Herpetology Notes 19: 517–523, published on 12 July 2026

Herpetofauna richness in urban and fragmented green spaces of Panama City

Marcelo Mack-Prado[1,2,*], Víctor Martínez-Cortes[2], Mahmood Sasa-Marín[3], Yostin Añino[4], and Ángel Sosa-Bartuano[5]

Abstract. Urbanisation is a global process that fragments and degrades habitats, threatening biodiversity. Amphibians and reptiles are vulnerable to these changes, but urban green spaces can serve as refugia. This study aimed to evaluate the diversity and composition of herpetofaunal assemblages in five sites in Panama City: Parque Natural Metropolitano (PNM), Albrook, Corozal, Campus Octavio Méndez Pereira - Universidad de Panamá (UP), and Reserva Natural Cerro Ancón (RNCA). Sampling was conducted at five sites from January 2023 to January 2024. At each site, two linear transects, 200 m long and 3 m wide on each side, were established. A total of 29 species (nine amphibians and 20 reptiles) were recorded, with the highest richness in the PNM (27 species) and the lowest in Albrook (12). Widespread species such as *Rhinella horribilis* and *Anolis auratus* were found in all sites, while others, for example *Rhinella centralis,* were only recorded at a single site. The cluster analysis showed that the PNM and Corozal are the most similar sites in richness ($S_j = 0.76$), while Albrook segregated from the rest with a similarity value below $S_j = 0.4$. Although PERMANOVA and NMDS analyses using fragment area (ha) and isolation distance (km) were not significant, likely due to a small sample area ($n = 5$), the observed patterns suggest that larger forest fragments, such as the PNM (232 ha), act as important reservoirs. The results demonstrate the importance of urban green spaces for herpetofauna conservation, providing scientific evidence for urban planning in Panama City.

Keywords. ecological resilience, generalist species, habitat fragmentation, *in situ* conservation, urban gradient

Introduction

Urbanisation is a global process that exerts pressure on biodiversity, leading to habitat fragmentation and loss, resulting in a decline in populations and an alteration of ecological communities (McKinney, 2006; Seto et al., 2012; Ijie et al., 2021; Muñoz-Pacheco et al., 2023). Urban green spaces, such as parks and forest patches, can function as refuges for wildlife, offering opportunities for *in situ* conservation and partially mitigating negative impacts (Goddard et al., 2010; Demartín et al., 2024). Understanding which factors facilitate the persistence of biodiversity in these landscapes is important for sustainable urban planning (Hamer and McDonnell, 2008). In this context, amphibians and reptiles are especially vulnerable due to their low mobility, specific microhabitat requirements, and sensitivity to pollution and changes in water and habitat quality (Hamer and McDonnell 2008; Scheffers and Paszkowski, 2012; Ijie et al., 2021; Luedtke et al., 2023). The literature consistently documents the detrimental effects of urbanisation on these groups, including reduced species richness and altered community structure (McKinney, 2006; Scheffers and Paszkowski, 2012; Demartín et al., 2024).

Tropical regions, harbouring the majority of the planet's terrestrial biodiversity (Mora-Macías et al., 2024), face a severe threat from rapid urban expansion (Ijie et al., 2021). Panama City is characterised by a matrix of forest fragments and protected areas, such as the Parque Natural Metropolitano, which are important for maintaining the local herpetofauna (Ávila-Nájera et al., 2018; Davison et al., 2021). Studies in other tropical regions have confirmed both the vulnerability of herpetofauna

[1] Departamento de Ciencias Ambientales, Universidad de Panamá, El Cangrejo, Apartado 0824, Panamá.
[2] Centro para Investigaciones y Respuestas en Ofidiología, Universidad de Panamá, El Cangrejo, Apartado 0824, Panamá.
[3] Instituto Clodomiro Picado, Facultad de Microbiología, Universidad de Costa Rica, Apartado 11501-2060, Dulce Nombre de Coronado, San José, Costa Rica.
[4] Museo de Invertebrados G. B. Fairchild, Universidad de Panamá, El Cangrejo, Apartado 0824, Panamá; and Coiba Scientific Station, City of Knowledge, Clayton, Panamá.
[5] Museo de Vertebrados de la Universidad de Panamá, Campus Octavio Méndez Pereira, Avenida Simón Bolívar, Apartado 0824, Panamá.
[*] Corresponding author: E-mail: marmack24@gmail.com

to urbanisation and the potential of vegetation remnants to maintain important diversity (Ijie et al., 2021; Zaffaroni-Caorsi et al., 2022; Demartín et al., 2023).

The diversity and composition of herpetofauna in urbanised landscapes are influenced by a complex combination of factors at the landscape scale and the local scale (Goddard et al., 2010; Ijie et al., 2021; Demartín et al., 2024; Sánchez-López et al., 2025). Given the heterogeneous urban-forest matrix in Panama City, there is a need to assess the diversity of its herpetofauna and understand the ecological factors that permit its persistence in urban forest fragments. The objective of this study is to evaluate the diversity and composition of herpetofaunal assemblages in five sites within Panama City: Parque Natural Metropolitano (PNM), Albrook, Corozal, Universidad de Panamá, Campus Octavio Méndez Pereira (UP), and Reserva Natural Cerro Ancón (RNCA).

Materials and Methods

Study area. This study was conducted at five sites within and surrounding Panama City, Panama Province: Metropolitan Natural Park (PNM), Albrook, Corozal, the Octavio Méndez Pereira Campus of the University of Panama (UP), and the Cerro Ancón Nature Reserve (RNCA) (Fig. 1). The region is characterised by a humid tropical climate, with a rainy season from May to November and a dry season from December to April (Navarro-Valencia et al., 2021). The average annual temperature is approximately 27 °C, with an average annual precipitation of 2600 mm (Trejos-Saucedo and Achurra, 2021). The urban landscape of Panama City comprises a matrix of residential, commercial, and industrial development, which creates significant local thermal variations (Candanedo and Villarreal, 2020). This matrix is interspersed with numerous fragments of humid tropical secondary forest, urban parks, and protected areas, as well as managed green spaces with scattered trees, such as the UP campus.

Fieldwork. Five urban forest fragments (PNM, Albrook, Corozal, UP, RNCA) were selected, exhibiting gradients in area (ranging from 33–600 ha) and degree of isolation (distance to the nearest continuous forest patch varying from 2–10 km) (Table 1). The Universidad de Panamá (UP) is not a forest fragment but was included as an urban site with scattered trees to evaluate herpetofauna in a location lacking continuous tree cover. For each site, geographic coordinates were recorded using a Garmin GPSMAP 65. The GIS software used for spatial analysis was ArcGIS Pro-3.0. Herpetofauna

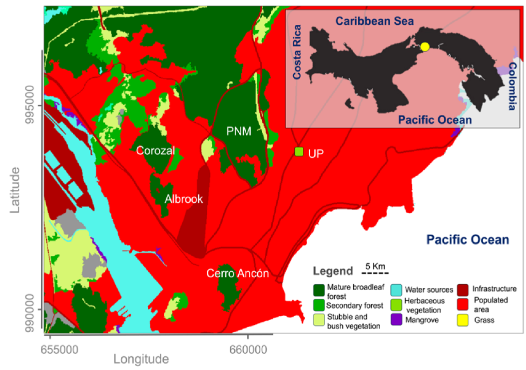

Figure 1. Map of the study sites in an urban landscape with forest fragments in Panama City.

sampling was conducted between January 2023 and January 2024, encompassing both the dry and rainy seasons to maximise species detection. Sampling protocols followed standardised Visual Encounter Survey (VES) methods adapted for tropical urban gradients (Heyer et al., 1994; Hamer and McDonnell, 2008).

At each site, standardised protocols based on previous studies conducted in tropical and urban environments were employed. Two linear transects, each 200 m in length and 3 m wide on each side, were established. Each transect was slowly surveyed (approximately 10 min) by two trained observers during both diurnal (07:00–09:00 h) and nocturnal (18:00–21:00 h) periods. Observers actively searched for amphibians and reptiles in all available microhabitats up to a height of 2 m, including water bodies. Daytime surveys were conducted once per week throughout the study year, whereas nighttime surveys were conducted during three consecutive nights each month. Two observers partici-

Table 1. Landscape-scale environmental variables of the five study sites in the urban-forest matrix of Panama City, Panama. Fragment area is ex-pressed in hectares (ha) and isolation as the distance to the nearest continuous forest patch in kilometres (km).

Site	Fragment area	Distance to continuous forest
PNM	232	0.04
Albrook	40	0.03
Corozal	85	0.03
UP	60	0.3
RNCA	40	1.48

pated consistently during the day, while four observers participated at night. Overall, this design resulted in a standardised sampling effort of approximately 744 person-hours per site over the full sampling period, corresponding to 312 person-hours during the diurnal period and 432 person-hours during the nocturnal period.

During the surveys, anuran species were recorded by their vocalisations. Recordings of species not identifiable in the field were made for subsequent analysis and comparison with reference sound libraries. For each individual observed, the species, time of encounter, GPS coordinates, and microhabitat where it was found were recorded. Taxonomic determination of the species was performed in the field using the amphibian and reptile guides for Central America (Köhler, 2008, 2011). The higher-level taxonomic classification and nomenclature used in this study follow the current updates of Amphibian Species of the World (Frost, 2026) for amphibians, and The Reptile Database (Uetz et al., 2026) for reptiles. Photographs were taken for comparison with reference collections. Manipulation and stress on the animals were minimised. No specimens were collected.

Data analysis. Statistical analyses were performed using R software v4.3.0. Diversity indices and rarefaction curves were calculated using the iNEXT package (Hsieh et al., 2016), while community and beta diversity analyses were performed with the vegan package (Oksanen et al., 2022). To evaluate differences in herpetofaunal assemblage composition among the sites, a species presence-absence matrix was constructed. From this matrix, Jaccard similarity (S_J) was calculated. This matrix was then used to perform a hierarchical cluster analysis (UPGMA) to group the sites based on their faunal similarity. Additionally, Jaccard dissimilarity ($D_J = 1 - S_J$) was utilised for the PERMANOVA and NMDS analyses to formally test the influence of landscape-scale variables (fragment area and distance to forest) on community structure. The significance level was set at $\alpha = 0.05$.

Results

A total of 29 species of amphibians and reptiles were recorded across the five sampling sites, of which nine corresponded to amphibians and 20 to reptiles (Table 2).

Richness and composition by family. Among amphibians, Bufonidae showed the highest richness, with four species observed, including *Rhinella horribilis* and *Rhinella alata*. The remaining families had a richness of two species or less. In reptiles, the Dipsadidae family was the most diverse with four species, while we recorded three or fewer species for the other families.

Species occurrence by site. Six species showed a wide distribution, being found across all sampled sites: *Rhinella horribilis*, *Anolis auratus*, *Gonatodes albogularis*, *Holcosus festivus*, *Leptodeira rhombifera*, and *Oxybelis vittatus*. Species with observations restricted to a single site were also found, such as *Rhinella centralis* and *Anolis gaigei*, both recorded exclusively in the PNM.

Richness per site. The total herpetofaunal species richness varied notably among the study sites (see Table 3). The PNM recorded the highest richness with 27 species (seven amphibians and 20 reptiles), making it the most diverse site. At the other extreme, the forest remnant of Albrook presented the lowest species richness, with only 12 species in total (two amphibians and 10 reptiles). The UP also had low richness, with 13 species (four amphibians and nine reptiles). Meanwhile, the RNCA and Corozal showed intermediate richness with 21 and 24 species, respectively.

Beta diversity analysis. The dendrogram showed that the PNM and Corozal presented the highest similarity in species composition ($S_j = 0.76$), forming a main cluster. A second cluster was observed between the RNCA and UP, with a similarity of approximately $S_j = 0.52$. These two main clusters joined at a similarity level of approximately $S_j = 0.44$. Notably, the Albrook site segregated from the rest of the sites, joining them at a similarity level below $S_j = 0.4$, which indicates a markedly different community composition (Fig. 2).

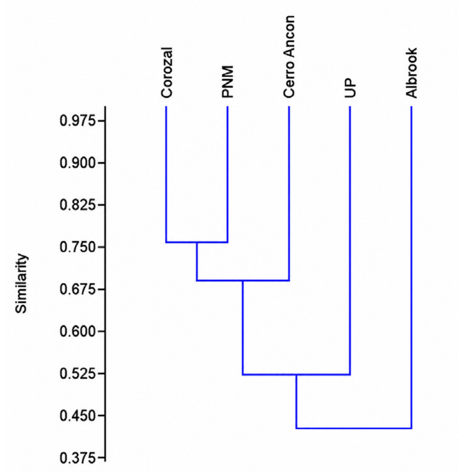

Figure 2. Similarity in herpetofaunal assemblage composition in an urban gradient, Panama City.

Table 2. Occurrence-absence matrix (1 = present, 0 = absent) of amphibian and reptile species in the five study sites.

Family	Species	PNM	Albrook	Corozal	UP	RNCA
Bufonidae	*Rhaebo haematiticus*	1	0	1	1	1
	Rhinella alata	1	1	1	0	1
	Rhinella centralis	1	0	0	0	0
	Rhinella horribilis	1	1	1	1	1
Craugastoridae	*Craugastor fitzingeri*	1	0	1	1	1
Eleutherodactylidae	*Diasporus diastema*	0	0	1	0	1
Hylidae	*Boana rosenbergi*	1	0	1	0	1
	Trachycephalus typhonius	0	0	1	0	0
Leptodactylidae	*Engystomops pustulosus*	1	0	1	1	1
Anolidae	*Anolis auratus*	1	1	1	1	1
	Anolis apletophallus	1	0	1	1	1
	Anolis gaigei	1	0	0	0	0
Corytophanidae	*Basiliscus basiliscus*	1	1	1	0	0
Iguanidae	*Iguana iguana**	1	1	1	0	1
Phyllodactylidae	*Thecadactylus rapicauda*	1	0	1	0	0
Scincidae	*Marisora unimarginata*	1	0	1	0	1
Sphaerodactylidae	*Gonatodes albogularis*	1	1	1	1	1
Teiidae	*Holcosus festivus*	1	1	1	1	1
	Holcosus leptophrys	1	0	0	0	1
Boidae	*Boa imperator*	1	0	1	1	1
	Epicrates maurus	1	1	1	1	0
Colubridae	*Dendrophidion percarinatum*	1	1	1	0	0
	Phrynonax poecilonotus	1	0	1	0	0
Dipsadidae	*Erythrolamprus epinephelus*	1	1	1	0	1
	Leptodeira ornata	1	0	1	1	1
	Leptodeira rhombifera	1	1	1	1	1
	Oxybelis vittatus	1	1	1	1	1
Elapidae	*Micrurus nigrocintus*	1	0	0	0	1
Viperidae	*Bothrops asper*	1	0	0	0	1

* Taxon corrected following van den Burg et al. (2021, 2026) and Iguana Taxonomy Working Group (2022). Recent data shows that the range limit of the subspecies *Iguana iguana rhinolopha* lies further west.

The PERMANOVA did not detect a statistically significant effect of the variables area\Ha and Distance\Forest\km, either individually or jointly, on herpetofaunal composition. The overall model results were: $R^2 = 0.47$, $F = 0.89$, $p = 0.56$.

The NMDS showed a very low stress value, suggesting a perfect fit, which is an artifact of the small number of sampled sites ($n = 5$). The overlay of environmental vectors on the ordination space suggested a trend in which PNM and Corozal were associated with fragment area, while RNCA tended to be related to a greater distance from a continuous forest patch.

Discussion

The herpetofaunal richness observed across the five study sites in Panama City presents a pattern apparently influenced by the degree of urbanisation and habitat quality. The amphibian richness recorded in this study corresponds to 28%, whereas reptile richness reached

Table 3. Species richness of amphibians, reptiles, and total richness for each study site.

Site	Richness of amphibians	Richness of reptiles	Total richness of species (Number of Hill q = 0)
PNM	7	20	27
Corozal	8	16	24
RNCA	4	17	21
UP	4	9	13
Albrook	2	10	12

29% of the richness reported for Barro Colorado Island (BCI) (Myers and Rand, 1969). Consistent with the theory of island biogeography and urban ecology (Ijie et al., 2021; Demartín et al., 2024), the PNM, the largest (232 ha) and most conserved area, served as an important biodiversity reservoir, harbouring the highest richness (27 spp.). The recorded richness may reflect the carrying capacity of these forest fragments within and in the vicinity of Panama City. The absence of historical data precludes direct comparison; however, BCI can serve as a reference for the potential richness of the study sites (Myers and Rand, 1969). The observed difference should not be interpreted as lower richness, but rather as an indication of the environmental filtering imposed by urbanisation, whereby only resilient species are able to persist. Our findings align with the global meta-analysis by Beninde et al. (2015), who identified that patch area is the most critical determinant for maintaining intra-urban biodiversity. This dominance is likely due to its area and reduced exposure to the urban matrix (lower isolation and pollution), enabling the maintenance of high-richness herpetofaunal assemblages. In contrast, Albrook and Universidad de Panamá (UP) sites exhibited the lowest richness (12 and 13 spp., respectively), reflecting severely impoverished assemblages dominated by species tolerant to disturbance. This decline in smaller fragments is consistent with the area thresholds suggested by Beninde et al. (2015), where reduced space often fails to support area-sensitive species.

Analysis of species composition further reinforces this divide. The occurrence of species with restricted distributions in the PNM, such as *Rhinella centralis* and *Trachycephalus typhonius*, suggests that this large fragment retains specific, high-quality microhabitats, such as permanent water bodies and dense leaf litter, required for specialist or disturbance-sensitive species (Urbina-Cardona et al., 2006). These specialised requirements are often lost in smaller fragments due to edge effects and increased desiccation, a process that particularly affects forest-dependent herpetofauna. This is consistent with the findings of Schneider-Maunoury et al. (2016), who demonstrated that specialist amphibians and reptiles are significantly more sensitive to forest edge effects, leading to their decline in smaller, more exposed patches. Conversely, the ubiquitous occurrence of species like *Rhinella horribilis* and *Anolis auratus* across all sites, including the most disturbed, confirms their status as highly tolerant generalists, a common feature of simplified, human-modified tropical landscapes (McKinney, 2006; Scheffers and Paszkowski, 2012).

The quantitative beta diversity analyses supported these ecological groupings. The hierarchical cluster analysis showed the highest similarity between PNM and Corozal (similarity 0.76), while the Albrook site segregated completely from the rest (similarity < 0.4), demonstrating a markedly different community composition. Valdés et al. (2023) found a similarity greater than 40% between the Corozal, PNM, and Albrook sites and a very distinct composition at the UP site, based on butterfly richness. The results of this work partially coincide; although Corozal and PNM show high similarity, this is not the case for Albrook, which showed greater similarity to UP. These discrepancies are likely due to taxon-specific responses to the urban matrix; while highly mobile insects such as butterflies may perceive connectivity across broader scales (Blair, 1999), amphibians and reptiles are more constrained by local environmental filters and physical barriers to dispersal (Jones and Leather, 2012).

Although the PERMANOVA did not detect a statistically significant effect of the landscape variables (area/ha and distance to forest/km) on species composition ($R^2 = 0.47$, $p = 0.56$), this lack of significance is likely a direct consequence of the low statistical power inherent in the small sample area ($n = 5$). Despite this limitation, the substantial R^2 value suggests these factors hold biological importance in structuring communities, as the magnitude of effect is often a more reliable indicator of ecological relevance than the p-value in restricted datasets (Di Stefano, 2004; Nakagawa and Cuthill, 2007). This interpretation is supported by the visual patterns in the NMDS and the intermediate richness observed in Corozal and the Reserva Natural Cerro Ancón (RNCA). These sites demonstrate that even smaller fragments, when connected or possessing specific habitat features, maintain significant local herpetofaunal diversity, highlighting the value of the entire network of green spaces in providing refuge within the urban matrix.

The observed patterns are fully consistent with the hypothesis that urbanisation negatively impacts herpetofaunal diversity, favouring generalists in small, highly exposed patches while conserving specialists primarily in the largest remnants (Hamer and McDonnell, 2008). These findings underscore that fragment area often serves as a proxy for the retention of forest interior conditions, which are critical for the survival of sensitive tropical taxa (Mendenhall et al., 2016). Future research must incorporate a larger number of sites and detailed microenvironmental variables, such as leaf litter depth, canopy cover, and water quality, to statistically quantify the mechanisms structuring these communities and overcome the limitations of the current study area (Urbina-Cardona et al., 2006).

Urban green spaces in Panama City are heterogeneous in their capacity to host herpetofaunal diversity, yet our findings provide critical evidence for their collective conservation value. The largest, best-conserved forest fragments, particularly the PNM, function as vital refugia for specialists and disturbance-sensitive species. The observed differentiation in community composition underscores the significant environmental filter exerted by urbanisation, which leads to the replacement of specialists with a few highly tolerant generalists in modified environments (Hamer and McDonnell, 2008). Crucially, the intermediate richness at Corozal and RNCA emphasises that the entire network of forest fragments maintains regional herpetofaunal diversity and must be integrated into urban planning. Protecting and restoring larger, high-value fragments like the PNM is essential, but management must also implement strategies to improve habitat quality and connectivity in smaller fragments. Enhancing these spaces will increase the city's ecological resilience against the pervasive challenges of climate change and rapid biodiversity loss (Ahern, 2013).

Acknowledgments. We thank the Secretaria de Ciencia, Tecnología e Innovación (SENACYT) of Panama (Grant/Award Number; DCCT-004-2023).

References

Ahern, J. (2013): Urban landscape sustainability and resilience: the promise and challenges of integrating ecology with urban planning and design. Landscape Ecology **28**: 1203–1212.

Beninde, J., Veith, M., Hochkirch, A. (2015): Biodiversity in cities needs space: a meta-analysis of factors determining intra-urban biodiversity variation. Ecology Letters **18**: 581–592.

Candanedo, M., Villarreal, D. (2020): Efecto de las islas de calor urbano en las principales vías de la Ciudad de Panamá. Revista I+D Tecnológico 16: 30–35.

Demartín, R.P., Ghirardi, R., López, J.A. (2024): Influence of natural and artificial habitats and microhabitats on urban amphibian diversity and behavior. Diversity **17**: 292.

Di Stefano, J. (2004): A confidence interval approach to data analysis. Forest Ecology and Management **187**: 173–183.

Frost, D.R. (2026). Amphibian Species of the World: an Online Reference (Version 6.2). American Museum of Natural History. Retrieved May 19, 2026, from https://amphibiansoftheworld.amnh.org/

Goddard, M.A., Dougill, A.J., Benton, T.G. (2010): Scaling up from gardens: biodiversity conservation in urban environments. Trends in Ecology & Evolution **25**: 90–98.

Hamer, A.J., McDonnell, M.J. (2008): Amphibian ecology and conservation in the urbanising world: a review. Biological Conservation **141**: 2432–2449.

Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.C., Foster, M.S. (1994): Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians. Washington, D.C., USA, Smithsonian Institution Press.

Hsieh, T.C., Ma, K.H., Chao, A. (2016): iNEXT: an R package for rarefaction and extrapolation of species diversity (Hill numbers). Methods in Ecology and Evolution **7**: 1451–1456.

Ijie, M.E., Alari, E.O., Ogoanah, S.O., Aisien, M.S.O. (2021): Amphibian diversity in urban and peri-urban landscapes of Benin City, a southern Nigerian city in the rainforest biotope. The Zoologist **19**: 52–59.

Iguana Taxonomy Working Group (2022): A checklist of the iguanas of the world (Iguanidae; Iguaninae) 2022 supplement to: 2016. Herpetological Conservation and Biology **11**: 4–46 and 2019 Supplement. [https://www.iucn-isg.org/wp-content/uploads/2022/05/ITWG_Checklist_2022_Supplement.pdf]

Köhler, G. (2008): Reptiles of Central America. Second Edition. Offenbach, Germany, Herpeton Verlag.

Köhler, G. (2011): Amphibians of Central America. Offenbach, Germany, Herpeton Verlag.

McKinney, M.L. (2006): Urbanisation as a major cause of biotic homogenization. Biological Conservation **127**: 247–260.

Mendenhall, C.D., Shields-Estrada, A., Krishnaswami, A.J., Daily, G.C. (2016): Quantifying and sustaining biodiversity in tropical agricultural landscapes. Proceedings of the National Academy of Sciences of the United States of America **113**: 14544–14549.

Mora-Macías, V.U., Colli-Mull, J.G., Hernández-Árciga, R., Chang-Martínez, L.A., Charre-Medellín, J.F., Álvarez-Jara, M. (2024): Diversidad herpetofaunística y uso de microhábitat en dos tipos de vegetación en la Reserva de la Biosfera Sierra Gorda de Guanajuato, México. Caldasia **46**(1): 179–193.

Muñoz-Pacheco, C.B., Villaseñor, N.R., Escobar, M.A. (2023): Fauna en vegetación nativa y plantaciones forestales del área periurbana de Quintay: una oportunidad para la conservación del patrimonio natural en la costa de Chile central. Revista de Geografía Norte Grande **86**: 1–24.

Myers, C.W., Rand, A.S. (1969): Checklist of amphibians and reptiles of Barro Colorado Island, Panama, with comments on faunal change and sampling. Washington, D.C., USA, Smithsonian Institution Press.

Nakagawa, S., Cuthill, I.C. (2007): Effect size, confidence intervals and statistical significance: a practical guide for biologists.

Biological Reviews **82**: 591–605.

Navarro-Valencia, V., Díaz, Y., Pascale, J.M., Boni, M.F., Sanchez-Galan, J.E. (2021): Assessing the effect of climate variables on the incidence of dengue cases in the Metropolitan Region of Panama City. International Journal of Environmental Research and Public Health **18**: 12108.

Oksanen, J., Simpson, G., Blanchet, F., Kindt, R., Legendre, P., Minchin, P., et al. (2022): vegan: Community Ecology Package. R package version 2.6-4.

Sánchez-López, K.E., Martín-Regalado, C.N., Gómez-Ugalde, R.M., Martínez-Ramírez, E. (2025): Diversity of amphibians and reptiles in conserved forests and disturbed areas: a comparison in southern Mexico. Diversity **17**: 141.

Scheffers, B.R., Paszkowski, C.A. (2012): The effects of urbanisation on North American amphibian species: identifying new directions for urban conservation. Urban Ecosystems **15**: 133–147.

Schneider-Maunoury, L., Lefebvre, V., Magrach, A., Fahrig, L., Peres, C.A., Dooley, J.L., Ewers, R.M. (2016): Abundance signals of amphibians and reptiles exposed to forest edge effects worldwide. Global Change Biology **22**: 715–726.

Seto, K.C., Güneralp, B., Hutyra, L.R. (2012): Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. Proceedings of the National Academy of Sciences of the United States of America **109**: 16083–16088.

Trejos-Saucedo, I.E., Achurra, G. (2021): Factores que aumentan la incidencia de inundaciones por precipitaciones pluviales en núcleos urbanos de la Ciudad Capital, Panamá. Investigación y Pensamiento Crítico **9**: 5–22.

Uetz, P., Freed, P., Aguilar, R., Reyes, F., Kudera, J., Hošek, J. (Eds.). (2026). The Reptile Database. Retrieved May 19, 2026, from http://www.reptile-database.org

Urbina-Cardona, J.N., Olivares-Pérez, M., Reynoso, V.H. (2006): Herpetofauna diversity and microhabitat use in a tropical rainforest fragment and perennial farmland of Mexico. Biological Conservation **128**: 328–339.

Valdés, L., Ortíz, O., Medianero, E. (2023): Diversidad y estructura de las comunidades de mariposas diurnas (Lepidoptera: Rhopalocera) en fragmentos de vegetación urbanas adyacentes a la Ciudad de Panamá. In: Insectos asociados a los bosques urbanos de la ciudad de Panamá, p. 23–71. Medianero Segundo, E., Santos Murgas, A., Eds., DECO Mc Pherson S.A.

van den Burg, M.P., Grandjean, F., Schikorski, D., Breuil, M., Malone, C.L. (2021): A genus-wide analysis of genetic variation to guide population management, hybrid identification, and monitoring of invasions and illegal trade in *Iguana* (Reptilia: Iguanidae). Conservation Genetics Resources **13**(4): 435–445.

van den Burg, M.P., de Queiroz, K., Ventayol, M., Debrot, A.O., Malone, C.L. (2026): Consideration of range-wide variation is critical when splitting widely distributed species: the case of the proposed *Iguana melanoderma*. Zootaxa **5748**: 387–399.

Zaffaroni-Caorsi, V., Both, C., Márquez, R., Llusia, D., Narins, P., Debon, M., Borges-Martins, M. (2022): Effects of anthropogenic noise on anuran amphibians. Bioacoustics **32**: 90–120.

Accepted by Julie M. Ray