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HERPETOFAUNAL DIVERSITY OF A NATURAL PROTECTED AREA IN THE ESPINAL REGION OF CENTRAL-EASTERN ARGENTINA

DIVERSIDAD HERPETOFAUNÍSTICA DE UN ÁREA NATURAL PROTEGIDA EN LA REGIÓN ESPINAL DEL CENTRO-ESTE ARGENTINO

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Resumen.– Los anfibios son los vertebrados más amenazados a nivel mundial (41 % de las especies en riesgo), mientras que los reptiles tienen el 21 % de sus especies bajo amenaza. Ambos grupos taxonómicos son indicadores de la salud de los ecosistemas. Estudiamos la herpetofauna de la Reserva de Uso Múltiple Juan Bautista Alberdi (JBAR), Entre Ríos, Argentina, un área natural protegida de la Ecorregión Espinal. Nuestros objetivos fueron: analizar la composición taxonómica de las comunidades herpetofaunísticas; estimar el índice de ocurrencia de especies, y evaluar y comparar las diversidades de Hill (^{0}D, ^{1}D y ^{2}D) de las comunidades entre diferentes hábitats en la JBAR. Utilizamos seis métodos de muestreo diferentes y registramos 18 especies de herpetozoos. Se detectaron once especies de anfibios, distribuidas en cinco géneros y tres familias. La familia Hylidae presentó la mayor riqueza de especies (cinco especies que representan el 45.4 %), seguida de Leptodactylidae (36.4 %) y Bufonidae (18.2 %). Se detectaron siete taxones de reptiles, pertenecientes a siete familias diferentes, cada una representando el 14.3 % del total. De acuerdo con el índice de constancia de ocurrencia, casi todas las especies fueron raras, conformando el 94.4 % de la comunidad (n = 17; < 25 %), mientras que las especies comunes representaron el 5.6 % restante (n = 1; > 25 %). La ocurrencia de especies fue significativamente mayor en el Tajamar (TA) en comparación con los otros hábitats (NF: Bosque nativo, EF: Bosque exótico y GR: Pastizal). El Tajamar también exhibió los valores más altos en todas las medidas de diversidad de Hill, mientras los restantes hábitats no mostraron diferencias significativas entre sí en ninguno de los parámetros estudiados. La cobertura de la muestra fue del 84.9 % en TA, 84.6 % en GR, 71.8 % en EF, mientras que NF fue de 54.2 %. Comprender la situación actual de la herpetofauna es clave para diagnosticar y encontrar soluciones a sus problemas actuales y futuros. Esperamos que nuestros aportes resalten el valor del patrimonio natural del JBAR en cuanto relicto de la Ecorregión del Espinal.

Palabras clave.–Anfibios, composición comunitaria, diversidad de Hill, índice de ocurrencia, reptiles.

Abstract.– Amphibians are the most endangered vertebrates worldwide (41 % of the species at risk), while reptiles have 21 % of their species at risk. Both taxonomic groups are indicators of ecosystem health. We study the herpetofauna of the Juan Bautista Alberdi Multiple Use Reserve (JBAR), Entre Ríos, Argentina, a natural protected area of the Espinal Ecoregion. Our aims were: analyze the taxonomic composition of the herpetofaunal communities; estimate the species occurrence index, and evaluate and

compare Hill's diversities (^{0}D, ^{1}D y ^{2}D) of the communities among different habitats in the JBAR. We used six different sampling methods and we registered 18 herpetofaunal species. Eleven amphibian species were detected, distributed in five genera and three families. The Hylidae family had the highest species richness (five species representing 45.4 %), followed by Leptodactylidae (36.4 %) and Bufonidae (18.2 %). Seven reptile taxa were detected, belonging to seven different families, each representing 14.3 % of the total. According to the occurrence constancy index, almost all species were rare, making up 94.4 % of the community (n = 17; <25 %), while common species accounted for the remaining 5.6 % (n = 1; > 25 %). Species occurrence was significantly higher in the Tajamar (TA) compared to other habitats (NF: Native Forest, EF: Exotic forest and GR: Grassland). Tajamar also exhibited the highest values in all Hill diversity measures, and the other habitats did not show significant differences between each other in any of the studied parameters. Sample coverage was 84.9 % in TA, 84.6 % in GR, 71.8 % in EF, while NF was 54.2 %. Understanding the current situation of herpetofauna is key to diagnosing and finding solutions to both current and future problems. We hope that our contributions highlight the value of the JBAR's natural heritage, as a relic of the Espinal Ecoregion.

Keywords.– Amphibians, community composition, Hill diversity, occurrence index, reptiles.

INTRODUCTION

The changes that ecosystems are undergoing worldwide threaten biodiversity and put at risk the various benefits they provide, including the stability and productivity of ecosystems (Cardinale et al., 2012; Roth-Monzón et al., 2018). Specifically, forest ecosystems have a total area of 4.06 billion hectares, covering 31 % of the Earth's surface. The tropical region has the highest proportion of forests in the world (45 %), followed by the boreal, temperate and subtropical zones (FAO, 2020). Since 1990, 178 million hectares of forest have been lost worldwide (Payn et al., 2015; FAO, 2020). This creates an urgent need to know and understand the biodiversity that forests protect as a tool to promote actions towards their conservation (Cardinale et al., 2012). In particular, amphibians and reptiles are taxonomic groups for which there has been a longstanding concern due to the decline in their populations. Amphibians are considered the most threatened vertebrates globally, with 41 % of their species at risk, while reptiles have 21 % of their species in some category of threat (IUCN, 2024). The main causes of the decline of both amphibians and reptiles are agriculture (annual and perennial crops) and livestock, use of biological resources (e.g., logging and timber harvesting, hunting and trapping of terrestrial animals), and residential and commercial development (in particular, housing construction and urban sprawl) (Cox et al., 2022; Luedtke et al., 2023; IUCN, 2024). Both taxonomic groups have traits that make them good indicators of ecosystem health, making their study of substantial importance (e.g., Weir et al., 2010; Díaz-García et al., 2017). The assemblage of amphibians and reptiles as a whole is therefore of great importance for assessing the state of ecosystems when they have been impacted by anthropogenic activities or by atypical natural events (Suárez González, 2017).

The Espinal, an Ecoregion of the Chaco-Pampeana plain in the southern cone of South America, is characterized by the presence of xerophytic forests dominated by the genus *Prosopis*, which covers an area of 291,941 km², spanning several Argentine provinces (Entre Ríos, Santa Fe, Córdoba, San Luis, Corrientes, La Pampa, and Buenos Aires). Within the Espinal, the northern part of Entre Ríos Province belongs to the Humid Pampean Plains Complex, whose vegetation forms a mosaic of forests in a grassland matrix, interrupted by reeds and riparian forest (Matteucci, 2012). The area has suffered significant impacts due to human activities such as selective logging, deforestation due to agricultural expansion, alterations in the natural fire regime, and the introduction of exotic species. Currently, the remaining Espinal forests are small relics surrounded by agricultural-livestock land, urban constructions, or forest plantations (Lewis et al., 2006; Lewis et al., 2009; Matteucci, 2012; Sione et al., 2024).

The Argentinean Espinal has records of 37 species of amphibians and 60 species of reptiles (Gallardo, 1982; Bosso et al., 1990; Cei, 1993; Peltzer & Lajmanovich, 1999; Peltzer et al., 2005; Giménez et al., 2008; Sanchez et al., 2008; Gangenova et al., 2012). However, there are still many areas within its surface that have not been sampled, therefore the knowledge about specific composition and diversity of herpetofaunal communities remains deficient. Quantifying diversity is the first step to identify and subsequently define information gaps, essential when establishing conservation priorities for the herpetofauna (Charruau et al., 2023). In this sense, intensive sampling in localized geographical areas, such as protected natural areas, provides necessary baseline information for developing management plans to adequately protect their

biological resources, while helping to increase our knowledge of this taxonomic group in the region (Céspedes et al., 2001).

There are several protected natural areas intended to preserve the Espinal Ecoregion in the province of Entre Ríos. Among these are the El Palmar National Park on the eastern side, the General San Martin Park and the Juan Bautista Alberdi Multiple Use Reserve (JBAR) on the western coast. The latter was created in 1992 and declared a cultural heritage site in 2000 (Muzzachiodi, 2002). Recent research has studied its mammal richness (Morguenstern et al., 2023) and has explored the effectiveness of different sampling techniques for amphibians there (Sanchez et al., 2023). In this context, our study presents the first description of the herpetofaunal biodiversity for the Juan Bautista Alberdi Multiple Use Reserve (JBAR), as an attempt to deepen efforts to document and protect its biodiversity. Our aims were: a) describe and compare composition and occurrence frequency of the herpetological community taxa among the different habitats of the JBAR, and b) evaluate and compare Hill's diversities of the communities among these defined habitats.

MATERIALS AND METHODS

Study area

The work was carried out in the JBAR, located at km 10.5 of Provincial Route N° 11, Oro Verde, Entre Ríos, Argentina (Fig. 1). It is located within the Espinal Ecoregion (Matteucci, 2012) and covers an area of 20 hectares. The climate of the region is humid temperate, with an average annual temperature of 18.4 °C and annual precipitation of 1,100-1,200 mm (Pausich et al., 2013).

Four habitats were differentiated in the JBAR: 1) NF: closed forest with predominance of native species (algarrobo blanco *Prosopis alba*, chañar *Geoffroea decorticans*, guayabo colorado *Myrcianthes cisplatensis*, ñangapirí *Eugenia uniflora*); 2) EF: open forest dominated by exotic species (broad-leaf privet *Ligustrum lucidum*, white mulberry *Morus* spp., white cedar *Melia azedarach*); 3) GR: native grassland (cortadera *Cortaderia selloana*, chilcas *Baccharis* spp., with some trees such as chañar *Geoffroea decorticans* and curupí *Sapium haematospermum*); and 4) TA: a permanent lagoon known by locals as "Tajamar". The

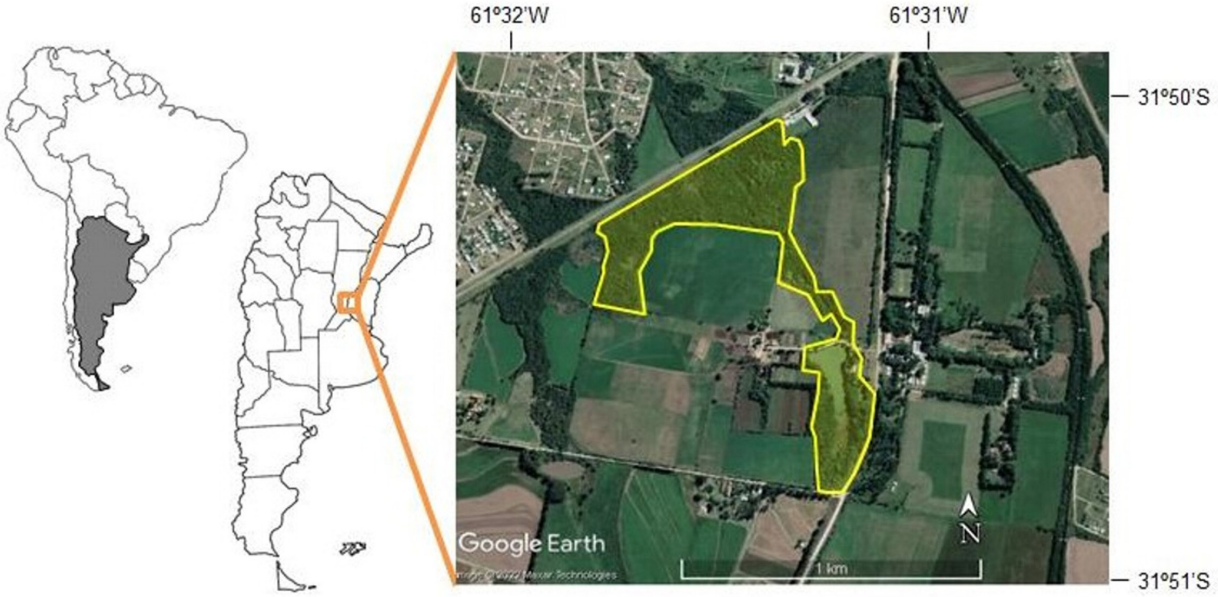

Figura 1. Localización geográfica de la Reserva de Usos Múltiples Juan Bautista Alberdi (JBAR) en el centro-este de Argentina.
Figure 1. Geographic location of the Juan Bautista Alberdi Multiple Use Reserve (JBAR) in central-east Argentina.

Figura 2. Evolución del nivel de agua en el "Tajamar" durante los muestreos realizados en la JBAR.

Figure 2. Evolution of the water level in the "Tajamar" during the samplings carried out in the JBAR.

latter had an area of 2.3 ha at the beginning of the surveys and its shoreline has a vegetation cover mainly composed of giant reed (*Arundo donax*), guayaba (*Psidium guayaba*), ombú (*Phytolacca dioica*), broad-leaf privet (*Ligustrum lucidum*) and yatay palm trees (*Butia yatay*) (Cacciabue & Savino, 2019). In total, seven sampling stations were set up distributed according to the surface of each habitat. Twelve surveys were carried out between December 2021 and April 2023, concentrated mainly in the season of most species activity (spring-summer). The surveys were systematic, and at each sampling station the following herpetofaunistic registration methods were implemented.

Aritificial shelters

The artificial shelters consisted of 1.60 x 0.60 m cardboard sheets placed on the ground and secured with stakes to prevent movement. Each cover was checked monthly, and data on ambient temperature and general weather conditions were recorded (Parmelee & Fitch, 1995). In habitats with more than one sampling station, covers were placed at least 50 m apart.

Species inventory

A complete species inventory was conducted by searching all possible microhabitats and natural shelters for herpetofauna. Surveys were carried out during the day on a monthly basis, with sampling effort measured in hours spent per habitat (Scott, 1994).

Pitfall traps

Pitfall traps were set up in transects, with three traps spaced 10 m apart in each transect. They were activated once a month and checked after three days (according to Sanchez et al., 2023).

Surveys

Acoustic and visual surveys were conducted by walking transects at sampling stations between 20:00 h and 23:00 h. In each station we done a 100-meter transect with acoustic survey points every 10 m. The same design was used for visual surveys (Sanchez et al., 2023).

Larval sampling

For larval sampling, daytime inspections were conducted at the ponds and internal pools of the JBAR with accumulated water. The net sampling method was applied (U.S. EPA, 2002) and a transect design was implemented with dipping points located every 10 m (Sanchez et al., 2023). Those larvae that could not be identified in the field were collected and preserved following the guidelines of ASIH et al. (2004) and the specific guidelines on animal euthanasia published in Underwood & Anthony (2020). It should be noted that the region experienced a drought stress situation during the sampling period, which worsened in mid-2022. As a result, the internal pools quickly dried up, and even the Tajamar dried up completely by October 2022 (Fig. 2).

Each recorded individual was taxonomically identified. In adults, this identification was carried out through external

morphological characteristics using previously published literature (e.g., Cei, 1980, 1986, 1993), and in the case of vocalizing anurans, through their species-specific calls, comparing them with sound reference guides (e.g., Straneck et al., 1993). The larvae, on the other hand, were analyzed under a Nikon SMZ 1000 binocular stereoscopic microscope with Nikon NI-150 epi-illumination, and taxonomic determination was made following descriptions provided by various authors for species in the region (Kehr & Williams, 1990; Rossa-Feres & Nomura, 2006; Vera-Candioti, 2007). Subsequently, they were included as voucher specimens in the Herpetological Collection of the Center for Scientific Research and Technological Transfer to Production, Diamante, Entre Ríos (CICYTTP-CONICET; acronym DIAM).

Statistical analysis

Due to the multiplicity of sampling methods employed and the variety of taxa addressed, data of incidence were used for statistical analyses. The occurrence of recorded species was evaluated using the occurrence index (Dajoz, 2005), by adding the positive registration data for each species over the 12 samplings and classifying the species as rare (present in < 25 % of samples), common (present in 25 to 50 % of samples), or abundant (present in > 50 % of samples). It was studied whether the habitat (NF, EF, GR, TA) or the taxonomic group (Amphibia, Reptilia) (predictor variables) had an effect on the occurrence index (response variable). Generalized linear models (GLM) were used, employing the "logarithm" link function with negative binomial error distribution due to the nature of the response variable (discrete variable with overdispersion). Applying the corrected Akaike information criteria for small samples (AICc) (Burnham & Anderson, 2002; Bartoń, 2024), all possible models were classified according to their AICc values and Akaike weights (wi). This process was implemented using the dredge function in the MuMIn package of R (Bartoń, 2024). Only in the case that no model exceeded a wi = 0.6, Multiple Model Inference (MMI) was performed using the model.avg function of the MuMIn package and the best final model was selected (Burnham & Anderson, 2002). Tukey contrasts were performed to analyze significance between different categories within the same predictor variable.

Finally, we calculated Hill diversities of order q = 0 (^{0}D = species richness), q = 1 (^{1}D = Shannon entropy exponential), and q = 2 (^{2}D = Simpson's inverse index) (Hill, 1973; Jost, 2006) to compare species diversity among the four habitats. For each Hill diversity measure, a rarefaction curve based on incidence data was constructed (following Chao et al., 2014). In this way, diversity estimates and associated 95 % confidence intervals for rarefaction and extrapolation curves were obtained, based on the bootstrap method with 1,000 iterations. Additionally, sample completeness in each habitat was estimated using the concept of sample coverage, following Chao et al. (2014). All statistical analyses were performed using R software version 4.4.1 (R Core Team, 2024), and the car (Fox & Weisberg, 2019), iNEXT (Hsieh et al., 2022), and ggplot2 (Wickham, 2016) libraries were used.

RESULTS

Eighteen herpetofaunal species were recorded. The amphibians included 11 species distributed in five genera and three families. The family Hylidae had the highest species richness (five species, 45.4 %), followed by Leptodactylidae (four species, 36.4 %) and Bufonidae (two species, 18.2 %). As for the reptiles, the seven taxa detected belonged to seven different families, each representing 14.3 % (Table 1).

According to the index of occurrence constancy (Table 1), almost all species were rare, constituting 94.4 % of the community (n = 17; <25 %), while the common species represented the remaining 5.6 % (n = 1; >25 %). There was no single generalized linear model that explained the occurrence of species (Table 2) and since none of the models reached a wi greater than 0.6, inference of multiple models was performed. This process showed that the predictor variable "Habitat" best explained the occurrence of species (Table 3). Tukey's post hoc tests revealed that species occurrence was significantly higher in TA compared to the rest of the habitats analyzed (Table 4; Fig. 3).

The TA habitat also exhibited the highest values in all Hill diversity measures (Table 5). The confidence intervals do not overlap between TA and the rest of the habitats for any of the three Hill numbers analyzed (^{0}D, ^{1}D, and ^{2}D), indicating significant differences at a 5 % level. On the other hand, NF, EF, and GR do not show relevant differences between each other in any of the parameters studied (Fig. 4). The sample coverage was 84.9 % in TA, 84.6 % in GR, 71.8 % in EF, while in NF it was 54.2 %.

DISCUSSION

Within the Espinal, the Humid Pampean Plains Complex covers an area of 41,913 km² (Matteucci, 2012). In the present study, we detected 30 % of the amphibian species and 12 % of the reptile species recorded for the Entre Ríos Espinal (Gallardo, 1982; Bosso et al., 1990; Cei, 1993; Peltzer & Lajmanovich, 1999; Peltzer et al., 2005; Giménez et al., 2008; Sanchez et al., 2008; Gangenova et al., 2012). Although previous studies in other protected areas of the region show a greater species richness, such as in the General San Martín Park, where 21 species of amphibians were cited for 594 ha (Peltzer et al., 2005), and El Palmar National Park, where

Tabla 1. Lista de especies de anfibios y reptiles, hábitats donde fueron registradas y clasificación obtenida a partir del índice de ocurrencia, para la Reserva de Uso Múltiple Juan Bautista Alberdi (JBAR), centro-este de Argentina, desde diciembre/21 hasta abril/23. NF, Bosque Nativo; EF, Bosque Exótico; GR, Pastizal Nativo; TA, Tajamar.

Table 1. List of amphibian and reptile species, habitats where they were recorded, and classification obtained from the occurrence index, for the Juan Bautista Alberdi Multiple Use Reserve (JBAR), central-eastern Argentina, from December/21 to April/23. NF, Native Forest; EF, Exotic Forest; GR, Native Grassland; TA, Tajamar.

Family	Species	Habitat	Ocurrence index
Amphibians			
Bufonidae	*Rhinella diptycha*	NF, TA	Rare
	Rhinella dorbignyi	NF, EF, GR, TA	Common
Hylidae	*Boana pulchella*	TA	Rare
	Dendropsophus nanus	TA	Rare
	Dendropsophus sanborni	TA	Rare
	Scinax acuminatus	TA	Rare
	Scinax nasicus	TA	Rare
Leptodactylidae	*Leptodactylus gracilis*	TA	Rare
	Leptodactylus latinasus	GR, TA	Rare
	Leptodactylus macrosternum	TA	Rare
	Leptodactylus mystacinus	NF, EF, TA	Rare
Reptiles			
Alligatoridae	*Caiman latirostris*	TA	Rare
Teiidae	*Salvator merianae*	TA	Rare
Gymnophthalmidae	*Cercosaura schreibersii*	GR	Rare
Scincidae	*Aspronema dorsivittatum*	GR	Rare
Colubridae	*Oxyrhopus rhombifer*	GR	Rare
Chelidae	*Phrynops hilarii*	TA	Rare
Emydidae	*Trachemys dorbigni*	TA	Rare

Tabla 2. Resumen de los resultados de la selección de modelos explicativos de la ocurrencia de especies herpetofaunísticas para la Reserva de Uso Múltiple Juan Bautista Alberdi (JBAR), centro-este de Argentina, en relación al hábitat, al grupo taxonómico y a la interacción entre ambos. Los modelos se muestran en orden decreciente de importancia según sus valores de AICc (criterio de información de Akaike corregido para muestras pequeñas) y ΔAICc (diferencia en el valor de AICc de cada modelo respecto al valor de AICc del mejor modelo, que es el de menor valor de AICc). Wi, Peso de Akaike; logLik, logaritmo de la verosimilitud; df, grados de libertad.

Table 2. Summary of the results of the selection of models explaining the occurrence of herpetofauna species for the Multiple Use Reserve Juan Bautista Alberdi (JBAR), central-east Argentina, in relation to the habitat, taxonomic group, and the interaction between both. The models are shown in decreasing order of importance according to their AICc values (Akaike's corrected information criterion for small samples) and ΔAICc (difference in AICc value of each model relative to the AICc value of the best model, which is the one with the lowest AICc value). Wi, Akaike weight; logLik, logarithm of the likelihood; df, degrees of freedom.

Model	df	logLik	AICc	ΔiAICc	wi
Habitat, Group	6	-72.417	158.1	0.00	0.580
Habitat, Group, Habitat*Group	9	-69.387	159.7	1.55	0.267
Habitat	5	-74.941	160.8	2.66	0.153
Group	3	-84.637	175.6	17.50	0.000
Null model	2	-86.631	177.4	19.31	0.000

22 species of amphibians and 28 species of reptiles were found in its 8,500 ha (Gallardo, 1982; Gangenova et al., 2012), it should be noted that our results correspond to a much smaller area of only 20 ha.

The marked difference found for species occurrence values and for all measures of hill diversity between the Tajamar area (TA) and the rest of the habitats is noteworthy. Regarding amphibians, 11 species were found in TA. This habitat was the only one in which exclusive species were recorded, which consisted of frogs from the Hylidae family (*Boana pulchella*, *Dendropsophus nanus*, *D. sanborni*, *Scinax acuminatus*, and *S. nasicus*) and two species from the Leptodactylidae family (*Leptodactylus gracilis* and *L. macrosternum*). The most generalist species turned out to be *Rhinella dorbignyi*, which was present in all four habitats, and *L. mystacinus*, found in three of them (all except the Native Grassland). These generalist species have been previously associated with different types of habitats, including sites with varying degrees of anthropogenic disturbance (Sanchez et al.,

Tabla 3. Parámetros estimados por la inferencia de múltiples modelos (MMI) para explicar la variación en la ocurrencia de especies herpetofaunísticas para la Reserva de Uso Múltiple Juan Bautista Alberdi (JBAR), centro-este de Argentina, en relación al hábitat, el grupo taxonómico y la interacción entre ambos. Se muestran los límites inferior y superior de los intervalos de confianza del 95 % para las variables explicativas. Las probabilidades se expresan en la escala del predictor lineal (Log de la media). NF, Bosque Nativo; EF, Bosque Exótico; GR, Pastizal Nativo; TA, Tajamar. AMPHIBIA+NF es el valor predeterminado en el intercepto de nuestros modelos.

Table 3. Parameters estimated by the inference of multiple models (MMI) to explain the variation in the occurrence of herpetofauna species for the Juan Bautista Alberdi Multiple Use Reserve (JBAR), center-east of Argentina, in relation to the habitat, the taxonomic group, and the interaction between both. The lower and upper limits of the 95 % confidence intervals for the explanatory variables are shown. Probabilities are expressed on the scale of the linear predictor (Log of the mean). NF, Native Forest; EF, Exotic Forest; GR, Native Grassland; TA, Tajamar. AMPHIBIA+NF is the default value in the Intercept of our models.

Explanatory variable	Estimated parameter	Confidence Interval	
		Lower	Upper
(Intercept)	-1.224	-2.379	0.068
Habitat - EF	-0.284	-1.95	1.382
Habitat - GR	0.91	-0.579	2.4
Habitat -TA	2.304	1.061	3.548
Group - REPTILIA	-6.599	-5111.139	5097.94
Habitat - EF: Group -REPTILIA	0.287	-12854.98	12855.56
Habitat - GR: Group -REPTILIA	19.049	-9071.003	9109.103
Habitat - TA: Group -REPTILIA	17.44	-9072.613	9107.494

Tabla 4. Parámetros estimados, valores Z y P, para los contrastes post hoc de Tukey que analizan la ocurrencia de especies herpetofaunísticas para la Reserva de Uso Múltiple Juan Bautista Alberdi (JBAR), centro-este de Argentina, en relación al hábitat. NF, Bosque Nativo; EF, Bosque Exótico; GR, Pastizal Nativo; TA, Tajamar. *, valores estadísticamente significativos.

Table 4. Estimated parameters, Z and P values, for Tukey's post hoc contrasts analyzing the occurrence of herpetofauna species for the Juan Bautista Alberdi Multiple Use Reserve (JBAR), center-east of Argentina, in relation to the habitat. NF, Native Forest; EF, Exotic Forest; GR, Native Grassland; TA, Tajamar. *, statistically significant values.

Habitats	Estimated parameter	Z value	*P*
EF - NF	-0.288	-0.344	0.985
GR - NF	1.012	1.498	0.429
TA - NF	2.351	3.771	<0.001 *
GR - EF	1.299	1.769	0.280
TA - EF	2.639	3.841	<0.001 *
TA - GR	1.340	2.796	0.026 *

Tabla 5. Valores de diversidad de Hill (q = 0, 1, 2) obtenidos para los cuatro hábitats relevados en la Reserva de Uso Múltiple Juan Bautista Alberdi (JBAR). NF, Bosque Nativo; EF, Bosque Exótico; GR, Pastizal Nativo; TA, Tajamar

Table 5. Hill diversity values (q = 0, 1, 2) obtained for the four habitats surveyed in the Juan Bautista Alberdi Multiple Use Reserve (JBAR). NF, Native Forest; EF, Exotic Forest; GR, Native Grassland; TA, Tajamar.

Habitat	^0D	^1D	^2D
NF	3	2.828	2.667
EF	2	1.890	1.800
GR	5	4.114	3.457
TA	15	10.733	8.481

2013; Medina et al., 2016; López et al., 2022; IUCN, 2024). Reptiles show a similar pattern, with TA presenting the greatest species richness, with four exclusive species: *Caiman latirostris, Salvator merianae, Phrynops hilarii* and *Trachemys dorbigni*.

These differences found between TA and the rest of the habitats could reflect the situation of drought stress and low rainfall that persisted in the region between late 2019 and early 2023 (Wingeyer et al., 2022; Mazzón & Rafaelli, 2023). This exceptional circumstance resulted in the temporary drying up of water bodies in the JBAR, and for most of the sampling period, the only environment with remaining water was the Tajamar. Also it is expected that this particular climatic reality conditioned the movements of individuals, reducing the probability of their detection in the other dried up studied areas as NF, EF, and GR (Martín et al., 2023). The Tajamar area may have served as an important water reservoir for the different species of amphibians and reptiles that depend on it. As a result, the greater activity recorded in this habitat translated into higher abundance and diversity values. Finally, in October 2022, Tajamar also dried up, an unprecedented event in the

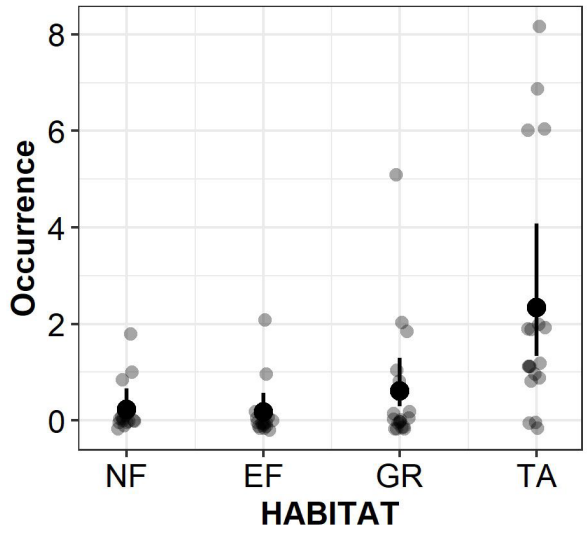

Figura 3. Valores predichos por el modelo seleccionado de ocurrencia de especies herpetofaunísticas para la Reserva de Uso Múltiple Juan Bautista Alberdi (JBAR), centro-este de Argentina, en relación al hábitat. Las barras de error están graficadas en negro. NF, Bosque Nativo; EF, Bosque Exótico; GR, Pastizal Nativo; TA, Tajamar.

Figure 3. Predicted values by the selected model of herpetofauna species occurrence for the Juan Bautista Alberdi Multiple Use Reserve (JBAR), central-east Argentina, in relation to the habitat. Error bars are plotted in black. NF, Native Forest; EF, Exotic Forest; GR, Native Grassland; TA, Tajamar.

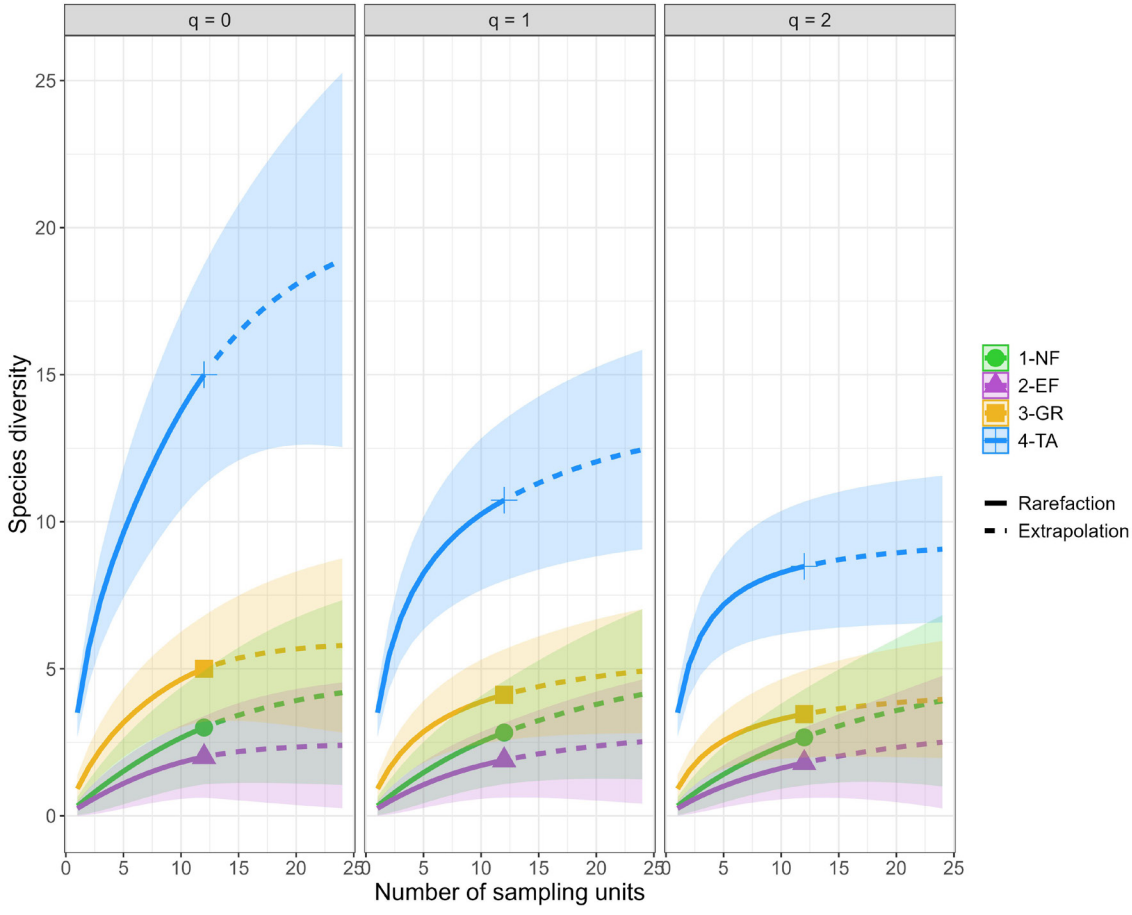

Figura 4. Curvas de rarefacción (líneas continuas) y de extrapolación (líneas discontinuas) con intervalos de confianza del 95 %, para las medidas de diversidad de Hill (q = 0, 1, 2), en ensambles herpetofaunísticos de la JBAR. NF, Bosque Nativo; EF, Bosque Exótico; GR, Pastizal Nativo; TA, Tajamar.

Figure 4. Rarefaction curves (solid lines) and extrapolation (dashed lines) with 95 % confidence intervals, for Hill diversity measurements (q = 0, 1, 2) in herpetofaunal assemblages of the JBAR. NF, Native Forest; EF, Exotic Forest; GR, Native Grassland; TA, Tajamar.

last two decades, mediated by the drought that affected the La Plata basin between 2019 and 2022, the worst recorded since 1944 (Naumann et al., 2023). For aquatic species, such as the turtles *Phrynops hilarii* and *Trachemys dorbigni*, the drought may have caused the mortality of numerous individuals in their population (Deppe et al., 2024), as evidenced by the encounter of lifeless specimens in the dry center of the Tajamar. In line with the above, Angarita-Sierra (2014) points out that both amphibian and reptile communities in Colombian savannas are significantly affected by periods of drought, even more so when they are longer and/or more intense. The author also emphasizes that the vegetation cover, which is strongly altered during these extreme events, is a key factor that influences the composition and specific richness of herpetofaunal communities. In this sense, the change in vegetation in the JBAR was evident as the drought worsened. This fact was compounded by anthropic intervention within the Grassland habitat (GR), which was mowed on more than one occasion using machinery (events recorded by the working group), likely in an attempt to reduce the load of flammable material. The Native Grassland habitat featured records of exclusive species within the JBAR (*Cercosaura schreibersii*, *Aspronema dorsivittatum*, and *Oxyrhopus rhombifer*), and following these management practices, sightings decreased, hinting at a negative effect on the herpetofaunal assemblage.

CONCLUSIONS

Our results show that the herpetofauna of the JBAR is composed of species widely distributed in the Espinal. However, the characteristic sensitivity of these faunal groups to environmental changes (Cox et al., 2022; Luedtke et al., 2023) raises questions about the long-term impact of the extreme drought event that occurred in the region on the herpetofaunal community. Knowledge of the state of the herpetofauna is a basic requirement for diagnosing and finding solutions to present and future problems (Comitti, 2017), so we consider it essential to continue studies in the area in order to analyze the evolution of these communities post-drought. Finally, we hope that our contributions highlight the value of the JBAR's natural heritage, as a relic of the Espinal Ecoregion.

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