-M., Heidrich, L., Rehling, F., Brandl, R., & Farwig, N. (2025). Burrowing facilitated the survival of mammals in harsh and fluctuating climates. Current Biology, 35(8), 1779–1790.e3. https://doi.org/10.1016/j.cub.2025.02.064

21. Raz, T., Allison, A., Avila, L. J., Bauer, A. M., Böhm, M., Caetano, G. H. D. O., Colli, G., Doan, T. M., Doughty, P., Grismer, L., Itescu, Y., Kraus, F., Martins, M., Morando, M., Murali, G., Nagy, Z. T., Nogueira, C. D. C., Novosolov, M., Oliver, P. M., … Meiri, S. (2024). Diversity gradients of terrestrial vertebrates—Substantial variations about a common theme. Journal of Zoology, 322(2), 126–140. https://doi.org/10.1111/jzo.13130

22. Robuchon, M., Pavoine, S., Véron, S., Delli, G., Faith, D. P., Mandrici, A., Pellens, R., Dubois, G., & Leroy, B. (2021). Revisiting species and areas of interest for conserving global mammalian phylogenetic diversity. Nature Communications, 12, Article 3694. https://doi.org/10.1038/s41467-021-23861-y

23. Theodoridis, S., Fordham, D. A., Brown, S. C., Li, S., Rahbek, C., & Nogués-Bravo, D. (2020). Evolutionary history and past climate change shape the distribution of genetic diversity in terrestrial mammals. Nature Communications, 11, Article 2557. https://doi.org/10.1038/s41467-020-16449-5

24. Toussaint, A., Brosse, S., Bueno, C. G., Pärtel, M., Tamme, R., & Carmona, C. P. (2021). Extinction of threatened vertebrates will lead to idiosyncratic changes in functional diversity across the world. Nature Communications, 12, Article 5162. https://doi.org/10.1038/s41467-021-25293-0

25. Williams, P. J., Zipkin, E. F., & Brodie, J. F. (2024). Deep biogeographic barriers explain divergent global vertebrate communities. Nature Communications, 15, Article 2457. https://doi.org/10.1038/s41467-024-46757-z