

Article

Comprehensive Terrestrial Vertebrates Inventory and Conservation Implications in the Sierra de Zapalinamé State Natural Reserve, Northeastern Mexico

Jorge E. Ramírez-Albores ^{1,*}, Erika J. Cruz-Bazan ², Juan A. Encina-Domínguez ², Eber G. Chavez-Lugo ²
and Francisco Cruz-García ³

¹ Departamento de Botánica, Universidad Autónoma Agraria Antonio Narro, Calzada Antonio Narro 1923, Col. Buenavista, Saltillo 25315, Coahuila, Mexico

² Departamento de Recursos Naturales Renovables, Universidad Autónoma Agraria Antonio Narro, Calzada Antonio Narro 1923, Col. Buenavista, Saltillo 25315, Coahuila, Mexico

³ Departamento Forestal, Universidad Autónoma Agraria Antonio Narro, Calzada Antonio Narro 1923, Col. Buenavista, Saltillo 25315, Coahuila, Mexico

* Correspondence: jorgeramirez22@hotmail.com

Simple Summary

This study provides a comprehensive assessment of vertebrate diversity in the Sierra de Zapalinamé State Natural Reserve, a mountain system located within a biogeographic transition zone (Chihuahuan Desert and Sierra Madre Oriental regions), in northeastern Mexico. Based on systematic monitoring conducted from 2020 to 2025 and complemented with scientific and citizen-generated records, the reserve was found to harbor 415 terrestrial vertebrate species, including a high proportion of regional avifauna and representative assemblages of mammals, reptiles, and amphibians. This high documented richness highlights the reserve as an important component of the terrestrial vertebrate diversity of northeastern Mexico. Overall, the study highlights the Sierra de Zapalinamé State Natural Reserve as a strategic conservation area and emphasizes the importance of integrating long-term monitoring, acoustic surveys, camera trapping, and historical records to support adaptive management, biodiversity conservation, and regional connectivity under increasing anthropogenic and climatic pressures.

Abstract

Detailed knowledge of biodiversity is fundamental to supporting conservation and management strategies in protected natural areas, especially in mountain systems located in biogeographic transition zones (Chihuahuan Desert and Sierra Madre Oriental regions). The Sierra de Zapalinamé State Natural Reserve is a priority system in northeastern Mexico; however, comprehensive long-term inventories of its terrestrial vertebrate fauna have been limited. The objective of this study was to comprehensively characterize the richness and composition of the terrestrial vertebrate fauna of the Sierra de Zapalinamé State Natural Reserve using a long-term, multi-source dataset integrating systematic field surveys, biological collections, and citizen science records, and to assess the extent to which the reserve represents the vertebrate diversity of northeastern Mexico. A total of 415 terrestrial vertebrate species were recorded, comprising 299 birds, 67 mammals, 42 reptiles, and 7 amphibians. Despite its proximity to urban areas and industrial activities, the reserve maintains high levels of biodiversity, harboring a substantial proportion of the terrestrial vertebrate fauna of northeastern Mexico. The results emphasize the importance of the Sierra de Zapalinamé State Natural Reserve as a regional biodiversity hotspot and support



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the strengthening of long-term monitoring and management strategies to improve wildlife conservation in underrepresented ecoregions facing increasing environmental pressures.

Keywords: biodiversity; Coahuila; semi-arid ecosystems; species richness; wildlife

1. Introduction

The conservation of terrestrial vertebrates is increasingly challenged by pervasive habitat loss and fragmentation, the structural simplification of landscapes, and the disruption of key ecological processes. Species with restricted distribution, low population densities, or specialized ecological requirements are particularly sensitive to rapid environmental change [1,2]. In the arid and semi-arid regions of northern Mexico, ongoing urban expansion, extensive livestock production, and agricultural conversion have substantially reduced landscape connectivity, thereby compromising the persistence of vertebrate assemblages adapted to highly seasonal and resource-limited environments [3].

Mountain systems in northeastern Mexico constitute critical reservoirs of biodiversity, largely due to their complex topography, pronounced altitudinal gradients, and the convergence of biogeographic elements from the Sierra Madre Oriental and the Chihuahuan Desert [4]. These features are associated with complex environmental mosaics that coincide with high levels of species richness and the coexistence of taxa with contrasting ecological requirements over relatively small spatial scales [4,5]. Within this framework, remnants of native vegetation and protected areas acquire relevance as both biodiversity refugia and natural laboratories for examining the structure and dynamics of biological communities [6]. Beyond their formal designation, such areas provide opportunities to investigate patterns of species richness, distribution, and habitat use, generating critical information for identifying priority taxa and key ecological processes.

The establishment of robust biological inventories, coupled with medium- and long-term monitoring programs, is essential for detecting population trends, quantifying species turnover, and assessing shifts in community composition in response to environmental change [7]. In this context, protected areas constitute the cornerstone of biodiversity conservation in Mexico by safeguarding priority ecosystems, ecological processes, and species with restricted distributions. The country currently contains more than 230 federally protected areas, complemented by an increasing number of state, municipal, community, ejidal, and privately managed reserves that collectively strengthen conservation coverage and regional land management [8]. Their role is particularly relevant in northeastern Mexico, where the convergence of the Chihuahuan Desert and the Sierra Madre Oriental has generated pronounced environmental gradients, complex biogeographic histories, and high ecological heterogeneity. These conditions sustain remarkable biological richness but also expose the region to increasing pressures associated with urban expansion, land-use change, and landscape fragmentation, reinforcing the need for long-term biodiversity assessment and monitoring frameworks.

Despite the ecological importance of the Sierra de Zapalinamé State Natural Reserve (SZSNR), previous information on the vertebrate fauna of the SZSNR was fragmented and largely derived from isolated records, short-term field surveys, scientific notes, theses, and opportunistic collections focused on specified taxonomic groups [9–13]. In this context, the SZSNR, located in southeastern Coahuila, represents one of the most prominent mountain systems in the region. Despite its proximity to major urban and industrial centers, the reserve encompasses a diverse array of ecosystems—including xerophytic scrubland, pine–oak forests, montane grasslands, and riparian corridors—resulting in pronounced

environmental heterogeneity [14,15]. Consequently, no comprehensive or standardized inventory integrating multiple vertebrate groups had been available prior to this study, and the total species richness of the reserve had not been formally synthesized. To address these knowledge gaps, our study represents an integrative assessment of vertebrate diversity in the reserve, consolidating historical information with systematic field records and multiple complementary data sources to provide a more robust baseline for biodiversity evaluation and conservation planning.

A detailed understanding of the faunal richness and composition of the SZSNR is therefore urgently needed in a landscape undergoing rapid fragmentation and progressive declines in ecological connectivity between mountain systems and adjacent valleys. Updating baseline information on wildlife assemblages within protected areas is critical for informing evidence-based conservation decisions. Given the biogeographic context and the strategic importance of protected areas for maintaining regional biodiversity, the objectives of this study were to (i) characterize the species richness, taxonomic composition, and conservation status of the terrestrial vertebrate fauna in the Sierra de Zapalinamé State Natural Reserve; and (ii) assess its representativeness within the broader context of northeastern Mexico, with particular emphasis on endemic and threatened species. Spatial and temporal patterns of vertebrate richness were examined within the reserve to provide insights relevant for biodiversity conservation strategies in semi-arid ecosystems. In addition, we hypothesized that the proportion of regional terrestrial vertebrate diversity represented within the reserve would exceed the proportion expected based solely on the reserve's contribution to the total land area of northeastern Mexico.

2. Materials and Methods

2.1. Study Area

The study was conducted in the Sierra de Zapalinamé State Natural Reserve (SZSNR), located southeast of Saltillo, Coahuila, Mexico (25°16' and 25°17' N, 101°13' and 100°48' W; Figure 1). The reserve encompasses approximately 25,000 ha and spans a pronounced altitudinal gradient from 1600 to 3140 m a.s.l., resulting in a transition from semi-arid lowlands to temperate montane environments. Its location at the interface between the Chihuahuan Desert and the Sierra Madre Oriental confers marked ecological and climatic heterogeneity [15,16].

Climatic conditions vary along this gradient. Lower elevations are characterized by a temperate semi-arid climate, with mean annual temperatures ranging from 15.0 to 18.5 °C and average precipitation of 380–450 mm. At mid- and high elevations, conditions shift to a temperate sub-humid regime, with increased summer rainfall exceeding 550 mm, largely driven by orographic effects. Vegetation patterns closely reflect this environmental heterogeneity. Lower zones are dominated by rosette desert scrub, with *Agave lechuguilla*, *Dasyllirion cedrosanum*, and *Opuntia engelmannii*. With increasing elevation, these communities transition into perennial grasslands dominated by *Bouteloua gracilis*, *Aristida purpurea*, and *Muhlenbergia arenicola*. Mid-elevation areas support chaparral and open oak woodlands, including *Quercus invaginata*, *Q. saltillensis*, and *Juniperus pinchotii*, while isolated pine–oak forest patches occur at higher elevations [15,16]. Current vegetation patterns reflect a history of logging, fire, and grazing, resulting in a heterogeneous mosaic that includes extensive secondary vegetation. Notably, the combination of semi-arid grasslands, rocky slopes, and deep soils provides key habitat for small mammals adapted to open environments.

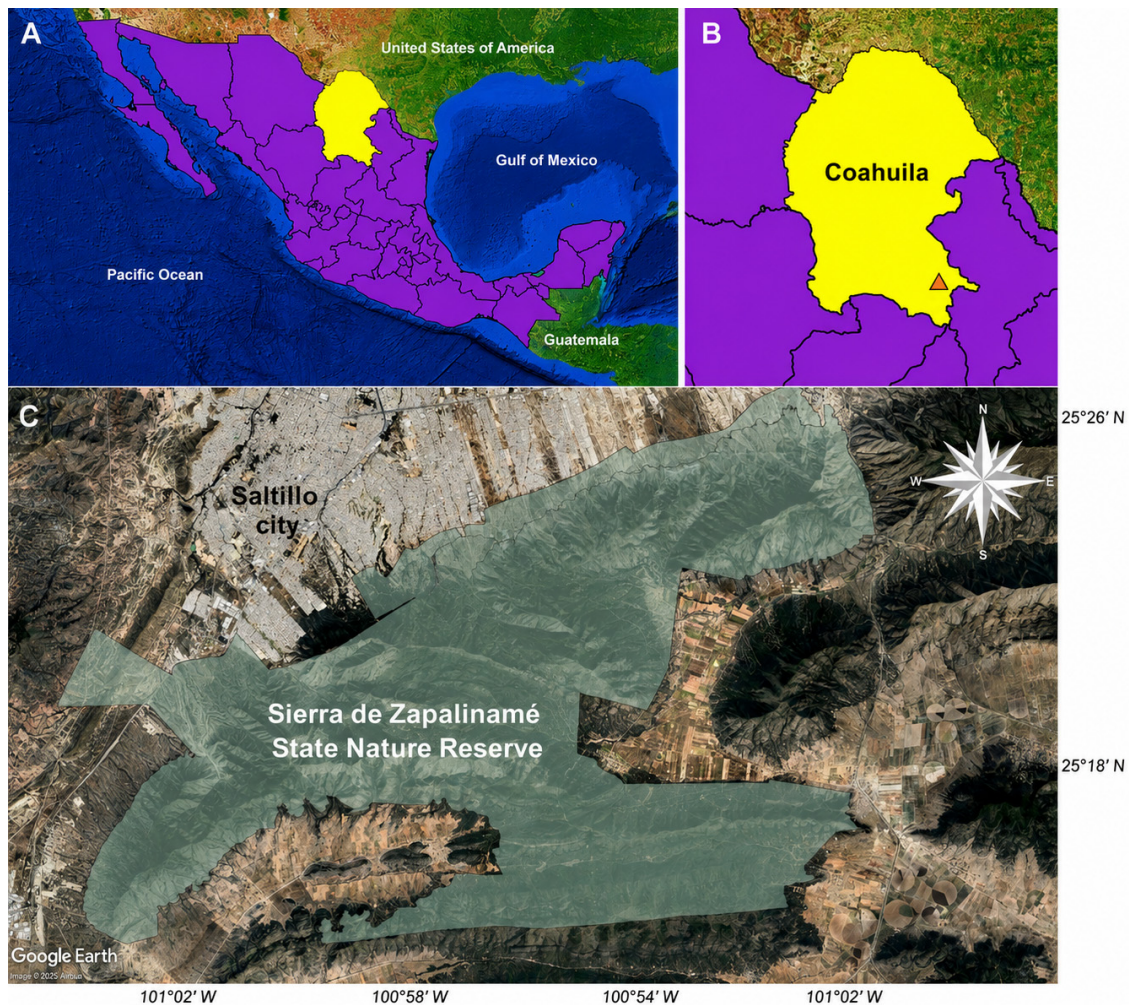


Figure 1. Location of the Sierra de Zapalinamé State Natural Reserve in northeastern Mexico. (A) Geographic location of the state of Coahuila within northeastern Mexico; (B) location of the Sierra de Zapalinamé State Natural Reserve within Coahuila (Δ); and (C) spatial relationship between the reserve and the metropolitan area of Saltillo, highlighting its proximity to the city and its strategic position within the regional landscape.

2.2. Sampling Effort and Strategies

The vertebrate inventory was developed through systematic field sampling conducted between January 2020 and December 2025, complemented by verified records from scientific collections, citizen science platforms (e.g., eBird, iNaturalistMX), and published literature: herpetofauna [10,17–19], birds [9,11,20–37], and mammals [12,13,38,39].

Fieldwork was conducted over a 72-month period through biweekly surveys lasting 2–3 consecutive days, resulting in a total of 432 field days. Sampling was carried out at 14 sites distributed throughout the Sierra de Zapalinamé State Natural Reserve using a stratified design based on the dominant vegetation types and elevational gradients (1700–3100 m a.s.l.) present within the reserve [15,16]. Sampling sites were selected to represent the major vegetation communities occurring along the reserve’s altitudinal gradient, including desert scrub, grasslands, chaparral, oak woodlands, and pine–oak forests. Collectively, the 14 sites encompassed the full range of environmental conditions within the reserve, from lower semi-arid slopes to upper montane habitats. Each sampling site contained 3–5 quadrats (50 × 50 m) separated by at least 200 m, resulting in a total of 56 habitat-sampling quadrats distributed among vegetation types in proportion to their occurrence and accessibility within the reserve (Table 1). This stratified design

ensured representative coverage of the principal vegetation types and elevation bands while minimizing spatial sampling bias and maximizing environmental representativeness.

Table 1. Sampling design, field methods, effort, temporal coverage, and habitat types surveyed for the principal vertebrate taxa recorded between 2020 and 2025 in the Sierra de Zapalinamé State Nature Reserve.

Taxon	Method	Sampling Effort	Temporal Coverage	Habitats Sampled
Amphibians/Reptiles	Visual encounter surveys + pitfall traps	4320 person-hours	2020–2025	Scrubland, ecotones, oak forest, grassland
Birds	Point counts + mist nets	3456 observation hours + 3024 net-hours	2020–2025	All vegetation types
Mammals	Sherman/Tomahawk traps + camera traps	360 trap-nights + 6300 camera-days	2020–2025	All vegetation types
Bats	Mist nets + acoustic monitoring	228 detector-hours	2023–2025 (seasonal)	Agriculture areas, riparian and forest habitats

The 14 sampling sites constituted the primary spatial sampling units, whereas the quadrats served as standardized subunits for habitat characterization and the spatial organization of field surveys (Table 1). However, the effective sampling units differed among vertebrate groups according to their ecology and detectability. Herpetofauna surveys were conducted using visual encounter transects, pitfall-trap arrays, and refuge searches established within or adjacent to the quadrats. Bird surveys were based on permanent point-count stations and mist-net locations established within each sampling site. Mammals were surveyed using Sherman and Tomahawk trap stations, camera traps, and track surveys deployed throughout each sampling site, whereas bats were sampled using mist nets and acoustic detectors positioned along flight corridors and vegetation edges. Although survey methods differed among taxa, all were implemented within the same stratified sampling framework to ensure comparable spatial coverage across vegetation types and elevational zones. Total sampling effort comprised 4320 person-hours for amphibian and reptile surveys, 3456 bird observation hours, 3024 mist-net hours, 360 trap-nights for terrestrial mammals, and 6300 camera-trap days. Repeated surveys were conducted across seasons throughout the study period to account for temporal variation in species activity and detectability, thereby improving the completeness and reliability of biodiversity inventories.

To capture environmental variability, sites spanned the full altitudinal gradient and included areas with contrasting conservation status, from relatively undisturbed vegetation to historically modified habitats. All sites were georeferenced using a Garmin eTrex 20 × GPS (Garmin Ltd., New Taipei City, Taipei) unit and subdivided into quadrats following standard biodiversity sampling protocols [40]. Within each quadrat, taxon-specific methods were applied while maintaining spatial consistency in sampling effort.

Herpetofauna were surveyed through standardized 1 km visual encounter transects conducted during both daytime and nighttime periods. Nocturnal surveys were performed by two observers and lasted approximately 2–3 h per transect. Surveys were complemented by targeted searches beneath rocks, logs, and other natural refuges, auditory surveys for anurans, and pitfall trap arrays equipped with drift fences. Three representative micro-watersheds were selected for pitfall sampling, each containing multiple trap arrays composed of 4–5 buckets connected by drift fences. Surveys were conducted during both wet and dry seasons to reduce seasonal detection bias associated with climatic variability

and reproductive activity. Repeated surveys were implemented to increase the detection probability of cryptic species. At each visit, three transects per site were surveyed, with particular attention to temporary water bodies, runoff channels, and humid microhabitats. Additional records were obtained from individuals encountered under rocks, logs, and vegetation, as well as through nocturnal searches using high-intensity LED lamps (Musco Lighting, Oskaloosa, IA, EE.UU.). Surveys were conducted between 09:00 and 16:00 h and 18:00–22:00 h to encompass periods of increased thermoregulatory activity in reptiles and nocturnal activity in amphibians and crepuscular species, totaling 4320 person-hours of effort. Taxonomic identification followed specialized references [17,41].

Bird communities were surveyed using a combination of fixed-radius point counts and mist-netting. At each sampling site, 3–5 permanent point-count stations were established and separated by at least 200 m to ensure spatial independence among detections. Point counts consisted of 10 min surveys conducted during peak morning activity (05:00–10:00 h), during which all birds detected visually or aurally within a 50 m radius were recorded. Detections beyond this distance were noted separately and excluded from abundance-based analyses to minimize distance-related detection bias. Each point-count station was surveyed repeatedly across seasons throughout the 72-month study period to account for temporal variation in species occurrence and detectability. Repeated visits encompassed both breeding and non-breeding periods, thereby improving inventory completeness and reducing the influence of short-term fluctuations in bird activity. Surveys were conducted by a small team of experienced observers trained in the identification of regional bird species by sight and sound. Observer turnover was minimized throughout the study, and standardized field protocols were consistently applied across sampling years to ensure comparability of observations. Mist-netting was conducted concurrently with point-count surveys using three mist nets (12 × 2.5 m) deployed at representative locations within each sampling site. Nets were operated from 05:00 to 12:00 h, coinciding with peak morning flight activity and foraging behavior, thereby maximizing capture efficiency. This effort yielded a total of 3024 net-hours. Combined visual and auditory surveys resulted in 3456 observation hours over the course of the study.

The combination of point counts and mist-netting was intended to reduce taxonomic and behavioral detectability biases, as some understory and cryptic species are undetected by a visual survey alone. Surveys were conducted between 06:00 and 11:00 h and 15:00–18:00 h to include periods of elevated vocal and movement activity while minimizing detection bias associated with reduced midday activity and high temperatures; and conducted by trained observers using standardized protocols to minimize observer-related variability. Captured individuals were photographed, identified using standard field guides [42,43], and released at the capture site. Taxonomy followed the American Ornithological Society [44].

Mammals were surveyed using a combination of direct and indirect methods. Medium-sized mammals were captured using Tomahawk traps (40 × 17 × 17 cm) baited with oats and vanilla essence, while small mammals were sampled using 30 Sherman traps distributed within each sampling unit. Total trapping effort reached 360 trap-nights. Indirect methods included systematic searches for tracks, scats, burrows, feeding signs, and scent stations using commercial attractants [45]. Additionally, camera traps (Bushnell Trophy Cam; Bushnell Corp., Overland Park, IA, EE.UU.) were strategically distributed at least 1 km apart along wildlife trails, water sources, and areas with evidence of animal activity to maximize spatial independence and detection probability across environmental gradients, accumulating 6300 camera-days. Camera stations were separated by at least 1 km to reduce spatial autocorrelation and increase sampling independence. Cameras were mounted on trees or stable supports at a height of approximately 30–50 cm above ground

level and operated continuously (24 h day⁻¹). Each camera was programmed to capture a sequence of three photographs per trigger event with minimal delay between consecutive triggers. Independent detection events were defined as consecutive photographs of the same species separated by at least 30 min, unless different individuals could be clearly distinguished. Camera traps remained active for standardized sampling periods at each station and were subsequently rotated among sampling locations to increase spatial coverage across vegetation types and elevational zones. Track identification followed established field guides [45,46]. Bats were recorded using mist nets and passive acoustic monitoring [47,48], employing an Echo Meter Touch 2 Pro ultrasonic detector (Wildlife Acoustics, Maynard, MA, USA, EE.UU.) coupled with a Samsung Galaxy A11 smartphone (Samsung Electronics, Suwon, Republic of Korea). The WAV recordings were analyzed using BatSound version 4.2, from which key echolocation call parameters—including maximum frequency, minimum frequency, and pulse duration—were extracted to support species identification. Acoustic identification was conducted through comparative analysis with published reference libraries and diagnostic call descriptions available in the literature, particularly those reported by Mac Swiney-González et al. [49], Jung et al. [50], and Ortega et al. [51]. Taxonomy followed the Mammal Diversity Database [52].

2.3. Literature and Database Collections Review

To complement field data, we compiled records from peer-reviewed publications (herpetofauna [10,17–19], birds [9,11,20–37], and mammals [12,13,38,39]), citizen science platforms (eBird, iNaturalistMX, EncicloVida), and online biodiversity databases, including the Global Biodiversity Information Facility (GBIF, available at Global Facility Biodiversity Information), UNIBIO-UNAM, VertNet, and the Atlas of the Birds of Mexico [20]. Citizen science, biological collection, and historical occurrence records were subjected to a multi-step validation and filtering process prior to analysis (Table S1). Only records with precise geographic coordinates, taxonomic consistency, and supporting evidence (photographic vouchers, expert validation, or research-grade status) were retained whenever available. Duplicate records, spatial outliers, and observations outside known elevational or geographic ranges were excluded. Taxonomic nomenclature was standardized according to current national and international reference databases. Historical records lacking sufficient metadata or spatial precision were discarded.

2.4. Data Analysis

Species conservation status was determined according to the Mexican official standard NOM-059-SEMARNAT-2010 [53] and the IUCN Red List [54]. Endemism classifications were based on González-García and Gómez de Silva [55], Ceballos and Olivas [46], and Lemos-Espinal and Smith [17]. Temporal patterns in vertebrate diversity between 2020 and 2025 were first evaluated using abundance data and Hill numbers implemented through the iNEXT framework (available at https://chao.shinyapps.io/iNEXT_4steps/, (accessed on 23 May 2026)), which allows the integration of species richness (q0), Shannon diversity (q1), and Simpson diversity (q2) into a unified diversity metric framework [56–58]. Interpolation and extrapolation curves were estimated to compare temporal diversity patterns while accounting for differences in sampling completeness. Sample coverage (SC) was also calculated to evaluate inventory representativeness and the potential influence of undetected rare species [59]. To assess temporal variation in community composition, a non-metric multidimensional scaling (NMDS) ordination was performed using abundance data and Bray–Curtis dissimilarities. NMDS is widely used in community ecology because it effectively represents ecological distances among assemblages without assuming linear relationships among variables [60,61]. Temporal differences in assemblage composition

among years were subsequently tested through permutational multivariate analysis of variance (PERMANOVA), using 9999 permutations to estimate statistical significance [62]. Finally, generalized additive models (GAMs) were used as an exploratory approach to evaluate potential temporal variation in three annual community metrics (total abundance, species richness, and Shannon diversity) across the six-year monitoring period (2020–2025). Although the limited number of annual observations precluded robust inference regarding complex temporal dynamics, GAMs were used to flexibly explore potential linear or non-linear patterns without imposing a predefined functional relationship. Species richness and Shannon diversity were modeled using Gaussian error distributions with identity link functions, whereas abundance was modeled using a negative binomial distribution with a log-link function. Because of the limited temporal replication, the GAM analyses were interpreted exclusively as exploratory and descriptive rather than inferential [63]. All analyses were performed in R v.4.5.0 [64].

Species richness data for other protected areas in northeastern Mexico were compiled from published inventories, management plans, biodiversity databases, and peer-reviewed studies [65–102]. When multiple inventories were available for a given reserve, the most comprehensive and up-to-date source was selected. Because standardized information on sampling effort was not consistently available across studies, species richness comparisons were intended as descriptive assessments rather than formal quantitative comparisons. Consequently, observed differences among protected areas may reflect variation in sampling intensity, survey duration, methodologies, taxonomic coverage, and inventory completeness, in addition to underlying biological differences. Relationships between reserve area and species richness were evaluated using Pearson correlation analyses after logarithmic transformation of reserve area to improve normality. Statistical analyses were conducted in R v.4.5.0 [64], adopting a significance threshold of $\alpha = 0.05$. The reserve area was log-transformed using the natural logarithm (ln) to improve linearity and normality assumptions. Heat maps were generated using kernel density interpolation based on georeferenced occurrence records aggregated within 1-km² grid cells. To reduce bias associated with uneven sampling intensity, the number of occurrence records within each grid cell was standardized by the cumulative sampling effort recorded for that cell, expressed as the total number of sampling events conducted within the cell (including visual surveys, trapping sessions, mist-net deployments, and camera-trap surveys). The resulting effort-standardized record densities were subsequently used for kernel density interpolation. Spatial analyses and graphical outputs were generated using JMP 19 (available at <https://www.jmp.com/es/home>, (accessed on 14 February 2026)) and QGIS 3.44 [103].

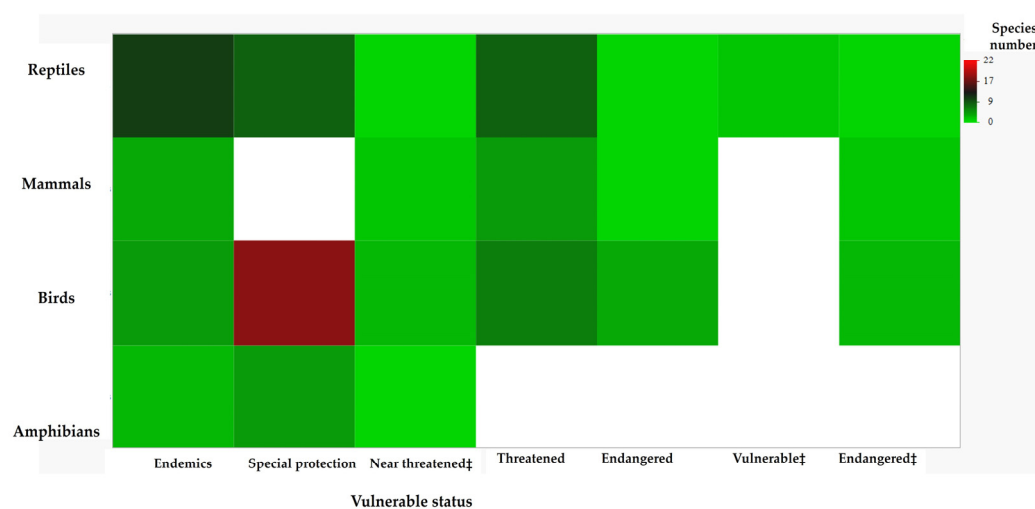
3. Results

A total of 415 vertebrate species were documented in the SZSNR, comprising 299 birds (72.0%), 67 mammals (16.2%), 42 reptiles (10.1%), and 7 amphibians (1.7%) (Table 2; Appendix A). Of the recorded taxa, 59 species (14.2%) are listed under a risk category in Mexican environmental legislation (NOM-059), whereas 15 species (3.6%) are classified within a threatened category on the IUCN Red List (Table 2; Figure 2; Appendix A). Additionally, 23 species (5.5%) are endemic to Mexico and 12 (2.9%) are introduced.

The integration of multiple data sources—including biological collections, citizen science platforms, and published records—combined with systematic field sampling, resulted in broad taxonomic coverage. Field surveys yielded direct records for 362 species (87.4%), including 5 amphibians, 33 reptiles, 275 birds, and 49 mammals (Appendix A).

Table 2. Number of species, genera, families and orders of vertebrates present in the Sierra de Zapalinamé State Nature Reserve.

	Amphibians	Reptiles	Birds	Mammals	Total
Species	7	42	299	67	415
Genera	7	25	176	48	256
Families	7	12	56	18	93
Orders	2	2	19	7	30
Species within the NOM-059	5	19	29	6	59
Species within Red List IUCN	1	4	6	4	15
Endemic species	3	11	5	4	23

**Figure 2.** Heat map showing the relative distribution of taxonomic groups according to their vulnerability status, considering the risk categories in NOM-059 and the IUCN Red List (‡). The color intensity reflects the proportion of species per category within each taxonomic group, allowing the identification of differential susceptibility patterns and potential conservation priorities.

3.1. Herpetofauna

Amphibians are represented by seven species distributed across two orders (Anura and Caudata), seven families, and seven genera (Appendix A), with each family represented by a single species (Figure 3A). Three taxa are endemic to Mexico: Spotted chirping frog (*Eleutherodactylus guttilatus*), Primeval splayfoot salamander (*Chiropterotriton priscus*), and Small-eared tree frog (*Reohyla miotympanum*). These species, together with Mexican spadefoot (*Spea multiplicata*) and Rio Grande leopard frog (*Lithobates berlandieri*), are listed under Special Protection (Pr) in NOM-059. At the global scale, *Chiropterotriton priscus* is categorized as Near Threatened by the IUCN, and its occurrence is closely associated with microhabitats characterized by dense vegetation cover and the availability of refuges (Table 2; Figure 2; Appendix A).

Reptiles include 42 species assigned to Testudines (3 species) and Squamata (39 species), with Colubridae (15 species) and Phrynosomatidae (11 species) as the most species-rich families (Figure 3B; Appendix A). Testudines are represented by the Texas spiny softshell turtle (*Apalone spinifer emoryi*), Meso-American slider (*Trachemys venusta*), and Texas tortoise (*Gopherus berlandieri*), with the first two being the most frequently recorded. Eleven reptile species are endemic to Mexico, and 19 are listed under NOM-059, while four are included in the IUCN Red List (Table 2; Figure 2; Appendix A). The relatively high proportion of endemism among reptiles, compared to amphibians, may reflect ecological specialization associated with semi-arid environments.

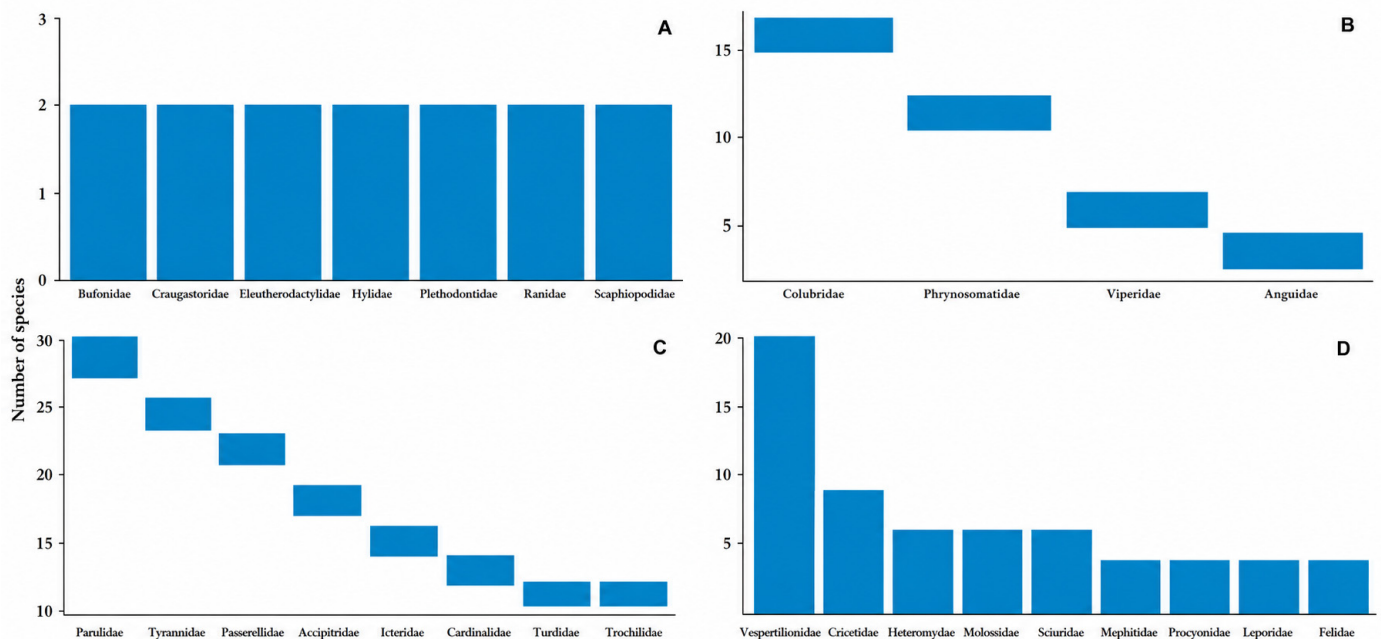


Figure 3. Most representative families in terms of number of species per taxonomic group (A), amphibians; (B), reptiles; (C), birds; (D), mammals) present in the Sierra de Zapalinamé State Nature Reserve.

3.2. Birds

A total of 299 bird species belonging to 19 orders and 56 families were recorded, accounting for 72.0% of total vertebrate richness in the SZSNR. The assemblage is dominated by Passeriformes, particularly Parulidae (31 species), Tyrannidae (26), and Passerellidae (23) (Figure 3C), which include a large proportion of insectivorous and granivorous taxa associated with forested and ecotonal habitats. This composition is consistent with avian communities typical of montane systems under strong Nearctic influence and pronounced climatic seasonality.

In terms of phenology, 151 species (50.5%) are migratory—primarily Nearctic winter visitors—while 138 (46.1%) are resident, and the remainder correspond to transient or introduced species. The high proportion of migratory taxa indicates that the SZSNR functions both as a wintering ground and as a stopover site along regional flyways, providing critical resources during energetically demanding periods. The coexistence of resident and migratory species increases potential temporal overlap among trophic guilds, particularly among foliage insectivores, potentially influencing seasonal resource partitioning. Guild structure is dominated by insectivores (approximately 45–50%), followed by granivores/omnivores and carnivores, including both diurnal and nocturnal raptors. Frugivores and nectarivores are less diverse but play functionally important roles in seed dispersal and pollination, particularly within oak-dominated systems and ecotones. The coexistence of multiple trophic guilds suggests ecological complexity. Notable species include the Golden eagle (*Aquila chrysaetos*) and the Maroon-fronted Parrot (*Rhynchopsitta terrisi*), both associated with relatively conserved habitats and specific nesting and foraging requirements, indicating the availability of structurally suitable conditions.

In conservation terms, 29 species (11.7%) are listed under NOM-059 and six (2.0%) are categorized as threatened by the IUCN (Table 2, Figure 2, Appendix A). Five species are endemic to Mexico. The proportion of at-risk species is higher among raptors and psittacids than among passerines, reflecting the greater vulnerability of large-bodied species with lower reproductive rates.

3.3. Mammals

The mammalian assemblage comprises 67 species distributed across 7 orders, 18 families, and 48 genera (Appendix A), reflecting high taxonomic diversification (species/family ratio = 3.7). Chiroptera is the most species-rich order (26.9%), followed by Rodentia (23.9%) and Carnivora (17.9%) (Figure 3D), a pattern consistent with montane systems in northeastern Mexico where Nearctic and Neotropical elements converge.

At the family level, Vespertilionidae (18 species) and Cricetidae (9 species) together represent 40.3% of total richness, highlighting the functional importance of aerial insectivores and small granivorous–omnivorous mammals in local trophic dynamics (Figure 3D). Insectivorous bats constitute the most diverse functional group, followed by herbivorous–granivorous rodents and lagomorphs, and medium to large carnivores. The presence of both mesocarnivores and apex predators suggests a trophic structure that still retains key functional components.

Four endemic species and ten species under national or international risk categories were recorded, representing 14.9% of the mammalian assemblage (Table 2, Figure 2). Species of ecological relevance include American black bear (*Ursus americanus*), Puma (*Puma concolor*), and Jaguarundi (*Herpailurus yagouaroundi*), all of which require extensive home ranges and relatively continuous habitat, suggesting that portions of the landscape may still permit movement and habitat use by wide-ranging species. In contrast, introduced species such as Brown rat (*Rattus norvegicus*), House mouse (*Mus musculus*), and feral dog (*Canis familiaris*) were primarily associated with peri-urban areas and may exert negative effects through competition, predation, and pathogen transmission.

3.4. Spatial and Temporal Patterns and Regional Comparison

Hill numbers revealed strong temporal increases in vertebrate diversity between 2020 and 2025, although responses differed among taxa. Amphibian assemblages remained extremely simplified during 2020–2022 (q_0 – q_2 = 1), but diversity increased markedly after 2023, peaking in 2025 (q_0 = 6.48; q_1 = 7.03; q_2 = 8) (Figure 4). Reptiles, birds, and mammals showed progressive richness increases through time, reaching maximum q_0 values of 34–36, 93.24, and 29 species, respectively. Shannon and Simpson diversity also increased substantially, indicating greater evenness and reduced dominance, particularly in reptiles and mammals (Figure 4). Sample completeness was generally high (SC = 0.72–1.00), although lower q_0 coverage and wider confidence intervals suggested the presence of rare or incompletely detected species.

NMDS ordination suggested differences in the distribution of taxonomic groups within ordination space (stress = 0.157), particularly for birds, although these patterns should be interpreted as descriptive because no formal test of group separation was conducted (Figure 5). Community composition differed significantly among years (PERMANOVA, R^2 = 0.42, p = 0.001). Exploratory GAM analyses did not detect evidence of consistent temporal trends in any of the annual community metrics evaluated (total abundance, species richness, and Shannon diversity) during the six-year monitoring period (2020–2025) (edf = 1, p = 0.115; Figure 6). Given the limited number of annual observations, these results should be interpreted as descriptive indications that no consistent directional trend was apparent over the six-year monitoring period. The smooth term indicated an approximately linear and weak temporal response, while the model explained only 8.24% of the total deviance (adjusted R^2 = 0.05), suggesting that temporal variation had limited influence on community structure during the study period.

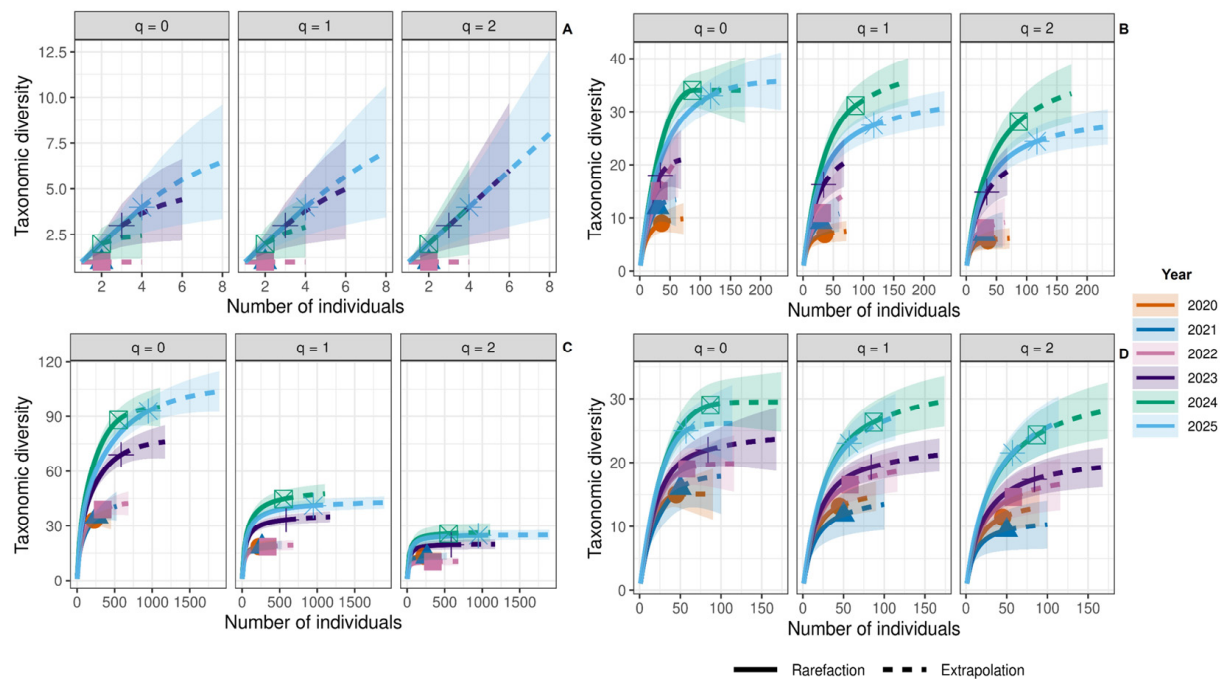


Figure 4. Sample-size-based rarefaction and extrapolation curves generated using the iNEXT framework for (A) Amphibians, (B) Reptiles, (C) Birds, and (D) Mammals. The x-axis represents the cumulative number of individuals sampled (sample size), as implemented in abundance-based rarefaction and extrapolation analyses in iNEXT, whereas the y-axis represents taxonomic diversity expressed as Hill numbers. Diversity is shown for $q = 0$ (species richness), $q = 1$ (exponential Shannon diversity), and $q = 2$ (inverse Simpson diversity). Solid lines represent rarefaction curves in the different monitoring years, whereas dashed lines indicate extrapolated diversity beyond the observed sampling effort. Shaded areas denote 95% confidence intervals around the diversity estimates.

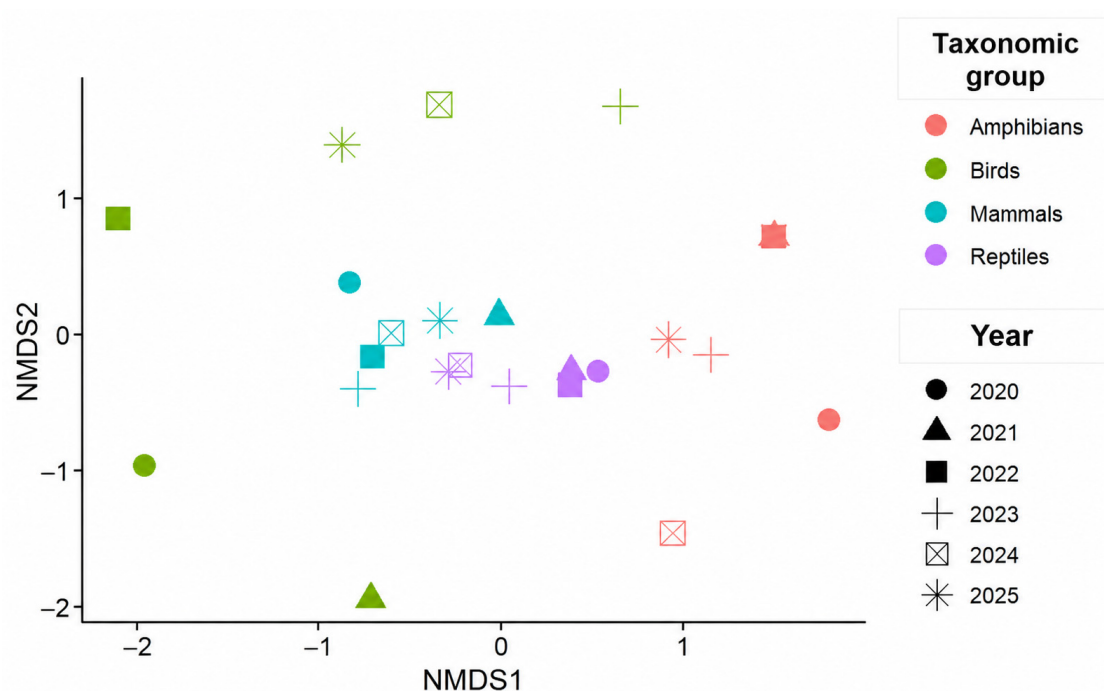


Figure 5. Non-metric multidimensional scaling (NMDS) ordination based on Bray–Curtis dissimilarities showing temporal variation in vertebrate community composition between 2020 and 2025. Each point represents the assemblage structure for a given year, and distances among points reflect compositional dissimilarity (stress value = 0.157).

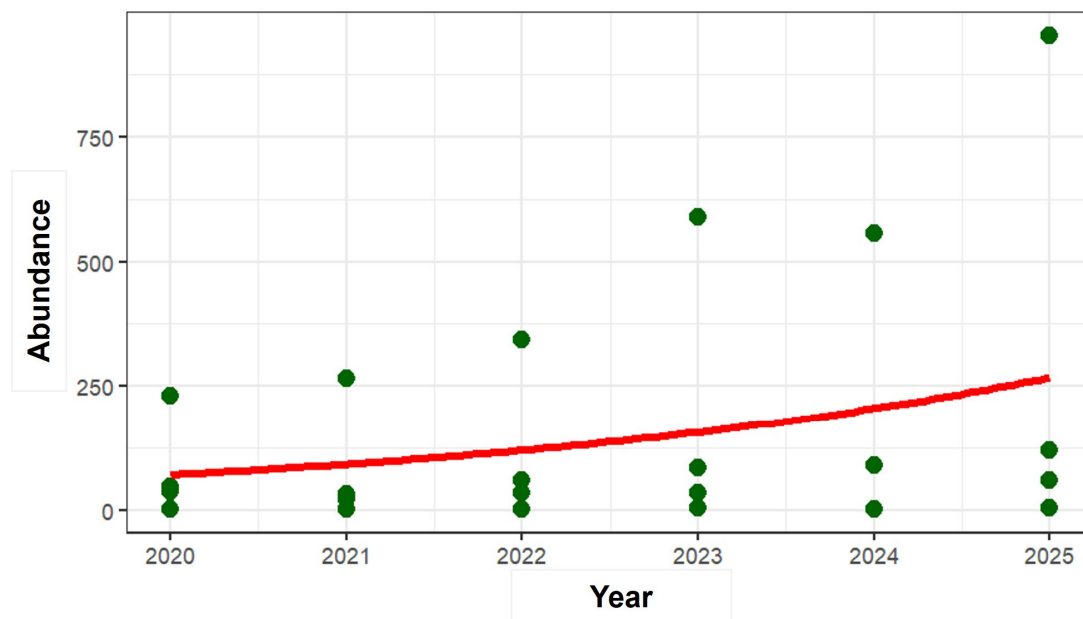


Figure 6. Exploratory generalized additive model (GAM) evaluating temporal variation in annual total abundance (response variable) during the 2020–2025 monitoring period. The fitted smooth term indicated no significant temporal trend ($\text{edf} = 1$, $p = 0.115$). Green dots represent the observed abundance values for each taxonomic group in each sampling year, whereas the red line represents the fitted generalized additive model (GAM) describing the temporal trend in abundance.

Spatial patterns of vertebrate richness within the SZSNR are heterogeneous. The highest concentrations of species occur in the central sector, where oak forests, coniferous forests, scrublands, grasslands, and ecotonal zones converge, as well as in the northeastern and eastern portions of the reserve (Figure 7A). Amphibian and reptile richness was concentrated in the central and northeastern sectors of the reserve, where wetter habitats and greater vegetation cover occur according to the regional vegetation map. However, these spatial associations were not formally evaluated (Figure 7B). Birds show peak richness in central, northern, and northeastern areas, while birds are widely distributed across central, northern, eastern, and northeastern sectors, coinciding with areas characterized by greater environmental heterogeneity (Figure 7C). Mammal richness is highest in the central and eastern regions (Figure 7D).

Based on the available published inventories, the 415 vertebrate species documented in the SZSNR place the reserve among the most species-rich protected areas reported for north-eastern Mexico. However, these comparisons should be interpreted cautiously because published inventories differ in sampling effort, survey duration, taxonomic scope, and inventory completeness. Its recorded richness is comparatively higher than that reported for the Mapimí Biosphere Reserve (340 species), Cumbres de Monterrey National Park (363), El Potosí National Park (255), and the Cuatro Ciénegas Flora and Fauna Protection Area (324), representing differences of 17.9%, 12.3%, 38.4%, and 21.7%, respectively (Figure 8A). Compared with other larger and geographically distant protected areas, the SZSNR also exhibits relatively high species richness, with values moderately higher than those reported for the Janos Biosphere Reserve (357 species), Maderas del Carmen (392), and Cañón de Santa Elena (330), differing by 13.8%, 5.3%, and 20.3%, respectively. Likewise, richness values were only slightly higher than those documented for Abra Tanchipa Biosphere Reserve (394 species), with a difference of 5.1%, suggesting broadly comparable diversity levels despite contrasting climatic and biogeographic conditions.

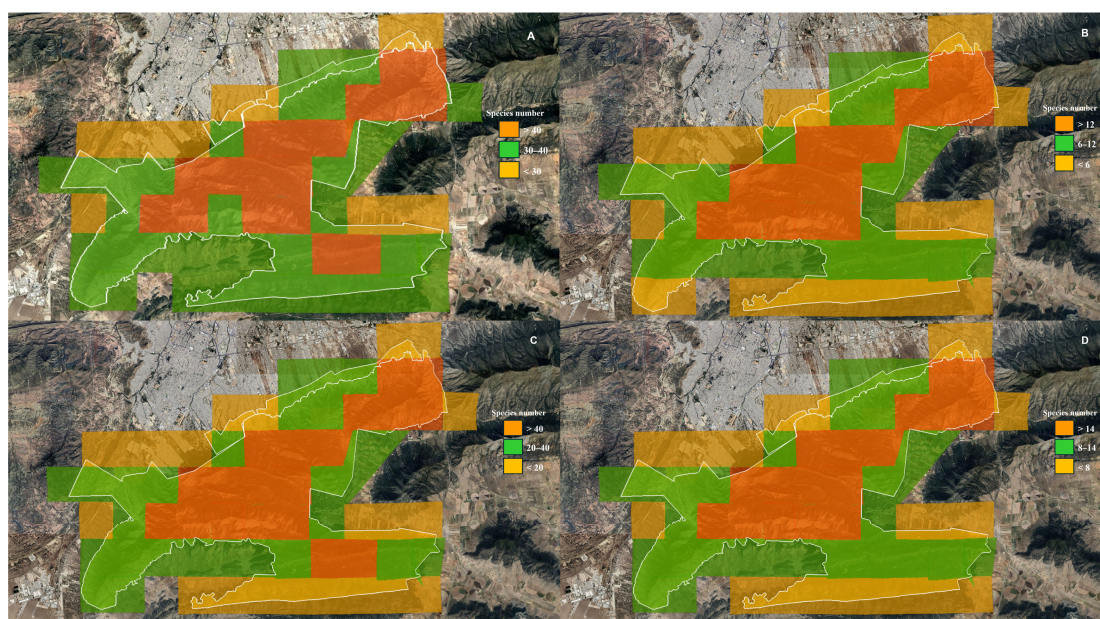


Figure 7. Heat map of species richness by taxonomic group (A), overall; (B), herpetofauna; (C), birds; (D), mammals) in the Sierra de Zapalinamé State Nature Reserve, where the color gradient represents the relative concentration of species recorded in each zone of the reserve. This analysis allows visualization of areas with greater taxonomic diversity and potential importance for the conservation of regional biodiversity.

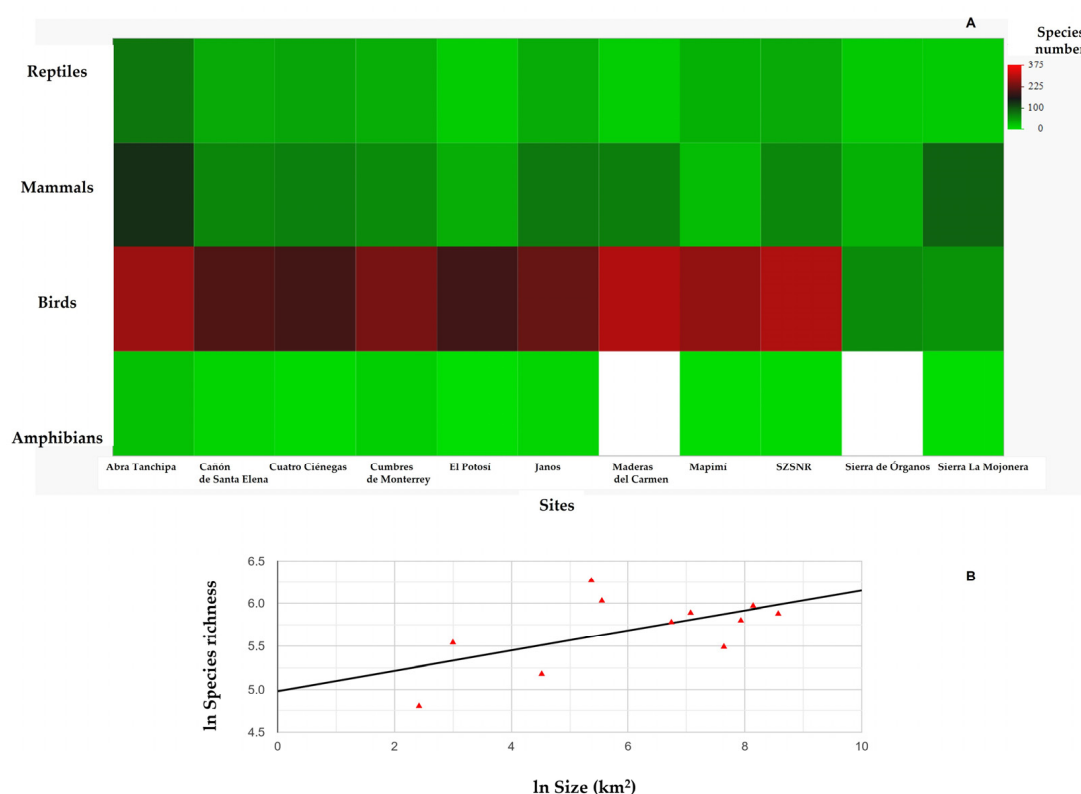


Figure 8. Comparative heat map of species richness by taxonomic group between the Sierra de Zapalinamé State Nature Reserve and other Protected Areas (PAs; (A)) and correlation between species richness and the surface area of PAs (B). The intensity of the color indicates the relative richness recorded in each area, facilitating the evaluation of the RNESZ's contribution in a regional conservation context.

In contrast, species richness in Sierra de Órganos National Park (121 species) is markedly lower (70.8% less), reflecting greater ecological isolation and reduced environmental heterogeneity. No significant relationship was detected between species richness and protected area size (Pearson's $r^2 = 0.34$, $p = 0.75$; Figure 8B), suggesting that environmental heterogeneity and environmental gradients may be associated with local richness patterns independently of protected-area size, although these relationships were not directly evaluated in the present study. In this regard, the SZSNR exhibits a relatively high concentration of species per unit area, underscoring its regional conservation value.

4. Discussion

The Sierra de Zapalinamé State Natural Reserve (SZSNR) emerges as a key biodiversity stronghold in northeastern Mexico, not simply because of its high species richness, but due to the disproportionate representation of regional terrestrial vertebrate diversity within a relatively small area, including approximately 33% of the herpetofauna [10,17,104], 69% of bird species [21,105], and 60% of mammals [36,106]. The ecological importance of the SZSNR is further highlighted by its location within the Nearctic–Neotropical transition zone, where desert and montane biotas converge. This biogeographic setting provides a plausible explanation for the coexistence of species with contrasting ecological affinities, including desert-associated taxa and montane specialists [15,107]. The predominance of birds (72% of total richness) is consistent with patterns reported for other mountainous protected areas in Mexico [108], where avian assemblages have been associated with vegetation structure and year-round resource availability [109,110]. Likewise, the high proportion of migratory species emphasizes the importance of the reserve as a wintering and stopover area within regional migratory routes [11]. From a conservation perspective [53,54], the co-occurrence of endemic, threatened, and wide-ranging species indicates that the SZSNR provides suitable habitat for a broad spectrum of vertebrate taxa. Collectively, these patterns are consistent with the reserve contributing to the conservation of habitat-sensitive species and maintaining landscape connectivity, although these ecological functions were not directly evaluated in the present study. Although these attributes are shared by many protected areas, their significance in the reserve is amplified by its strategic location within the biogeographic transition between the Chihuahuan Desert and the Sierra Madre Oriental. This environmental convergence promotes high environmental heterogeneity, elevational turnover, and species interchange between Nearctic desert and temperate montane assemblages, contributing to exceptional regional diversity. Such multifunctionality is particularly relevant in northeastern Mexico, where accelerated urban expansion, infrastructure development, and land-use change increasingly threaten ecological connectivity among natural landscapes [12,111].

Hill numbers revealed progressive increases in vertebrate diversity between 2020 and 2025, although the magnitude of change differed among taxonomic groups. Amphibians showed the greatest increase after 2023, whereas reptiles, birds, and mammals exhibited more gradual increases in richness and effective diversity. These temporal patterns are consistent with expectations for environmentally heterogeneous mountain systems, although the mechanisms underlying these changes were not evaluated directly. High sample coverage indicates that the inventory captured most of the documented diversity, although broader confidence intervals for $q = 0$ suggest that rare species remain incompletely sampled. Ecological theory predicts that transitional landscapes characterized by steep environmental gradients and vegetation turnover frequently support elevated biodiversity due to increased niche availability and species overlap among adjacent biogeographic regions [112,113]. The SZSNR contains a pronounced transition between xeric and montane environments, and the spatial coincidence between these environmental gradients and

the richness patterns documented here is consistent with those theoretical expectations, although the underlying mechanisms were not directly evaluated. The concurrent increases in Shannon and Simpson diversity indicate greater evenness and lower dominance over time, patterns commonly associated with increases in habitat heterogeneity and ecological stabilization processes [112]. Although sample coverage was generally high, lower completeness values for q_0 and broader confidence intervals indicate that rare species likely remain undetected, particularly within the most diverse assemblages, which is consistent with expectations for vertebrate monitoring programs [57,58].

The NMDS ordination further demonstrated clear temporal segregation among assemblages, indicating marked shifts in species composition through time. The stress value (0.157) suggests that the ordination adequately represented ecological relationships among years and supports the interpretation of substantial temporal turnover in community structure. Temporal reorganization of vertebrate assemblages is a common ecological pattern in heterogeneous systems, where climatic variability, habitat dynamics, species colonization, and local extinction processes can drive changes in species composition even when total diversity remains relatively stable [114,115]. The PERMANOVA analysis confirmed these compositional differences, showing that year explained a substantial proportion of community variation ($R^2 = 0.42$, $p = 0.001$). This result indicates that temporal turnover was not random but instead reflected structured ecological changes occurring during the study period. Such patterns may arise from shifts in environmental conditions, successional dynamics, or variation in resource availability that differentially affect species occurrence and dominance through time [60]. Importantly, the relatively high proportion of explained variance suggests that temporal dynamics represented one of the principal drivers shaping vertebrate assemblage structure during the monitoring period. In contrast, the exploratory GAM analyses did not provide evidence of consistent directional temporal trends in annual total abundance, species richness, or Shannon diversity. Because the analysis was based on only six annual observations, these results should be interpreted cautiously and primarily as descriptive assessments of temporal variability rather than formal evidence of temporal stability. The non-significant smooth term, together with the low explained deviance and adjusted R^2 values, suggests that temporal effects on overall community metrics were comparatively weak. This apparent discrepancy between significant multivariate compositional change and weak univariate temporal responses is ecologically informative because assemblages may undergo substantial species replacement without pronounced changes in total richness or abundance [116]. Therefore, the results collectively indicate that vertebrate communities experienced temporal reorganization primarily through shifts in species identity and relative dominance rather than through strong directional increases or declines in overall diversity.

The spatial concentration of species in ecotonal and structurally complex areas coincided with zones characterized by vegetation transitions and environmental variability. Although these patterns are consistent with ecological expectations, the mechanisms underlying this association were not directly evaluated [117]. Consequently, conservation strategies should prioritize maintaining these transition zones, as they disproportionately contribute to overall diversity and ecosystem functioning [118].

Although amphibians represent a smaller fraction of total richness, their ecological significance is considerable. Amphibians provide insight into local environmental conditions due to their sensitivity to microclimatic and hydrological changes [119,120]. The persistence of species such as *Chiropterotriton priscus* and *Reohyla miotympanum* suggests that suitable microhabitats remain but also points to their vulnerability under scenarios of reduced water availability and increasing climatic variability. In this context, amphibian records were concentrated near temporary ponds and riparian corridors, highlighting the importance

of seasonal water availability for maintaining local amphibian assemblages. Protection of ephemeral wetlands and associated riparian vegetation should therefore represent a conservation priority within the reserve. The occurrence of Red-spotted toad (*Anaxyrus punctatus*), Rio Grande leopard frog (*Lithobates berlandieri*), and Mexican spadefoot (*Spea multiplicata*) is consistent with historical records [17], but also highlights the susceptibility of these species to hydrological alterations, including prolonged drought, runoff diversion, and modification of temporary water bodies. The decline of both permanent and seasonal aquatic habitats has been identified as a major threat to amphibians in northeastern Mexico [121], emphasizing the need for integrated hydrological and population monitoring programs.

Reptiles, on the other hand, reflect the biogeographic duality of the reserve [104]. The coexistence of taxa associated with rocky, high-elevation environments and species typical of arid lowlands illustrates the role of the SZSNR as a transitional system. Families such as Colubridae and Phrynosomatidae play key ecological roles as regulators of invertebrate and small vertebrate populations and as prey for higher trophic levels [122]. The presence of Testudines associated with aquatic and riparian environments highlights the conservation importance of these habitats, which are often underrepresented in management strategies. The reptile assemblage reflects the biogeographic duality of the reserve: species such as Rock rattlesnake (*Crotalus lepidus*), Crevice spiny lizard (*Sceloporus poinsettii*), and Mesquite lizard (*Sceloporus grammicus*) are associated with higher elevations and rocky substrates, whereas Eastern spotted whiptail (*Aspidoscelis gularis*), Texas horned lizard (*Phrynosoma cornutum*), and Western diamond-backed rattlesnake (*Crotalus atrox*) are characteristic of lower, desert-influenced areas. This juxtaposition highlights the capacity of the SZSNR to support contrasting ecological assemblages within relatively short spatial distances. Nevertheless, information gaps persist regarding the population dynamics of reptiles associated with rocky escarpments, which are particularly vulnerable to substrate disturbance and recreational pressure.

Bird assemblages provide strong evidence of the functional role of the SZSNR at broader spatial scales [11]. The reserve appears to provide suitable habitat for migratory birds during winter and stopover periods and may contribute to maintaining landscape connectivity across elevational gradients. The presence of species with high habitat specificity, such as *Aquila chrysaetos* and *Rhynchopsitta terrisi*, indicates that key structural elements of the ecosystem remain intact [11,22]. The recurrent presence of Golden-cheeked warbler (*Setophaga chrysoparia*), Black-capped vireo (*Vireo atricapilla*), and Wilson's warbler (*Cardellina pusilla*) during breeding or migratory periods indicates that montane forests and humid canyons continue to function as effective altitudinal corridors. Likewise, species sensitive to fragmentation—such as Elegant trogon (*Trogon elegans*), Acorn woodpecker (*Melanerpes formicivorus*), and Pygmy nuthatch (*Sitta pygmaea*)—reinforce the role of the reserve as a refuge under increasing anthropogenic pressure. The persistence of xerophytic scrubland species, including Cactus wren (*Campylorhynchus brunneicapillus*) and Curve-billed thrasher (*Toxostoma curvirostre*), further indicates structural continuity in arid habitats. More importantly, the coexistence of resident and migratory species suggests that ecological processes operate across temporal scales, reinforcing the need to maintain habitat continuity along elevational gradients. Patterns observed in the SZSNR are consistent with those reported for other mountain systems in Coahuila and Nuevo León, where topographic complexity generates environmental gradients that favor high avian diversity [23,24,123]. Overall, the avifauna highlights the importance of maintaining intact altitudinal gradients, given the seasonal movements of many species between lowlands and higher elevations [11,24].

The mammalian assemblage further highlights the ecological importance of the reserve by documenting the occurrence of species occupying multiple trophic levels, including wide-ranging carnivores [10]. The occurrence of apex predators such as *Puma concolor*,

Herpailurus yagouaroundi, and *Ursus americanus* indicates that the reserve still maintains sufficient habitat continuity and prey availability to sustain high trophic levels [124]. However, the limited representation of small mammals and bats highlights an important knowledge gap [12,37]. However, this limitation reflects a broader regional bias toward studies focused on carnivores and ungulates. The paucity of recent, systematic sampling for bats is especially notable [13,37], given their key roles in pollination, insect regulation, and seed dispersal. Given the functional roles of these groups—particularly in seed dispersal, pollination, and insect regulation—future research should prioritize systematic sampling of underrepresented taxa.

At the same time, the presence of introduced species underscores ongoing management challenges. Feral populations of *Canis familiaris*, along with *Rattus norvegicus* and *Mus musculus*, may alter community dynamics through predation, competition, and disease transmission [125]. Their control should therefore be incorporated into conservation strategies as part of an integrated management framework.

The high proportion of species documented through systematic field surveys (87.3%) demonstrates the effectiveness of the standardized long-term sampling design in capturing vertebrate diversity across the reserve. The integration of field surveys with biological collections and validated citizen-science records further increased taxonomic completeness and strengthened the robustness of the inventory [126]. This combined approach is particularly effective in megadiverse regions where logistical constraints often limit long-term field efforts. Nonetheless, certain groups—especially amphibians and small mammals—may remain underrepresented due to their cryptic behavior and seasonal activity patterns.

Available inventories indicate that the vertebrate richness documented in the SZSNR is broadly comparable to that of other mountainous protected areas in northeastern Mexico. Because published inventories differ in sampling design, effort, taxonomic coverage, and temporal scope, these comparisons should be interpreted descriptively rather than quantitatively. Nevertheless, the documented richness, together with the reserve's location within a biogeographic transition zone, highlights its importance as a regional biodiversity node and supports continued long-term monitoring and conservation [15,127–131].

5. Conclusions

Taken together, these findings position the Sierra de Zapalinamé Natural Reserve as a strategic conservation unit whose ecological value extends beyond its administrative boundaries. Maintaining its ecological integrity will require transitioning from a static protection scheme toward an adaptive, landscape-scale management approach that explicitly incorporates connectivity with surrounding mountain systems and intermontane valleys. Priority actions should include the conservation of ecotonal zones and altitudinal corridors, the protection and restoration of hydrological microhabitats critical for amphibians, and the implementation of targeted control programs for invasive species, particularly feral dogs. Likewise, establishing long-term and standardized monitoring programs—especially for underrepresented groups such as bats and small mammals—will be essential for detecting ecological change and supporting evidence-based management decisions. Introduced mammals were primarily recorded near peri-urban sectors and access corridors, suggesting that urban interfaces may facilitate biological invasions within the reserve. Monitoring and control efforts should therefore prioritize areas adjacent to roads, recreational zones, and expanding urban boundaries where interactions between invasive and native fauna are more likely to occur.

The available evidence indicates that the Sierra de Zapalinamé State Natural Reserve supports a high documented richness of terrestrial vertebrates relative to other protected areas reported for northeastern Mexico. Nevertheless, because published inventories differ

in sampling methodologies and effort, these regional comparisons should be interpreted as providing ecological context rather than definitive measures of relative conservation value. Although richness patterns spatially coincided with major vegetation transitions and elevational gradients, the present study did not explicitly quantify environmental heterogeneity metrics. Consequently, the proposed influence of habitat heterogeneity on vertebrate diversity should be interpreted as an ecologically consistent hypothesis rather than a directly tested causal mechanism. Future studies integrating landscape metrics, vegetation structure, and spatial environmental modeling would help clarify the relative contribution of heterogeneity to biodiversity patterns within the reserve. This pattern is particularly notable considering the relatively restricted area of the reserve and its proximity to an expanding metropolitan zone. Unlike many protected areas dominated by a single ecological region, the SZSNR encompasses a marked environmental transition between the Chihuahuan Desert and the Sierra Madre Oriental, promoting high habitat heterogeneity and species turnover across short elevational gradients. In this context, the reserve represents an important biogeographic interface where Nearctic desert, temperate montane, and semi-arid assemblages converge. Given the accelerating pressures of urban expansion, habitat fragmentation, and climate variability in northeastern Mexico, integrating the reserve into broader regional conservation and land-use planning frameworks is imperative for maintaining ecological processes and long-term biodiversity persistence across the region.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/wild3030029/s1>, Table S1: Data-validation workflow and record retention across data sources.

Author Contributions: Conceptualization, J.E.R.-A. and J.A.E.-D.; methodology, J.E.R.-A.; software, J.E.R.-A.; validation, F.C.-G., J.A.E.-D. and J.E.R.-A.; formal analysis, J.E.R.-A.; investigation, E.J.C.-B., E.G.C.-L., F.C.-G. and J.E.R.-A.; resources, F.C.-G., J.E.R.-A. and J.A.E.-D.; data curation, J.E.R.-A., E.J.C.-B. and E.G.C.-L.; writing—original draft preparation, J.E.R.-A.; writing—review and editing, E.J.C.-B., J.A.E.-D., J.E.R.-A., F.C.-G. and E.G.C.-L.; visualization, J.E.R.-A.; supervision, J.A.E.-D. and J.E.R.-A.; project administration, J.E.R.-A.; funding acquisition, J.E.R.-A. and J.A.E.-D. All authors have read and agreed to the published version of the manuscript.

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Abbreviations

CONABIO: National Commission for the Knowledge and Use of Biodiversity; CONANP: National Commission of Natural Protected Areas; GBIF: Global Biodiversity Information Facility; IUCN: International Union for Conservation of Nature and Natural Resources; NOM-059 Mexican Official Standard 059; PA: Protected Areas; SEMARNAT: Ministry of the Environment and Natural Resources;

SZSNR: Sierra de Zapalinamé State Natural Reserve; UNIBIO-UNAM: Biodiversity Information Unit of the National Autonomous University of Mexico.

Appendix A

List of vertebrates present in the Sierra de Zapalinamé State Natural Reserve, Coahuila. Vulnerability categories in the NOM-059-SEMARNAT-2010 (SEMARNAT, 2010 [53]): under special protection (Pr), threatened (A), and endangered (P). Vulnerability categories in the IUCN Red List (IUCN, 2026 [54]): near threatened (NT), endangered (EN), and vulnerable (VU). Record: records from scientific collection databases, publications, and citizen science (Rb); records made in the field through systematic monitoring by at least one of the authors (Oc).

Class Orden	Family	Scientific Name	NOM-059- Semarnat- 2010	IUCN	Endemism	Record
AMPHIBIA						
Anura						
	Bufonidae	<i>Anaxyrus punctatus</i>				Rb, Oc
	Craugastoridae	<i>Craugastor augusti</i>				Rb, Oc
	Eleutherodactylidae	<i>Eleutherodactylus guttillatus</i>	Pr		Endemic	Rb
	Scaphiopodidae	<i>Spea multiplicata</i>	Pr			Rb, Oc
	Hylidae	<i>Rheohyla miotympanum</i>	Pr		Endemic	Rb, Oc
	Ranidae	<i>Lithobates berlandieri</i>	Pr			Rb, Oc
Caudata	Plethodontidae	<i>Chiropoterotriton priscus</i>	Pr	NT	Endemic	Rb
REPTILIA						
Testudines						
	Trionychidae	<i>Apalone spinifera emoryi</i>	Pr		Introduced	Rb
	Testudinidae	<i>Gopherus berlandieri</i>	A			Rb
	Emydidae	<i>Trachemys venusta</i>				Rb
Squamata						
	Anguidae	<i>Gerrhonotus infernalis</i>				Rb
		<i>Gerrhonotus parvus</i>	P	EN	Endemic	Rb
		<i>Barisia ciliaris</i>			Endemic	Rb, Oc
	Phrynosomatidae	<i>Cophosaurus texanus</i>	A			Rb, Oc
		<i>Phrynosoma orbiculare</i>	A		Endemic	Rb, Oc
		<i>Phrynosoma modestum</i>				Rb, Oc
		<i>Sceloporus cautus</i>			Endemic	Rb, Oc
		<i>Sceloporus grammicus</i>	Pr			Rb, Oc
		<i>Sceloporus oregon</i>		VU	Endemic	Rb
		<i>Sceloporus ornatus</i>	A	NT		Rb, Oc
		<i>Sceloporus parvus</i>			Endemic	Rb, Oc
		<i>Sceloporus poinsettii</i>				Rb, Oc
		<i>Sceloporus samcolemanni</i>			Endemic	Rb, Oc
		<i>Sceloporus spinosus</i>			Endemic	Rb, Oc
	Scincidae	<i>Plestiodon tetragrammus</i>				Rb, Oc
	Teiidae	<i>Aspidoscelis gularis</i>				Rb, Oc

Class Orden	Family	Scientific Name	NOM-059- Semarnat- 2010	IUCN	Endemism	Record
AVES	Colubridae	<i>Masticophis flagellum</i>	A			Rb, Oc
		<i>Masticophis schotti</i>				Rb, Oc
		<i>Masticophis taeniatus</i>				Rb, Oc
		<i>Pantherophis emoryi</i>				Rb, Oc
		<i>Diadophis punctatus</i>				Rb, Oc
		<i>Gyalopion canum</i>				Rb, Oc
		<i>Heterodon kennerlyi</i>	Pr			Rb, Oc
		<i>Lampropeltis leonis</i>	A		Endemic	Rb, Oc
		<i>Pituophis deppei</i>	A		Endemic	Rb, Oc
		<i>Salvadora lineata</i>				Rb, Oc
		<i>Storeria hidalgoensis</i>		VU	Endemic	Rb, Oc
		<i>Tantilla rubra</i>	Pr			Rb, Oc
		<i>Tantilla wilcoxi</i>				Rb, Oc
		<i>Thamnophis cyrtopsis</i>	A			Rb, Oc
		<i>Thamnophis proximus</i>	A			Rb, Oc
	Leptotyphlopidae	<i>Rena dulcis</i>				Rb, Oc
	Viperidae	<i>Crotalus atrox</i>	Pr			Rb, Oc
		<i>Crotalus lepidus</i>	Pr			Rb, Oc
		<i>Crotalus molossus</i>	Pr			Rb, Oc
		<i>Crotalus pricei</i>	Pr			Rb
		<i>Crotalus scutulatus</i>	Pr			Rb
	Gekkonidae	<i>Hemidactylus turcicus</i>			Introduced	Rb, Oc
	Typhlopidae	<i>Indotyphlops braminus</i>			Introduced	Rb
Anseriformes	Anatidae	<i>Cairina moschata</i>			Introduced	Rb, Oc
		<i>domesticus</i>				
		<i>Spatula discors</i>				Rb, Oc
		<i>Spatula cyanoptera</i>				Rb, Oc
		<i>Spatula clypeata</i>				Rb, Oc
		<i>Mareca strepera</i>				Rb, Oc
		<i>Anas diazi</i>				Rb, Oc
		<i>Anas acuta</i>				Rb, Oc
		<i>Anas crecca</i>				Rb, Oc
		<i>Aythya valisineria</i>				Rb, Oc
		<i>Ortalis vetula</i>				Rb
	Cracidae	<i>Callipepla squamata</i>				Rb, Oc
		<i>Cyrtonyx montezumae</i>	Pr			Rb, Oc
	Phasianidae	<i>Meleagris gallopavo</i>	A			Rb, Oc
Podicipediformes	Podicipedidae	<i>Podilymbus podiceps</i>				Rb, Oc
		<i>Podiceps nigricollis</i>				Rb, Oc
Columbiformes	Columbidae	<i>Columba livia</i>			Introduced	Rb, Oc
		<i>Patagioenas fasciata</i>				Rb, Oc
		<i>Streptopelia decaocto</i>			Introduced	Rb, Oc
		<i>Columbina inca</i>				Rb, Oc
		<i>Columbina passerina</i>				Rb, Oc
		<i>Leptotila verreauxi</i>				Rb, Oc
		<i>Zenaida asiatica</i>				Rb, Oc
		<i>Zenaida macroura</i>				Rb, Oc

Class Orden	Family	Scientific Name	NOM-059- Semarnat- 2010	IUCN	Endemism	Record
Cuculiformes	Cuculidae	<i>Geococcyx californianus</i>				Rb, Oc
		<i>Coccyzus erythrophthalmus</i>				Rb, Oc
Caprimulgiformes	Caprimulgidae	<i>Chordeiles acutipennis</i>				Rb, Oc
		<i>Chordeiles minor</i>				Rb, Oc
		<i>Phalaenoptillus nuttallii</i>				Rb, Oc
		<i>Anthrostomus arizonae</i>				Rb, Oc
Apodiformes	Apodidae	<i>Chaetura vauxi</i>				Rb, Oc
		<i>Aeronautes saxatalis</i>				Rb, Oc
	Trochilidae	<i>Colibri thalassinus</i>				Rb, Oc
		<i>Eugenes fulgens</i>				Rb, Oc
		<i>Lampornis clemenciae</i>				Rb, Oc
		<i>Calothorax lucifer</i>				Rb, Oc
		<i>Archilochus colubris</i>				Rb, Oc
		<i>Archilochus alexandri</i>				Rb, Oc
		<i>Calypte anna</i>				Rb
		<i>Selasphorus rufus</i>				Rb, Oc
		<i>Selasphorus platycercus</i>				Rb, Oc
		<i>Cynanthus latirostris</i>				Rb, Oc
		<i>Basilinna leucotis</i>				Rb, Oc
Gruiformes	Rallidae	<i>Fulica americana</i>				Rb, Oc
Charadriiformes	Recurvirostridae	<i>Recurvirostra americana</i>				Rb, Oc
	Charadriidae	<i>Charadrius vociferus</i>				Rb, Oc
		<i>Anarhynchus montanus</i>				Rb
	Scolopacidae	<i>Numenius americanus</i>				Rb
		<i>Calidris bairdi</i>				Rb, Oc
		<i>Calidris minutilla</i>				Rb, Oc
		<i>Gallinago delicata</i>				Rb, Oc
		<i>Actitis macularius</i>				Rb, Oc
		<i>Tringa solitaria</i>				Rb, Oc
		<i>Tringa flavipes</i>				Rb, Oc
		<i>Tringa melanoleuca</i>				Rb, Oc
		<i>Phalaropus tricolor</i>				Rb, Oc
	Laridae	<i>Larus delawarensis</i>				Rb, Oc
Suliformes	Phalacrocoracidae	<i>Nannopterum brasilianum</i>				Rb, Oc
Pelecaniformes	Threskiornithidae	<i>Plegadis chihi</i>				Rb, Oc
	Ardeidae	<i>Egretta thula</i>				Rb, Oc
		<i>Egretta tricolor</i>				Rb, Oc
		<i>Nycticorax nycticorax</i>				Rb, Oc
		<i>Butorides virescens</i>				Rb, Oc
		<i>Ardea alba</i>				Rb, Oc
		<i>Ardea ibis</i>			Introduced	Rb, Oc
		<i>Ardea herodias</i>				Rb, Oc
Cathartiformes	Cathartidae	<i>Coragyps atratus</i>				Rb, Oc
		<i>Cathartes aura</i>				Rb, Oc
Accipitriformes	Pandionidae	<i>Pandion haliaetus</i>				Rb, Oc
	Accipitridae	<i>Elanus leucurus</i>				Rb, Oc
		<i>Chondrohierax uncinatus</i>	Pr			Rb
		<i>Aquila chrysaetos</i>	A			Rb, Oc
		<i>Accipiter striatus</i>	Pr			Rb, Oc
		<i>Astur cooperi</i>	Pr			Rb, Oc

Class Orden	Family	Scientific Name	NOM-059- Semarnat- 2010	IUCN	Endemism	Record
Strigiformes	Tytonidae Strigidae	<i>Astur gentilis</i>	A	NT		Rb
		<i>Circus hudsonius</i>				Rb, Oc
		<i>Ictinia mississippiensis</i>	Pr			Rb
		<i>Buteogallus anthracinus</i>	Pr			Rb
		<i>Parabuteo unicinctus</i>	Pr			Rb, Oc
		<i>Geranoaetus albicaudatus</i>				Rb
		<i>Buteo plagiatus</i>				Rb, Oc
		<i>Buteo lineatus</i>	Pr			Rb, Oc
		<i>Buteo platypterus</i>	Pr			Rb, Oc
		<i>Buteo brachyurus</i>				Rb, Oc
		<i>Buteo swainsoni</i>	Pr			Rb, Oc
		<i>Buteo albonotatus</i>	Pr			Rb, Oc
		<i>Buteo jamaicensis</i>				Rb, Oc
		<i>Buteo regalis</i>	Pr			Rb, Oc
		<i>Tyto furcata</i>				Rb, Oc
		<i>Megascops trichopsis</i>				Rb
		<i>Megascops kennicotti</i>				Rb, Oc
		<i>Magascops asio</i>				Rb, Oc
		<i>Bubo virginianus</i>				Rb, Oc
		<i>Glaucidium gnoma</i>				Rb, Oc
		<i>Athene cunicularia</i>				Rb, Oc
		<i>Strix occidentalis</i>	A			Rb
		<i>Strix virgata</i>				Rb
		<i>Asio otus</i>				Rb
Trogoniformes	Trogonidae	<i>Aegolius acadicus</i>		NT		Rb
		<i>Trogon elegans</i>				Rb
		<i>Trogon mexicanus</i>				Rb, Oc
		<i>Megascops asio</i>				Rb, Oc
Piciformes	Picidae	<i>Chloroceryle americana</i>				Rb, Oc
		<i>Melanerpes formicivorus</i>				Rb, Oc
		<i>Melanerpes aurifrons</i>				Rb, Oc
		<i>Sphyrapicus thyroideus</i>				Rb
		<i>Sphyrapicus varius</i>				Rb, Oc
		<i>Dryobates scalaris</i>				Rb, Oc
		<i>Dryobates villosus</i>				Rb, Oc
		<i>Colaptes auratus</i>				Rb, Oc
Falconiformes	Falconidae	<i>Caracara plancus</i>				Rb, Oc
		<i>Falco sparverius</i>				Rb, Oc
		<i>Falco columbarius</i>				Rb, Oc
		<i>Falco femoralis</i>	A			Rb
		<i>Falco peregrinus</i>	Pr			Rb, Oc
		<i>Falco mexicanus</i>	A			Rb, Oc
Psittaciformes	Psittacidae	<i>Psittacara holochlorus</i>		EN	Endemic	Rb, Oc
Passeriformes	Tyrannidae	<i>Rhynchopsitta terrisi</i>	P			Rb, Oc
		<i>Camptostoma imberbe</i>				Rb, Oc
		<i>Myiarchus tuberculifer</i>				Rb, Oc
		<i>Myiarchus cinerascens</i>				Rb, Oc
		<i>Myiarchus crinitus</i>				Rb, Oc
		<i>Myiarchus tyrannulus</i>				Rb, Oc

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		<i>Pitangus sulphuratus</i>				Rb, Oc
		<i>Tyrannus vociferans</i>				Rb, Oc
		<i>Tyrannus verticalis</i>				Rb, Oc
		<i>Tyrannus forficatus</i>				Rb, Oc
		<i>Mitrephanes phaeocercus</i>				Rb, Oc
		<i>Contopus cooperi</i>				Rb, Oc
		<i>Contopus pertinax</i>				Rb, Oc
		<i>Contopus sordidulus</i>				Rb, Oc
		<i>Contopus virens</i>				Rb, Oc
		<i>Empidonax traillii</i>				Rb, Oc
		<i>Empidonax minimus</i>				Rb, Oc
		<i>Empidonax hammondi</i>				Rb, Oc
		<i>Empidonax wrightii</i>				Rb, Oc
		<i>Empidonax oberholseri</i>				Rb, Oc
		<i>Empidonax affinis</i>				Rb, Oc
		<i>Empidonax occidentalis</i>				Rb
		<i>Empidonax fulvifrons</i>				Rb, Oc
		<i>Sayornis nigricans</i>				Rb, Oc
		<i>Sayornis phoebe</i>				Rb, Oc
		<i>Sayornis saya</i>				Rb, Oc
		<i>Pyrocephalus rubinus</i>				Rb, Oc
	Vireonidae	<i>Vireo atricapilla</i>	P	NT		Rb
		<i>Vireo griseus</i>				Rb, Oc
		<i>Vireo belli</i>				Rb, Oc
		<i>Vireo huttoni</i>				Rb, Oc
		<i>Vireo cassinii</i>				Rb, Oc
		<i>Vireo solitarius</i>				Rb, Oc
		<i>Vireo gilvus</i>				Rb, Oc
	Laniidae	<i>Lanius ludovicianus</i>		NT		Rb, Oc
	Corvidae	<i>Cyanocorax yncas</i>				Rb, Oc
		<i>Cyanocitta stelleri</i>				Rb, Oc
		<i>Aphelocoma woodhouseii</i>				Rb, Oc
		<i>Aphelocoma wollweberi</i>				Rb, Oc
		<i>Corvus cryptoleucus</i>				Rb, Oc
		<i>Corvus corax</i>				Rb, Oc
	Remizidae	<i>Auriparus flavipes</i>				Rb, Oc
	Paridae	<i>Poecile sclateri</i>				Rb, Oc
		<i>Baeolophus wollweberi</i>				Rb, Oc
	Alaudidae	<i>Eremophila alpestris</i>				Rb, Oc
	Hirundinidae	<i>Riparia riparia</i>				Rb, Oc
		<i>Tachycinetta thalassina</i>				Rb, Oc
		<i>Stelgidopteryx serripennis</i>				Rb, Oc
		<i>Progne subis</i>				Rb
		<i>Hirundo rustica</i>				Rb, Oc
		<i>Petrochelidon pyrrhonota</i>				Rb, Oc
		<i>Petrochelidon fulva</i>				Rb, Oc
	Aegithalidae	<i>Psaltiriparus minimus</i>				Rb, Oc
	Regulidae	<i>Corthylio calendula</i>				Rb, Oc
		<i>Regulus satrapa</i>				Rb, Oc

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	Bombycillidae	<i>Bombycilla cedrorum</i>				Rb, Oc
	Ptiliogonatidae	<i>Ptiliogonys cinereus</i>				Rb, Oc
		<i>Phainopepla nitens</i>				Rb, Oc
	Sittidae	<i>Sitta canadensis</i>				Rb, Oc
		<i>Sitta carolinensis</i>				Rb, Oc
		<i>Sitta pygmaea</i>				Rb
	Certhiidae	<i>Certhia americana</i>				Rb, Oc
	Poliophtilidae	<i>Poliophtila caerulea</i>				Rb, Oc
		<i>Poliophtila melanura</i>				Rb, Oc
	Troglodytidae	<i>Salpinctes obsoletus</i>				Rb, Oc
		<i>Catherpes mexicanus</i>				Rb, Oc
		<i>Campylorhynchus brunneicapillus</i>				Rb, Oc
		<i>Thryomanes bewickii</i>				Rb, Oc
		<i>Troglodytes aedon</i>				Rb, Oc
		<i>Troglodytes hiemalis</i>				Rb, Oc
		<i>Cistothorus palustris</i>				Rb, Oc
	Mimidae	<i>Toxostoma curvirostre</i>				Rb, Oc
		<i>Toxostoma longirostre</i>				Rb, Oc
		<i>Toxostoma crissale</i>				Rb, Oc
		<i>Oreoscoptes montanus</i>				Rb, Oc
		<i>Mimus polyglottos</i>				Rb, Oc
	Sturnidae	<i>Sturnus vulgaris</i>			Introduced	Rb, Oc
	Turdidae	<i>Sialia sialis</i>				Rb, Oc
		<i>Sialia mexicana</i>				Rb, Oc
		<i>Sialia currucoides</i>				Rb, Oc
		<i>Myadestes townsendi</i>	Pr			Rb, Oc
		<i>Myadestes occidentalis</i>	Pr			Rb, Oc
		<i>Catharus occidentalis</i>				Rb, Oc
		<i>Catharus ustulatus</i>				Rb, Oc
		<i>Catharus guttatus</i>				Rb, Oc
		<i>Turdus grayi</i>				Rb, Oc
		<i>Turdus migratorius</i>				Rb, Oc
		<i>Ridgwayia pinicola</i>	Pr		Endemic	Rb
	Peucedramidae	<i>Peucedramus taeniatus</i>				Rb, Oc
	Passeridae	<i>Passer domesticus</i>			Introduced	Rb, Oc
	Motacillidae	<i>Anthus rubescens</i>				Rb, Oc
		<i>Anthus spragueii</i>				Rb, Oc
	Fringillidae	<i>Chlorophonia elegantissima</i>			Introduced	Rb
		<i>Haemorhous mexicanus</i>				Rb, Oc
		<i>Haemorhous cassinii</i>				Rb, Oc
		<i>Loxia curvirostra</i>				Rb, Oc
		<i>Spinus pinus</i>				Rb, Oc
		<i>Spinus psaltria</i>				Rb, Oc
	Calcariidae	<i>Calcarius ornatus</i>				Rb, Oc
	Passerellidae	<i>Peucaea botteri</i>				Rb, Oc
		<i>Peucaea cassinii</i>				Rb, Oc
		<i>Ammodramus savaanarum</i>				Rb, Oc

Class Orden	Family	Scientific Name	NOM-059- Semarnat- 2010	IUCN	Endemism	Record
		<i>Arremonops rufivirgatus</i>				Rb, Oc
		<i>Amphispiza bilineata</i>				Rb, Oc
		<i>Chondestes grammacus</i>				Rb, Oc
		<i>Spizella passerina</i>				Rb, Oc
		<i>Spizella pallida</i>				Rb, Oc
		<i>Spizella atrogularis</i>				Rb, Oc
		<i>Spizella breweri</i>				Rb, Oc
		<i>Spizella wortheni</i>	P	EN	Endemic	Rb, Oc
		<i>Junco hyemalis</i>				Rb, Oc
		<i>Junco phaeonotus</i>				Rb, Oc
		<i>Zonothrichia leucophrys</i>				Rb, Oc
		<i>Poocetes gramineus</i>				Rb, Oc
		<i>Passerculus sandwichensis</i>				Rb, Oc
		<i>Melospiza melodia</i>				Rb, Oc
		<i>Melospiza lincolnii</i>				Rb, Oc
		<i>Melospiza fusca</i>				Rb, Oc
		<i>Aimophila ruficeps</i>				Rb, Oc
		<i>Pipilo chlorurus</i>				Rb, Oc
		<i>Pipilo maculatus</i>				Rb, Oc
		<i>Atlapetes pileatus</i>			Endemic	Rb, Oc
	Icteriidae	<i>Icteria virens</i>				Rb, Oc
	Icteridae	<i>Xanthocephalus</i>				Rb, Oc
		<i>xanthocephalus</i>				Rb, Oc
		<i>Sturnella magna</i>				Rb, Oc
		<i>Sturnella neglecta</i>				Rb, Oc
		<i>Icterus wagleri</i>				Rb, Oc
		<i>Icterus spurius</i>				Rb, Oc
		<i>Icterus cucullatus</i>				Rb, Oc
		<i>Icterus bullocki</i>				Rb, Oc
		<i>Icterus graduacauda</i>				Rb, Oc
		<i>Icterus galbula</i>				Rb, Oc
		<i>Icterus parisorum</i>				Rb, Oc
		<i>Agelaius phoeniceus</i>				Rb, Oc
		<i>Molothrus aeneus</i>				Rb, Oc
		<i>Molothrus ater</i>				Rb, Oc
		<i>Euphagus cyanocephalus</i>				Rb, Oc
		<i>Quiscalus mexicanus</i>			Introduced	Rb, Oc
		<i>Seiurus aurocapilla</i>				Rb, Oc
		<i>Parkesia motacilla</i>				Rb, Oc
		<i>Parkesia noveboracensis</i>				Rb, Oc
		<i>Mniotilta varia</i>				Rb, Oc
		<i>Oreothlypis superciliosa</i>				Rb, Oc
		<i>Leiothlypis celata</i>				Rb, Oc
		<i>Leiothlypis crissalis</i>	Pr			Rb, Oc
		<i>Leiothlypis ruficapilla</i>				Rb, Oc
		<i>Leiothlypis virginiae</i>				Rb, Oc
		<i>Geothlypis tolmiei</i>	A			Rb, Oc
		<i>Geothlypis formosa</i>				Rb, Oc

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	Cardinalidae	<i>Geothlypis trichas</i>			Endemic	Rb, Oc
		<i>Geothlypis nelsoni</i>				Rb, Oc
		<i>Setophaga ruticilla</i>				Rb, Oc
		<i>Setophaga tigrina</i>				Rb, Oc
		<i>Setophaga americana</i>				Rb, Oc
		<i>Setophaga pitiayumi</i>				Rb, Oc
		<i>Setophaga fusca</i>				Rb, Oc
		<i>Setophaga petechia</i>				Rb, Oc
		<i>Setophaga pensylvanica</i>				Rb, Oc
		<i>Setophaga coronata</i>				Rb, Oc
		<i>Setophaga nigrescens</i>				Rb, Oc
		<i>Setophaga townsendi</i>				Rb, Oc
		<i>Setophaga occidentalis</i>				Rb, Oc
		<i>Setophaga chrysoparia</i>	P	EN		Rb, Oc
		<i>Setophaga virens</i>			Rb, Oc	
		<i>Basileuptyerus rufifrons</i>			Rb, Oc	
		<i>Cardellina canadensis</i>			Rb, Oc	
		<i>Cardenilla pusilla</i>			Rb, Oc	
		<i>Myioborus pictus</i>			Rb, Oc	
		<i>Myioborus miniatus</i>			Rb, Oc	
		<i>Piranga rubra</i>			Rb, Oc	
		<i>Piranga ludoviciana</i>			Rb, Oc	
		<i>Piranga bidentata</i>			Rb, Oc	
		<i>Cardinalis cardinalis</i>			Rb, Oc	
		<i>Cardinalis sinuatus</i>			Rb, Oc	
		<i>Pheucticus melanocephalus</i>			Rb, Oc	
		<i>Pheucticus ludovicianus</i>			RB, Oc	
		<i>Cyanocompsa parellina</i>			Rb, Oc	
		<i>Passerina caerulea</i>			Rb, Oc	
		<i>Passerina amoena</i>			Rb, Oc	
		<i>Passerina cyanea</i>			Rb, Oc	
		<i>Passerina versicolor</i>			Rb, Oc	
		<i>Passerina ciris</i>	Pr		Rb, Oc	
		<i>Spiza americana</i>			Rb, Oc	
MAMMALIA						
Didelphimorphia	Didelphidae	<i>Didelphis virginiana</i>				Rb, Oc
Insectivora	Soricidae	<i>Notiosorex crawfordi</i>	A			Rb
Chiroptera	Phyllostomidae	<i>Choeronycteris mexicana</i>	A	NT		Rb, Oc
		<i>Leptonycteris nivalis</i>	A	EN		Rb, Oc
	Vespertilionidae	<i>Myotis californicus</i>				Rb, Oc
		<i>Myotis planiceps</i>	P	EN	Endemic	Rb, Oc
		<i>Myotis thysanodes</i>				Rb, Oc
		<i>Myotis velifer</i>				Rb, Oc
		<i>Myotis volans</i>				Rb, Oc
		<i>Myotis yumanensis</i>				Rb, Oc
		<i>Myotis ciliolabrum</i>				Rb, Oc
		<i>Corynorhinus mexicanus</i>		NT	Endemic	Rb, Oc
		<i>Corynorhinus townsendii</i>				Rb, Oc

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Carnivora	Molossidae	<i>Eptesicus fuscus</i>				Rb, Oc
		<i>Idionycteris phyllotis</i>				Rb, Oc
		<i>Lasiurus borealis</i>				Rb, Oc
		<i>Lasiurus cinereus</i>				Rb, Oc
		<i>Lasiurus ega</i>				Rb
		<i>Lasiurus xanthinus</i>				Rb
		<i>Lasiurus intermedius</i>				Rb, Oc
		<i>Parastrellus hesperus</i>				Rb
		<i>Antrozous pallidus</i>				Rb
		<i>Eumops perotis</i>				Rb
		<i>Molossus rufus</i>				Rb, Oc
		<i>Nyctinomops femorosaccus</i>				Rb
		<i>Nyctinomops macrotis</i>				Rb
		<i>Tadarida brasiliensis</i>				Rb, Oc
	Canidae	<i>Canis latrans</i>				Rb, Oc
		<i>Urocyon cinereoargenteus</i>				Rb, Oc
		<i>Herpailurus yagouaroundi</i>	A			Rb
	Felidae	<i>Lynx rufus</i>				Rb, Oc
		<i>Puma concolor</i>				Rb, Oc
		<i>Conepatus leuconotus</i>				Rb, Oc
	Mephitidae	<i>Mephitis macroura</i>				Rb, Oc
		<i>Mephitis mephitis</i>				Rb, Oc
		<i>Spilogale leucoparia</i>				Rb, Oc
		<i>Mustela frenata</i>				Rb
	Mustelidae	<i>Taxidea taxus</i>	A			Rb, Oc
		<i>Bassariscus astutus</i>				Rb, Oc
	Procyonidae	<i>Nasua narica</i>				Rb
		<i>Procyon lotor</i>				Rb, Oc
		<i>Ursus americanus eremicus</i>				Rb, Oc
Artiodactyla	Ursidae					
	Cervidae	<i>Odocoileus virginianus</i>				Rb, Oc
Rodentia	Tayassuidae	<i>Dicotyles tajacu</i>				Rb, Oc
	Sciuridae	<i>Sciurus alleni</i>			Endemic	Rb, Oc
		<i>Ictidomys parvidens</i>				Rb
		<i>Xerospermophilus spilosoma</i>				Rb, Oc
		<i>Otospermophilus variegatus</i>				Rb, Oc
		<i>Neotamias solivagus</i>			Endemic	Rb
		<i>Baiomys taylori</i>				Rb
		<i>Neotoma leucodon</i>				Rb, Oc
		<i>Neotoma micropus</i>				Rb, Oc
		<i>Onychomys arenicola</i>				Rb, Oc
		<i>Peromyscus eremicus</i>				Rb
		<i>Peromyscus leucopus</i>				Rb, Oc
		<i>Peromyscus nasutus</i>				Rb
		<i>Reithrodontomys megalotis</i>				Rb, Oc
		<i>Sigmodon hispidus</i>				Rb, Oc
		<i>Thomomys bottae</i>				Rb, Oc
	Geomyidae					
	Heteromyidae	<i>Dipodomys merriami</i>				Rb, Oc

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Lagomorpha	Leporidae	<i>Dipodomys ordii</i>				Rb
		<i>Chaetodipus eremicus</i>				Rb
		<i>Chaetodipus hispidus</i>				Rb
		<i>Perognathus flavus</i>				Rb, Oc
		<i>Lepus californicus</i>				Rb, Oc
		<i>Sylvilagus audubonii</i>				Rb, Oc
		<i>Sylvilagus floridanus</i>				Rb, Oc

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