Introductory page. *Dryophytes eximius* (Baird, 1854). The distribution of the Mountain Treefrog extends from south-central Durango and the Sierra Madre Oriental in Tamaulipas southward to the Transverse Volcanic Range of Jalisco, Colima, Michoacán, México, Morelos, Distrito Federal, Puebla, Hidalgo, and Veracruz, Mexico (Frost 2022). This individual was photographed in the community of El Garbanzo, in the municipality of Irapuato. Wilson et al. (2013b) calculated its EVS as 10, placing it at the lower limit of the medium vulnerability category. IUCN has considered its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

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The herpetofauna of Guanajuato, Mexico: composition, distribution, and conservation status

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***Abstract.*—The herpetofauna of the Mexican state of Guanajuato currently consists of 24 anurans, three salamanders, 71 squamates, and three turtles, for a total of 101 species. The members of the herpetofauna are categorized among the three recognized physiographic regions of the Central Plateau, the Transmexican Volcanic Belt, and the Sierra Madre Oriental. The total number of species in each of these regions ranges from 60 in the Central Plateau to 75 in the Sierra Madre Oriental. The numbers of species shared among these three regions range from 44 between the Central Plateau and the Sierra Madre Oriental to 56 between the Central Plateau and the Transmexican Volcanic Belt. A similarity dendrogram based on the Unweighted Pair Group Method with Arithmetic Averages (UPGMA) demonstrates that of the three physiographic regions, the Central Plateau (CP) and the Transmexican Volcanic Belt (TVB) cluster at the 0.84 level, and that the Sierra Madre Oriental (SMO) clusters with the other two regions at the 0.65 level. This pattern was expected given that both the CP and TVB are relatively large areas of similar size in the state that lie adjacent to one another; in contrast, the SMO is the smallest region in the state and it is adjoined only to the CP region. The level of herpetofaunal endemism in Guanajuato is relatively high, with 56 of the 101 species categorized as country endemics. The distributional categorization of the entire herpetofauna includes 56 country endemics, 40 non-endemics, and five non-natives. The 40 non-endemic species are placed into the following distributional categories: MXUS (26), USCA (six), MXCA (four), MXSA (three), and USSA (one). The principal environmental threats to the herpetofauna of Guanajuato are agriculture, industry, forestry, cattle production, and mining. We assessed the conservation status of each native species by using the SEMARNAT, IUCN, and EVS systems, of which the EVS system proved to be the most useful. We applied the Relative Herpetofaunal Priority method to determine the rank order of the three regions, which indicates that the Transmexican Volcanic Belt is the region of greatest conservation importance. Twenty-four natural protected areas have been designated in Guanajuato. Fourteen of these areas lie within the Transmexican Volcanic Belt, which is fortunate from a conservation perspective. All but four native species have been documented in these 24 areas. Finally, we provide a set of conclusions and recommendations to help improve the future protection of the Guanajuato herpetofauna.**

Keywords. Anurans, caudates, physiographic regions, protected areas, protection recommendations, squamates, turtles

***Resumen.*—La herpetofauna del estado mexicano de Guanajuato actualmente consiste de 24 anuros, tres salamandras, 71 escamosos y tres tortugas, para un total de 101 especies. Los miembros de la herpetofauna se clasifican en tres regiones fisiográficas reconocidas, que incluyen la Meseta Central, la Faja Volcánica Transmexicana y la Sierra Madre Oriental. El número total de especies en estas regiones consiste desde 60 en la Meseta Central hasta 75 en la Sierra Madre Oriental. El número de especies compartidas entre estas tres regiones va desde 44 entre el Altiplano Central y la Sierra Madre Oriental hasta 56 entre el Altiplano Central y la Faja Volcánica Transmexicana. Un dendrograma de similitud basado en el Método de Grupos de Pares No Ponderados con Promedios Aritméticos (UPGMA) demuestra que de las tres regiones fisiográficas, la Meseta Central (CP) y la Faja Volcánica Transmexicana (TVB) se agrupan en el nivel .84 y que la Sierra Madre Oriental (SMO) se agrupan con las otras dos regiones en el nivel .65. Se espera este patrón dado que CP y TVB son áreas relativamente grandes de tamaño similar en el estado y son adyacentes entre sí; de lo contrario, la**

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SMO es la región más pequeña del estado y está unida solo a la región CP. El nivel de endemismo de la herpetofauna en Guanajuato es relativamente alto, con 56 de las 101 especies categorizadas como endémicas del país. La categorización distribucional de toda la herpetofauna es la siguiente: 56 endémicas del país, 40 no endémicas y cinco no nativas. Las 40 especies no endémicas se ubican en las siguientes categorías de distribución: MXUS (26), USCA (seis), MXCA (cuatro), MXSA (tres) y USSA (una). Las principales amenazas ambientales son agricultura, industria, silvicultura, ganadería y minería. Evaluamos la conservación de cada especie nativa utilizando los sistemas de SEMARNAT, UICN y EVS, de los cuales el sistema EVS demostró ser el más utilitario. Se utilizó el método de Prioridad Relativa de la Herpetofauna para determinar el orden de clasificación de las tres regiones, y este método indicó que la Faja Volcánica Transmexicana es la región de mayor importancia para la conservación. Todas menos cuatro especies nativas están documentadas en estas 24 áreas. Finalmente, brindamos un conjunto de conclusiones y recomendaciones destinadas a aumentar las posibilidades para la futura protección de la herpetofauna guanajuatense.

Palabras Claves. Anuros, áreas protegidas, caudados, escamosos, estatus de conservación, recomendaciones de protección, regiones fisiográficas, tortugas

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"If we keep trashing our unique ecosystems, how much longer with they be able to deal with wave after wave of new challenges?"

Rick Shine (2018)

Introduction

The state of Guanajuato is located in central Mexico, at the intersection of three major physiographic regions: the Central Plateau, the Transmexican Volcanic Belt, and the Sierra Madre Oriental. To the north, the state is bounded by a sliver of Zacatecas and a large portion San Luis Potosí, to the east by Querétaro, to the south by Michoacán, and to the west by Jalisco. Guanajuato is the 22nd largest state in Mexico, with a surface area of 30,607 km^2 (http://inegi.org.mx/monografias/informacion/gto/; Accessed 18 February 2022). In 2020, the population of the state was 6,166,934, which ranks sixth in the country, and the state's population density is 200 people/km^2, which ranks fifth (http://inegi.org.mx/monografias/informacion/gto/poblacion/default.aspx; Accessed 25 May 2022).

Historically, Guanajuato is an important place with regard to the Mexican herpetofauna, since this state is considered the birthplace for the formal study of these ectotherms by the father of Mexican herpetology, Alfredo Dugès, who conducted the first studies on the diversity of vertebrates, including aspects of their natural history (Reynoso et al. 2012; Leyte-Manrique et al. 2015; Flores-Villela et al. 2018). Dugés recorded 56 species in the state, including 12 amphibians and 44 reptiles. However, although Guanajuato has been important in the Mexican herpetological literature, there is no species list representing the current composition of its herpetofauna. In this regard, the study of Mendoza-Quijano et al. (2001), carried out in Sierra de Santa Rosa, is viewed as the watershed work for formally reestablishing the investigation of the herpetofauna found in this state. Important recent works include *Guía de los Anfibios y Reptiles de Charco Azul, Xichú, Guanajuato* (Leyte-Manrique and Domínguez-Laso 2014), which provides a list of 18 species. Subsequently, two studies in 2018 assessed the herpetofauna at a larger scale. Báez-Montes (2018) reported a total of 86 species (21 amphibians and 65 reptiles) living in natural protected areas, and Arciga-Hernández et al. (2018) reported 108 species (27 amphibians and 81 reptiles). The latter study was based mostly on records from natural protected areas, but it includes species present in the surrounding states that are also potentially found in Guanajuato. Furthermore, areas outside of the natural protected areas in Guanajuato, both considerably undisturbed and disturbed (such as agro-ecosystems), have been studied during the last six years (Cadena-Rico et al. 2020; Leyte-Manrique et al. 2015, 2016, 2019, 2021; Letye-Manrique 2022). The work of Leyte-Manrique et al. (2015) focused on the entire herpetofauna of the state, from both historical and contemporaneous perspectives, and discusses the findings in 10 published papers. Herein, we provide an updated assessment of the herpetofauna of Guanajuato.

Materials and Methods

Our Taxonomic Position

In this contribution we follow the taxonomic position that was explained in detail in previous works on other portions of Mesoamerica (Johnson et al. 2015a,b; Mata-Silva et al.

2015; Terán-Juárez et al. 2016; Woolrich-Piña et al. 2016, 2017; Nevárez-de los Reyes et al. 2016; Cruz-Sáenz et al. 2017; Gonzalez-Sánchez et al. 2017; Lazcano et al. 2019; Ramírez-Bautista et al. 2020; Torres-Hernández et al. 2021; Cruz-Elizalde et al. 2022; Barragán-Vázquez et al. 2022). Johnson (2015a) can be consulted for a statement of this position, with special reference to the subspecies concept.

System for Determining Distributional Status

The system developed by Alvarado-Díaz et al. (2013) for the herpetofauna of Michoacán was applied here to ascertain the distributional status of members of the herpetofauna of Guanajuato. Subsequently, Mata-Silva et al. (2015), Johnson et al. (2015a), Terán-Juárez et al. (2016), Woolrich-Piña et al. (2016, 2017), Nevárez-de los Reyes et al. (2016), Cruz-Sáenz et al. (2017), González-Sánchez et al. (2017), Lazcano et al. (2019), Ramírez-Bautista et al. (2020), Torres-Hernández et al. (2021), Cruz-Elizalde et al. (2022), and Barragán-Vázquez et al. (2022) utilized this system, which consists of three categories in the present paper: CE = endemic to Mexico; NE = not endemic to Mexico; and NN = non-native in Mexico.

Systems for Determining Conservation Status

To assess the conservation status of the herpetofauna of Guanajuato, this study employed the three systems (i.e., SEMARNAT, IUCN, and EVS) used by Alvarado-Díaz et al. (2013), Mata-Silva et al. (2015), Johnson et al. (2015a), Terán-Juárez et al. (2016), Woolrich-Piña et al. (2016, 2017), Nevárez-de los Reyes et al. (2016), Cruz-Sánchez et al. (2017), González-Sánchez et al. (2017), Lazcano et al. (2019), Ramírez-Bautista et al. (2020), Torres-Hernández et al. (2021), Cruz-Elizalde et al. (2022), and Barragán-Vázquez et al. (2022). Detailed descriptions of these three systems appear in the earlier papers in this series, and are not repeated here.

The Mexican Conservation Series

The Mexican Conservation Series (MCS) was initiated in 2013, with a study on the herpetofauna of Michoacán (Alvarado-Díaz et al. 2013), as part of a set of five papers designated as the "Special Mexico Issue" of *Amphibian & Reptile Conservation*. The basic format of the entries in the MCS was established in this paper, i.e., an examination of the composition, physiographic distribution, and conservation status of the herpetofauna of a given Mexican state or group of states. Two years later, the MCS was resumed with a paper on the herpetofauna of Oaxaca (Mata-Silva et al. 2015), and that year Johnson et al. (2015a) presented a paper on the herpetofauna of Chiapas. In the ensuing year, three entries in the MCS were published, on Tamaulipas (Terán-Juárez et al. 2016), Nayarit (Woolrich-Piña et al. 2016), and Nuevo León (Nevárez-de los Reyes et al. 2016). Three more entries were published the following year, on Jalisco (Cruz-Sáenz et al. 2017), the Mexican Yucatan Peninsula (González-Sánchez et al. 2017), and Puebla (Woolrich-Piña et al. 2017). These entries were followed by an article on Coahuila (Lazcano et al. 2019) and another on Hidalgo (Ramírez-Bautista et al. 2020). In the most recent two years, papers on Veracruz (Torres-Hernández et al. 2021), Querétaro (Cruz-Elizalde et al. 2022), and Tabasco (Barragán-Vázquez et al. 2022) were published. Thus, this paper on the herpetofauna of Guanajuato is the 15th entry in the MCS series.

Physiography and Climate

Physiographic Regions

The state of Guanajuato contains a diversity of landscapes, flora, and fauna, which is found within the three physiographic regions recognized here: the Sierra Madre Oriental, the Central Plateau, and the Transmexican Volcanic Belt.

Sierra Madre Oriental (SMO). The Sierra Madre Oriental is a mountain chain located in the eastern portion of Mexico, outlining the Gulf coastal region, from Chihuahua (Parras), Coahuila, San Luis Potosí, Nuevo León, Hidalgo, Veracruz, Puebla, Tlaxcala, Querétaro, and Guanajuato, to the Zongolica region in Veracruz, at elevations above 1,500 m (Morrone 2001; Chávez-Cabello et al. 2011). The SMO is characterized by the presence of a set of minor mountain ranges with folded sedimentary and marine strata (e.g., limestone, shale, and sandstone), which were formed during the Cretaceous-Jurassic periods (Oliva-Aguilar 2012). The SMO is associated with the Gulf of Mexico and it is connected with the TMB and the CP, so is considered a province of Neotropical origin given its temperate and semi-warm climates that support most of the montane cloud forests in the country, primarily in the states of Hidalgo, Puebla, and Veracruz (Morrone 2001; Rzedowski 2006; Cruz-Elizalde et al. 2022). In northeastern Guanajuato, the SMO spans elevations ranging from 1,300 to 2,600 m, within the municipalities of San Luis de La Paz, Victoria, Xichú, and Atarjea, which are embedded in the Sierra Gorda and border the states of San Luis Potosí and Querétaro (Oliva-Aguilar 2012). The SMO is characterized by a temperate climate in the southern portion of the Sierra Gorda, which supports pine and oak forests. To the north, in the municipalities of San Luis de La Paz, Xichú, and Victoria, this region is characterized by a semi-warm tropical climate and contains low tropical forest such as in Xichú, which is influenced by the Gulf of Mexico physiographic region, an area that contains the Río Santa María as one of the main tributaries (Rzedowski 2006; INEGI 2009; Cruz-José et al. 2012; Oliva- Aguilar 2012).

No. 1. *Anaxyrus compactilis* (Wiegmann, 1833). The distribution of the Plateau Toad is widely separated into three populations: (1) the northern Sierra Madre of western Chihuahua; (2) the eastern and western slopes of the Sierra Madre in southern Durango and adjacent western Zacatecas; and (3) south-central Zacatecas and the plateau of Jalisco and Aguascalientes eastward to Tlaxcala and Puebla (Frost 2022). This individual came from El Garbanzo, in the municipality of Irapuato. Wilson et al. (2013b) ascertained its EVS as 14, placing it at the lower limit of the high vulnerability category. IUCN has judged its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 2. *Anaxyrus punctatus* (Baird and Girard, 1852). The distribution of the Red-spotted Toad extends from "southeastern California through southern Nevada and southern Utah to southwestern and southeastern Colorado (excluding high elevations) and southwestern Kansas (USA), thence south to southern Baja California, Sinaloa, Aguascalientes, Jalisco, Guanajuato, San Luis Potosí, Hidalgo, and Tamaulipas (Mexico)" (Frost 2022). This individual came from El Garbanzo, in the municipality of Irapuato. Wilson et al. (2013b) calculated its EVS as 5, placing it in the lower portion of the low vulnerability category. IUCN has considered its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by María del Carmen Mendoza-Portilla.*

No. 3. *Incilius occidentalis* (Camerano, 1879). The Pine Toad is a Mexican endemic species distributed from "the mountains of northern Durango southward over much of the Mexican Plateau and the Transvolcanic Belt" (Lemos-Espinal and Dixon 2013: 39). This individual was encountered at El Copal, in the municipality of Irapuato. Wilson et al. (2013b) calculated its EVS as 11, placing it in the lower portion of the medium vulnerability category. IUCN has considered its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 4. *Craugastor augusti* (Dugès, 1879). The distribution of the Common Barking Frog extends from "Arizona to Texas in the United States, and in Mexico from Sonora to Oaxaca, and from Chihuahua, Coahuila, Nuevo León, and Tamaulipas to Puebla" (Lemos-Espinal and Dixon 2013: 42). This juvenile was found at Urirero, in the municipality of Salvatierra. Wilson et al. (2013b) calculated its EVS as 8, placing it in the upper portion of the low vulnerability category. IUCN has evaluated its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

Central Plateau (CP). The Central Plateau is located in the north-central portion of Mexico, in a region known as the Mexican Altiplano (= high plateau), which is characterized by its semi-desert environment with a Nearctic influence (Morrone 2001; Nieto-Samaniego et al. 2005). The CP includes portions of the states of Chihuahua, Coahuila, Durango, Guanajuato, Hidalgo, Jalisco, Mich-oacán, Puebla, Querétaro, San Luis Potosí, Tlaxcala, and Zacatecas (Cruz-Elizalde et al. 2022). The elevation in this region ranges from 1,700 to 4,000 m. To the south, it is delimited by the Río Balsas depression, to the east by the Sierra Madre Oriental, to the west by the Sierra Madre Occidental, and to the north this region is influenced by the arid areas of the Chihuahuan Desert. Its largest hydrological basin is the Lerma-Santiago system (CONABIO 2008; Domínguez-Domínguez and Pérez-Ponce de León 2009). This region comprises most of northern Guanajuato, and is characterized by underground aquifers and elevations above 2,000 m (e.g., the Sierra de Guanajuato). In addition, the CP is composed of wide plains interrupted by isolated volcanic mountains and small mountain ranges (INEGI 2009; Cruz-José et al. 2012), such as the Sierra Gorda with its intricate topography of volcanic origin (Olivar-Aguilar 2012). The municipalities located in the CP are the northern portions of León, Guanajuato, Juventino Rosas, Celaya, and Apaseo El Grande; the southern portions of Xichú, Victoria, and San Luis de la Paz; as well as Comonfort, Dolores Hidalgo, Doctor, Mora San Miguel de Allende, San José Iturbide, Santa Catarina, and Tierra Blanca (INEGI 2009). Geologically, this region contains the oldest rocks in the state, which are metamorphic rocks from the Triassic-Jurassic period. Importantly, the plains and valleys seen in this physiographic region today were formed during the Quaternary (INEGI 2009). To the south, the CP is delimited to by the Transmexican Volcanic Belt, and to the east by the Sierra Madre Oriental (INEGI 2009; Oliva-Aguilar 2012).

Transmexican Volcanic Belt (TMB). The Transmexican Volcanic Belt is an arc of volcanic mountain ranges (Pico de Orizaba is the highest peak, at 5,636 m asl) that extend across central-southern Mexico from Nayarit (Bahía de San Blas) and Jalisco (Bahía Banderas) eastward in the direction of Veracruz to reach the coast of the Gulf of Mexico; and this belt extends for about 1,000 km from west to east, and from 80 to 230 km from north to south (Gómez-Tuena et al. 2005; Ferrusquía-Villafranca 2007). Based on its geology and tectonics, the TMB is divided into three regions: the western portion includes the coastal area from the Gulf of California to Nayarit and Jalisco; the central portion contains the Taxco-San Miguel de Allende fault system; and the eastern portion extends in the direction of the Gulf of Mexico and has elevations ranging from 1,300 to 3,000 m (Gómez-Tuena et al. 2005).

The TMB covers approximately 45% of the state of Guanajuato (portions in the central and southern parts of the state), and is characterized by the presence of volcanic mountains, calderas, and plains formed by deposits, with El Bajío consisting of a mosaic of landscapes that include alluvial plains, steep mountain ranges, plains, hills, and lakes, including one of the highest elevations of 3,110 m asl at Cerro de Los Agustinos (Oliva-Aguilar 2012; CONABIO 2008). The TMB crosses the southern part of the state from the borders with Jalisco, Michoacán, and Querétaro; the dominant climate in this physiographic region is semi-arid, with temperatures ranging from 15 to 20 °C (INEGI 2009). One of the main tributaries is the Río Lerma, which crosses this region from south to west, in addition to other bodies of water, such as Laguna de Yuriria (Walter and Brooks 2009). The municipalities in the TMB are Huanimaro, Pénjamo, Cuerámaro, Abasolo, Pueblo Nuevo, Irapuato, Villagrán, Romita, Silao, Coroneo, Acámbaro, Jerécuaro, Tarandacuao, Santiago Maravatio, Salvatierra, Tarimoro, Apaseo El Alto, Jaral del Progreso, Valle de Santiago, and those that border the CP to the south including Apaseo El Grande, León, Celaya, Juventino Rosas, and Salamanca.

Climate

Temperature. Table 1 shows the monthly minimum, mean, and maximum temperatures for each of the three recognized physiographic regions in Guanajuato based on the data for numerous localities in each region (37 in the Central Plateau, 68 in the Transmexican Volcanic

Table 1. Monthly minimum, mean ± SD (in parentheses), maximum, and annual temperature data (in °C) for the three physiographic regions of Guanajuato, Mexico. Data were taken from the Network of Climatological Stations (CONAGUA 2021).

Physiographic region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Central Plateau (n = 37)	10.1 (12.5 ± 1.2) 15.7	11.8 (13.9 ± 1.2) 17.1	13.9 (16.3 ± 1.2) 19.4	16.3 (18.6 ± 1.2) 21.5	17.1 (20.0 ± 1.2) 22.6	16.6 (19.5 ± 1.2) 22.0	16.1 (18.4 ± 1.2) 20.8	16.5 (18.3 ± 1.2) 20.8	15.6 (17.7 ± 1.2) 20.2	13.8 (16.2 ± 1.2) 18.8	12.5 (14.5 ± 1.1) 17.2	11.3 (13.0 ± 1.1) 16.1	16.6
Transmexican Volcanic Belt (n = 68)	5.9 (14.5 ± 1.5) 17.1	6.5 (15.9 ± 1.6) 18.2	8.3 (18.1 ± 1.6) 20.7	11.2 (20.4 ± 1.5) 23.0	13.8 (22.0 ± 1.5) 24.5	14.9 (21.6 ± 1.4) 23.6	14 (20.3 ± 1.3) 22.2	13.7 (19.6 ± 1.3) 21.6	13.4 (19.6 ± 1.3) 21.6	11.2 (18.3 ± 1.4) 20.3	8.4 (16.5 ± 1.4) 18.8	6.2 (15.0 ± 1.5) 17.8	18.5
Sierra Madre Oriental (n = 3)	15.9 (16.7 ± 0.9) 17.7	17.3 (18.4 ± 1.2) 19.7	20.8 (21.7 ± 1.2) 23.1	23.2 (24.1 ± 1.3) 25.8	24.7 (25.7 ± 1.3) 27.1	24.1 (25.0 ± 1.2) 26.3	22.9 (23.8 ± 1.3) 25.2	22.7 (23.7 ± 1.5) 25.4	21.4 (22.5 ± 1.5) 24.2	19.4 (20.7 ± 1.5) 22.3	17.6 (18.9 ± 1.1) 19.8	15.6 (17.0 ± 1.5) 18.6	21.5

No. 5. *Craugastor occidentalis* (Taylor, 1941). The distribution of Taylor's Barking Frog is from "western Michoacán, Colima, and northeastern Jalisco west and north to southern Zacatecas and southern Sinaloa, Mexico" (Frost 2022). This individual was found at Área Natural Protegida Las Musas, in the municipality of Manuel Doblado. Wilson et al. (2013b) determined its EVS as 13, placing it at the upper limit of the medium vulnerability category. IUCN has assessed its conservation status as Data Deficient, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 6. *Dryophytes arenicolor* (Cope, 1866). The distribution of the Canyon Treefrog is in the mountainous and plateau areas of the USA (southern Utah and southern Colorado southward through eastern Arizona, western and northern New Mexico eastward to about Las Vegas, and the Trans-Pecos region of Texas), southward in Mexico to Michoacán, Colima, México, Guerrero, Hidalgo, and Oaxaca (Frost 2022). This individual was photographed in El Ocotero, in the municipality of Xichú. Wilson et al. (2013b) calculated its EVS as 7, placing it in the middle portion of the low vulnerability category. IUCN has evaluated its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 7. *Hypopachus variolosus* (Cope, 1866). The distribution of the Mexican Narrow-mouthed Toad is in southern Texas (USA), southern Sonora and adjacent southwestern Chihuahua (Mexico) southward in the lowlands and foothills (including the Balsas Depression of southern Mexico) to northern Costa Rica, at elevations mostly below 1,600 m, as well as on Isla Maria Madre in the Tres Marias Archipelago of Nayarit, Mexico (Frost 2022). This individual came from El Potrero within Área Natural Protegida Las Musas, in the municipality of Manuel Doblado. Wilson et al. (2013b) estimated its EVS as 4, placing it in the lower portion of the low vulnerability category. IUCN has judged its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 8. *Lithobates berlandieri* (Baird, 1859). The distribution of the Rio Grande Leopard Frog ranges from "central and western Texas and southern New Mexico (USA) through eastern Chihuahua to central Veracruz and Hidalgo, Mexico; introduced into the lower Colorado River and lower Gila River drainages of Sonora and Baja California del Norte, Mexico, and California and Arizona, USA" (Frost 2022). This individual was found in Xichú, in the municipality of the same name. Wilson et al. (2013b) calculated its EVS as 7, placing it in the middle portion of the low vulnerability category. IUCN has considered its conservation status as Least Concern, and SEMARNAT as a species of Special Protection (Pr). *Photo by Adrian Leyte-Manrique.*

Table 2. Monthly and annual precipitation data (in mm) for the physiographic regions of Guanajuato, Mexico. Data were taken from the Network of Climatological Stations (CONAGUA 2021). The shaded area indicates the months of the rainy season. The monthly values are given as minimum, mean ± SD (in parentheses), and maximum.

Physiographic region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Central Plateau (n = 37)	4.6 (14.5 ± 6.3) 42.2	2.3 (10.8 ± 3.8) 17.6	0.9 (7.1 ± 2.6) 11.5	7 (14.8 ± 4.4) 27	23.6 (37.7 ± 8.9) 55.7	37.5 (87.5 ± 26.3) 158.8	51.6 (112.5 ± 38.3) 213.2	44.9 (95.5 ± 28.9) 154.5	29.7 (80.7 ± 21.8) 127.8	11.7 (36.4 ± 10.6) 71.1	3.5 (10.3 ± 3.9) 21.2	3.7 (7.5 ± 3.3) 19.1	515.3
Transmexican Volcanic Belt (n = 68)	4 (14.2 ± 4.5) 41.3	1 (9.5 ± 3.1) 17.4	0.6 (5.7 ± 2.2) 12.9	3.6 (9.7 ± 4.3) 25.7	12.8 (29.8 ± 7.0) 46.3	61.1 (111.9 ± 13.8) 138.6	99.7 (158.2 ± 21.9) 209.2	82.2 (138.7 ± 23.0) 222.2	54.7 (107.2 ± 17.4) 159.1	17.8 (42.0 ± 9.1) 68.9	3.5 (9.9 ± 3.4) 21.5	2.2 (6.5 ± 2.2) 13.2	642.9
Sierra Madre Oriental (n = 3)	13.2 (15.2 ± 2.0) 17.2	10.7 (11.0 ± 0.4) 11.4	6.1 (7.8 ± 1.8) 9.7	23.3 (27.4 ± 3.9) 31	29.5 (39.7 ± 10.3) 50.0	74.8 (94.0 ± 17.1) 107.8	86 (115.0 ± 35.9) 155.2	92.6 (102.5 ± 10.4) 113.3	102.4 (121.6 ± 20.1) 142.5	35.2 (54.6 ± 20.8) 76.5	11.4 (15.3 ± 3.4) 17.5	7.7 (9.2 ± 2.3) 11.9	613.4

Belt, and three in the Sierra Madre Oriental). The mean annual temperature is highest in the Sierra Madre Oriental at 21.5 °C, followed by the Transmexican Volcanic Belt at 18.5 °C, and is lowest in the Central Plateau at 16.6 °C.

In the Central Plateau the minimum monthly temperatures range from 10.1 °C in January to 17.1 °C in May, and the monthly maximum temperatures vary from 15.7 °C in January to 22.0 °C in June. In the Transmexican Volcanic Belt, the minimum monthly temperatures range from 5.9 °C in January to 14.9 °C in June, and the monthly maximum temperatures from 17.1 °C in January to 24.5 °C in May. In the Sierra Madre Oriental, the minimum monthly temperatures range from 15.6 °C in December to 24.7 °C in May, and the monthly maximum temperatures from 17.7 °C in January to 27.1 °C in May.

The mean monthly temperatures in the Central Plateau range from 12.5 °C in January to 20.0 °C in May; in the Transmexican Volcan Belt these temperatures range from 14.5 °C in January to 22.0 °C in May; and in the Sierra Madre Oriental they vary from 16.7 °C in January to 25.7 °C in May.

Precipitation. The precipitation regime typically seen in tropical climates also occurs in Guanajuato. In general, this regime is divided into a six-month wet season that extends from May to October, and a dry season from November to April (Table 2).

The mean monthly precipitation is highest in July in the Central Plateau (51.6 mm) and the Transmexican Volcanic Belt (99.7 mm), and in September in the Sierra Madre Oriental (102.4 mm). Based on the mean monthly figures during the rainy season, the percentages of the annual precipitation are 76.4% in the Central Plateau, 86.0% in the Sierra Madre Oriental, and 91.4% in the Transmexican Volcanic Belt. The annual rainfall is lowest in the Central Plateau at 515.3 mm, followed by the Sierra Madre Oriental at 613.4 mm, and highest is in the Transmexican Volcanic Belt at 642.9 mm.

Composition of the Herpetofauna

Families

The species of amphibians and reptiles in Guanajuato are arranged in 25 families, including seven families of anurans, two of salamanders, 14 of squamates, and two of turtles (Table 3). No families of caecilians or crocodylians are represented in the state. The total of 25 families comprises 45.5% of the 55 families represented in Mexico (Ramírez-Bautista et al., In Press). Among the nine families of amphibians, 56.7% (17) of the 30 species (Table 4) are in the families Bufonidae (five), Hylidae (six), and Ranidae (six). Among the 16 families of reptiles, 71.6% (53) of the 74 species (Table 4) are in the families Phrynosomatidae (10), Colubridae (18), Dipsadidae (11), Natricidae (nine), and Viperidae (five).

Genera

Fifty-four herpetofaunal genera are represented in Guanajuato, including 11 genera of anurans, three of salamanders, 38 of squamates, and two of turtles (Table 3). These 54 genera constitute 25.0% of the 216 known from Mexico (Ramírez-Bautista et al., in press). Among the amphibians (Table 4), the most speciose genera are *Eleutherodactylus* (three), *Dryophytes* (three), and *Lithobates* (six). Among the reptiles (Table 4), the most speciose genera are *Sceloporus* (eight), *Plestiodon* (three), *Masticophis* (three), *Geophis* (four), *Rhadinaea* (three), *Thamnophis* (six), and *Crotalus* (five).

Species

The herpetofauna of Guanajuato consists of 101 species, including 24 anurans, three salamanders, 71 squamates, and three turtles (Table 3). Of these 101 species, 96 are native to the state and five are non-native. Currently, the numbers of native species in these groups are 255, 161, 920, and 53, respectively (Ramírez-Bautista et al.,

Table 3. Composition of the native and non-native herpetofauna of Guanajuato, Mexico.

Order	Families	Genera	Species
Anura	7	11	24
Caudata	2	3	3
Subtotal	**9**	**14**	**27**
Squamata	14	38	71
Testudines	2	2	3
Subtotal	**16**	**40**	**74**
Total	**25**	**54**	**101**

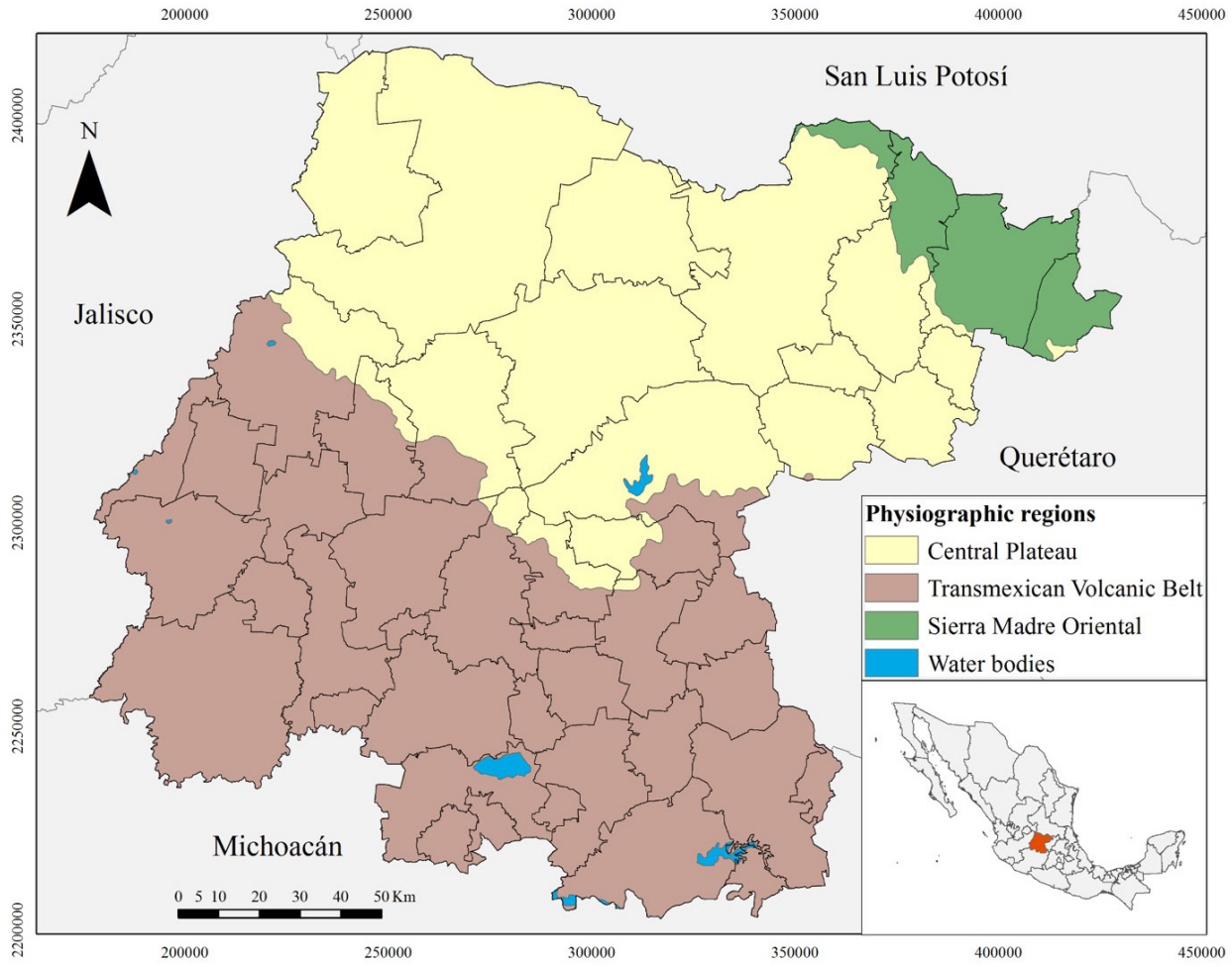


Fig. 1. Physiographic regions in the state of Guanajuato, Mexico.

In Press). The 96 native species in Guanajuato constitute 6.9% of the 1,395 native species in all of Mexico (Ramírez-Bautista et al., In Press).

Patterns of Physiographic Distribution

We recognize three physiographic regions in Guanajuato (Fig. 1), and the distribution of members of the herpetofauna among these three regions is documented in Table 4 and summarized in Table 5.

The numbers of species in the three physiographic regions range from a low of 60 in the Central Plateau (CP) to a high of 75 in the Sierra Madre Oriental (SMO). The percentages of the entire state herpetofauna in each of the three physiographic regions, in order of size, are (60/101) 59.4% (CP), (74/101) 73.3% (TVB), and (75/101) 74.3% (SMO). The mean percentage of occupancy is 69.0%.

Among the amphibians and reptiles represented in Guanajuato, the numbers of species are similar for the two larger groups found in the Transmexican Volcanic Belt (TVB) and the Sierra Madre Oriental (SMO), with 74 and 75 species, respectively. The numbers of species in the four orders in these two regions are, respectively, anurans (19 and 18), salamanders (two and three), squamates (50 and 51), and turtles (three and three).

The members of the Guanajuato herpetofauna occupy from one to three of the three physiographic regions, as follows: one (33; 32.7%); two (28; 27.7%); and three (40; 39.6%). The average regional occupancy is 2.1, indicating that each species inhabits about two-thirds of the physiographic regions in the state.

A sizable portion of the herpetofauna occupies either one or two regions (61 or 60.4% of the total of 101 species). As in most of the previous MCS studies, this situation is of considerable conservation significance, and we discuss it in detail in the section on conservation status below.

The numbers of species inhabiting a single region range from none in the Central Plateau (CP) to 22 in the Sierra Madre Oriental (SMO). The intermediate number of 10 is found in the Transmexican Volcanic Belt (TVB). The 22 single-region species in the SMO are:

Incilius nebulifer
Rhinella horribilis
*Rheohyla miotympanum**
*Aquiloeurycea cephalica**
*Abronia taeniata**

Table 4. Distribution of the amphibians, squamates, and turtles of Guanajuato, Mexico, by physiographic region. Abbreviations are as follows: CP = Central Plateau, TVB = Transmexican Volcanic Belt, and SMO = Sierra Madre Oriental. See text for descriptions of these regions. * = species endemic to Mexico and ** = non-native species.

	Physiographic region			Number of regions occupied
Taxa	**CP**	**TVB**	**SMO**	
Anura (24 species)				
Bufonidae (5 species)				
*Anaxyrus compactilis**	+	+		2
Anaxyrus punctatus	+	+	+	3
Incilius nebulifer			+	1
*Incilius occidentalis**	+	+	+	3
Rhinella horribilis			+	1
Craugastoridae (2 species)				
Craugastor augusti	+	+	+	3
*Craugastor occidentalis**		+		1
Eleutherodactylidae (3 species)				
*Eleutherodactylus angustidigitorum**		+	+	2
Eleutherodactylus guttilatus	+	+	+	3
*Eleutherodactylus verrucipes**	+		+	2
Hylidae (6 species)				
Dryophytes arenicolor	+	+	+	3
*Dryophytes eximius**	+	+	+	3
*Dryophytes plicata**		+	+	2
*Rheohyla miotympanum**			+	1
Smilisca baudinii	+		+	2
Smilisca fodiens		+		1
Microhylidae (1 species)				
Hypopachus variolosus	+	+	+	3
Ranidae (6 species)				
Lithobates berlandieri	+	+	+	3
*Lithobates catesbeianus***		+		1
*Lithobates megapoda**	+	+		2
*Lithobates montezumae**	+	+	+	3
*Lithobates neovolcanicus**	+	+		2
*Lithobates spectabilis**	+	+	+	3
Scaphiopodidae (1 species)				
Spea multiplicata	+	+	+	3
Caudata (3 species)				
Ambystomatidae (1 species)				
*Ambystoma velasci**	+	+	+	3
Plethodontidae (2 species)				
*Aquiloeurycea cephalica**			+	1
*Isthmura bellii**	+	+	+	3
Squamata (71 species)				
Anguidae (4 species)				
*Abronia taeniata**			+	1
*Barisia imbricata**	+	+	+	3
Gerrhonotus infernalis	+	+	+	3
Gerrhonotus liocephalus		+		1
Dactyloidae (2 species)				
*Norops nebulosus**	+	+		2
Norops sericeus			+	1
Gekkonidae (2 species)				
*Hemidactylus frenatus***		+		1
*Hemidactylus turcicus***		+		1
Phrynosomatidae (10 species)				
Holbrookia maculata			+	1

Table 4 (continued). Distribution of the amphibians, squamates, and turtles of Guanajuato, Mexico, by physiographic region. Abbreviations are as follows: CP = Central Plateau, TVB = Transmexican Volcanic Belt, and SMO = Sierra Madre Oriental. See text for descriptions of these regions. * = species endemic to Mexico and ** = non-native species.

	Physiographic region			Number of regions occupied
Taxa	**CP**	**TVB**	**SMO**	
*Phrynosoma orbiculare**	+	+	+	3
*Sceloporus aeneus**	+	+		2
*Sceloporus dugesii**	+	+		2
Sceloporus grammicus	+	+	+	3
*Sceloporus minor**	+		+	2
*Sceloporus scalaris**	+	+	+	3
*Sceloporus spinosus**	+	+	+	3
*Sceloporus torquatus**	+	+	+	3
Sceloporus variabilis			+	1
Scincidae (3 species)				
*Plestiodon dugesii**		+		1
*Plestiodon lynxe**		+	+	2
Plestiodon tetragrammus			+	1
Sphenomorphidae (1 species)				
*Scincella silvicola**			+	1
Teiidae (1 species)				
Aspidoscelis gularis	+	+	+	3
Xantusiidae (2 species)				
*Lepidophyma gaigeae**			+	1
*Lepidophyma occulor**			+	1
Boidae (1 species)				
Boa imperator			+	1
Colubridae (18 species)				
*Conopsis lineata**	+	+	+	3
*Conopsis nasus**	+	+	+	3
Drymarchon melanurus	+	+	+	3
*Lampropeltis mexicana**		+	+	2
*Lampropeltis polyzona**	+	+		2
*Leptophis diplotropis**	+	+		2
Masticophis flagellum		+	+	2
Masticophis mentovarius	+	+	+	3
Masticophis schotti			+	1
Oxybelis microphthalmus		+	+	2
Pantherophis emoryi			+	1
*Pituophis deppei**	+	+	+	3
*Pseudoficimia frontalis**	+	+		2
*Salvadora bairdi**	+	+	+	3
Senticolis triaspis	+	+	+	3
*Tantilla bocourti**	+	+	+	3
Tantilla rubra			+	1
Trimorphodon tau	+	+	+	3
Dipsadidae (11 species)				
Diadophis punctatus	+	+		2
*Geophis dugesii**		+		1
*Geophis latifrontalis**			+	1
*Geophis petersii**		+		1
Geophis sartorii			+	1
Hypsiglena jani	+	+	+	3
*Hypsiglena tanzeri**	+	+	+	3
Leptodeira septentrionalis			+	1
*Rhadinaea gaigeae**			+	1
*Rhadinaea hesperia**	+	+		2

Table 4 (continued). Distribution of the amphibians, squamates, and turtles of Guanajuato, Mexico, by physiographic region. Abbreviations are as follows: CP = Central Plateau, TVB = Transmexican Volcanic Belt, and SMO = Sierra Madre Oriental. See text for descriptions of these regions. * = species endemic to Mexico and ** = non-native species.

	Physiographic region			Number of regions occupied
Taxa	**CP**	**TVB**	**SMO**	
*Rhadinaea taeniata**			+	1
Elapidae (1 species)				
Micrurus tener	+	+	+	3
Natricidae (9 species)				
*Adelophis copei**		+		1
Storeria dekayi			+	1
*Storeria storerioides**	+	+	+	3
Thamnophis cyrtopsis	+	+	+	3
Thamnophis eques	+	+		2
*Thamnophis melanogaster**	+	+		2
*Thamnophis pulchrilatus**		+	+	2
*Thamnophis scalaris**	+	+	+	3
*Thamnophis scaliger**	+	+		2
Typhlopidae (1 species)				
*Virgotyphlops braminus***	+	+		2
Viperidae (5 species)				
*Crotalus aquilus**	+	+	+	3
Crotalus atrox			+	1
Crotalus molossus	+	+	+	3
*Crotalus polystictus**	+	+		2
Crotalus scutulatus	+		+	2
Testudines (3 species)				
Emydidae (1 species)				
*Trachemys scripta***		+	+	2
Kinosternidae (2 species)				
Kinosternon hirtipes	+	+	+	3
*Kinosternon integrum**	+	+	+	3
Total (101 species)	**60**	**74**	**75**	—

Norops sericeus
Holbrookia maculata
Sceloporus variabilis
Plestiodon tetragrammus
*Scincella silvicola**
*Lepidophyma gaigeae**
*Lepidophyma occulor**
Boa imperator
Masticophis schotti
Pantherophis emoryi
Tantilla rubra
*Geophis latifrontalis**
Leptodeira septentrionalis
*Rhadinaea gaigeae**
*Rhadinaea taeniata**
Storeria dekayi
Crotalus atrox

As the single asterisks indicate country endemics, 13 of the 22 SMO single-region species are non-endemics (59.1%) and nine are country endemics (40.9%).

The 10 single-region species in the TVB are:

*Craugastor occidentalis**
Smilisca fodiens
*Lithobates catesbeianus***
Gerrhonotus liocephalus
*Hemidactylus frenatus***
*Hemidactylus turcicus***
*Plestiodon dugesii**
*Geophis dugesii**
*Geophis petersii**
*Adelophis copei**

Five of the 10 single-region TVB species are country endemics (50.0%), two are non-endemics (20.0%), and the three indicated by double-asterisks are non-natives (30.0%).

In summary, of the 32 single-region species, 15 are non-endemics (46.9%), 14 are country endemics (43.8%), and three are non-natives (9.4%). Of the three physiographic regions, the SMO has considerable conservation significance (but see section on Relative Herpetofaunal Priority), inasmuch as it contains the highest numbers of species (75 of 101, or 74.3%), country endemics (37 of 56, or 66.1%), and single-region species (22 of 32, or 68.8%).

No. 9. *Lithobates neovolcanicus* (Hillis and Frost, 1985). The distribution of the Transverse Volcanic Leopard Frog is in pine-oak forest and mesquite-grassland at elevations from 1,500 to 2,500 m along the southern edge of the Mexican Plateau in the states of Guanajuato, Jalisco, Colima, Zacatecas, Michoacán, México, and Hidalgo, Mexico (Frost 2022). This individual came from San Nicolás de los Agustinos, in the municipality of Salvatierra. Wilson et al. (2013b) calculated its EVS as 13, placing it at the upper limit of the medium vulnerability category. IUCN has judged its conservation status as Near Threatened, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 10. *Spea multiplicata* (Cope, 1863). The distribution of the Mexican Spade-foot Toad is in southeastern Utah and southern Colorado through western Oklahoma, Arizona, New Mexico, and West Texas, in the USA, southward to the southern edge of the Mexican Plateau as far as Nayarit, Guerrero, Oaxaca, Hidalgo, and Tlaxcala, Mexico, at elevations from sea level to 2,743 m (Frost 2022). This individual came from La Torrecilla within Área Natural Protegida Las Musas, in the municipality of Manuel Doblado. Wilson et al. (2013b) reported its EVS as 6, placing it in the middle of the low vulnerability category. IUCN has not evaluated its conservation status, and SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 11. *Ambystoma velasci* (Dugés, 1888). The Plateau Tiger Salamander is a Mexican endemic occurring from "northwestern Chihuahua south along the eastern slope of the Sierra Madre Occidental and southern Nuevo Leon to Hidalgo in the Sierra Madre Oriental, west to Zacatecas, and south into the Transverse Volcanic range of central Mexico" (Frost 2022). This individual was photographed in pine-oak forest within the Reserva de la Biósfera Sierra Gorda in the community of El Ocotero, in the municipality of Xichú. Wilson et al. (2013b) calculated its EVS as 10, placing it at the lower limit of the medium vulnerability category. IUCN has considered its conservation status as Least Concern, and SEMARNAT as a species of Special Protection (Pr). *Photo by Adrian Leyte-Manrique.*

No. 12. *Isthmura bellii* (Gray, 1850). Bell's Salamander is a Mexican endemic occurring from "southern Tamaulipas, Tlaxcala, Hidalgo and the Sierra Madre del Sur of Guerrero, Mexico, and west and north to southern Nayarit and southern Zacatecas" (Frost 2022). This individual was found in the Sierra de los Agustinos, in the municipality of Guanajuato. Wilson et al. (2013b) established its EVS as 12, placing it in the upper portion of the medium vulnerability category. IUCN has judged its conservation status as Vulnerable, and SEMARNAT lists this species as Threatened (A). *Photo by José Carlos Arenas-Monroy.*

Table 5. Summary of the distributional occurrence of herpetofaunal families in Guanajuato, Mexico, by physiographic province. See Table 4 for an explanation of the abbreviations.

Family	Number of species	Distributional occurrence		
		CP	TVB	SMO
Bufonidae	5	3	3	4
Craugastoridae	2	1	2	1
Eleutherodactylidae	3	2	2	3
Hylidae	6	3	4	5
Microhylidae	1	1	1	1
Ranidae	6	5	6	3
Scaphiopodidae	1	1	1	1
Subtotal	**24**	**16**	**19**	**18**
Ambystomatidae	1	1	1	1
Plethodontidae	2	1	1	2
Subtotal	**3**	**2**	**2**	**3**
Total	**27**	**18**	**21**	**21**
Anguidae	4	2	3	3
Dactyloidae	2	1	1	1
Gekkonidae	2	—	2	—
Phrynosomatidae	10	8	7	8
Scincidae	3	—	2	2
Sphenomorphidae	1	—	—	1
Teiidae	1	1	1	1
Xantusiidae	2	—	—	2
Subtotal	**25**	**12**	**16**	**18**
Boidae	1	—	—	1
Colubridae	18	12	15	15
Dipsadidae	11	4	6	7
Elapidae	1	1	1	1
Natricidae	9	6	8	5
Typhlopidae	1	1	1	—
Viperidae	5	4	3	4
Subtotal	**46**	**28**	**34**	**33**
Emydidae	1	—	1	1
Kinosternidae	2	2	2	2
Subtotal	**3**	**2**	**3**	**3**
Total	**74**	**42**	**53**	**54**
Sum Total	**101**	**60**	**74**	**75**

A Coefficient of Biogeographic Resemblance (CBR) matrix was constructed using the Duellman (1990) algorithm to assess the herpetofaunal similarity relationships among the three physiographic regions in Guanajuato (Table 6). These data were then used to produce a UPGMA dendrogram (Fig. 10; Sokal and Michener 1958). The SMO harbors the greatest amount of species richness (75 species), and the CP has the least (60 species). The average species richness value for the three regions is 69.7. The lowest number of shared species (44) is between the CP and the SMO, which is interesting inasmuch as these two regions of the state abut one another. The highest number of shared species (56) is between the CP and the TVB, two regions that also contact one another.

Distribution Status Categorizations

The system employed by Alvarado-Díaz et al. (2013) and the remainder of the MCS entries (see above) was used to analyze the distributional status of members of the Guanajuato herpetofauna. The three categories that apply to the Guanajuato herpetofauna are non-endemic, country endemic, and non-native. No state endemic

Table 6. Pair-wise comparison matrix of Coefficient of Biogeographic Resemblance (CBR) data for the herpetofaunal relationships between the three physiographic regions in Guanajuato, Mexico. Underlined values = number of species in each region; upper triangular matrix values = species in common between two regions; and lower triangular matrix values = CBR values. The formula for this algorithm is CBR = $2C/N_1 + N_2$ (Duellman 1990), where C is the number of species in common to both regions, N_1 is the number of species in the first region, and N_2 is the number of species in the second region. See Fig. 10 for the UPGMA dendrogram produced from the CBR data.

	Central Plateau	Transmexican Volcanic Belt	Sierra Madre Oriental
Central Plateau	<u>60</u>	56	44
Transmexican Volcanic Belt	0.84	<u>74</u>	48
Sierra Madre Oriental	0.65	0.73	<u>75</u>

species are known to occur in Guanajuato. The basic data are given in Table 7 and summarized in Table 8.

The numbers of species in each of these three categories, in descending order of size, are as follows: country endemics, 56 (55.4%); non-endemics, 40 (39.6%); and non-natives, five (5.0%). In this fashion, the Guanajuato herpetofauna resembles those of many of the other states dealt with in the MCS, i.e., the largest number of species occupies the country endemic category, as was found in Michoacán (Alvarado-Díaz et al. 2013), Nayarit (Woolrich-Piña et al. 2016), Jalisco (Cruz Sáenz et al. 2017), Puebla (Woolrich-Piña et al. 2017), Hidalgo (Ramírez-Bautista et al. 2020), and Querétaro (Cruz-Elizalde et al. 2022). In other states, the number of non-endemic species exceeds that of the country endemic species: Oaxaca (Mata-Silva et al. 2015); Chiapas (Johnson et al. 2015a); Tamaulipas (Terán-Juárez et al. 2016); Nuevo León (Nevárez-de los Reyes et al. 2016); the Mexican Yucatan Peninsula (González-Sánchez et al. 2017), Coahuila (Lazcano et al. 2019), Veracruz (Torres-Hernández et al. 2021), and Tabasco (Barragán-Vázquez et al. 2022).

As noted above, in some instances in the MCS the number of country endemics is higher than the number of non-endemic species, whereas in other cases the reverse is true. Therefore, the ratios of country endemics to non-endemic species vary extensively. The ratios in which the number of country endemics is higher than the number of non-endemics range from 0.53 in the case of Jalisco to 0.88 in Hidalgo. The ratios in which the number of non-endemics exceeds the number of country endemics range from 1.12 in the case of Oaxaca (Mata-Silva et al. 2015) to 127.0 in the Yucatan Peninsula (González-Sánchez et al. 2017). In general, the nature of this ratio depends on how close the state in question is to either the United States or Central America. This ratio also depends upon the size of these two aspects of a given herpetofauna as to whether the ratio will be more or less than one.

Fig. 2. Water pool in low deciduous forest in the community of La Torrecilla, Manuel Doblado, Las Musas Natural Protected Area, Transmexican Volcanic Belt. *Photo by Ma. del Carmen Mendoza-Portilla.*

Fig. 3. Panoramic view of Cerro de "El Veinte." The vegetation consists of low deciduous forest, with agricultural crops in the background. Town of Cuchicuato, Irapuato, Guanajuato, in the Transmexican Volcanic Belt. *Photo by Adrian Leyte-Manrique.*

Fig. 4. Cerro de Tetillas. Low deciduous forest near Janicho, Salvatierra, south of Guanajuato. This area is an agricultural region in the Transmexican Volcanic Belt. *Photo by Adrian Leyte-Manrique.*

Fig. 5. A mountain range at Vergel de Bernalejo, in the municipality of San Luis de la Paz, Guanajuato in the Sierra Madre Oriental physiographic region. *Photo by Oscar Báez-Montes*.

Table 7. Distributional and conservation status measures for members of the herpetofauna of Guanajuato, Mexico. Distributional status: CE = endemic to country of Mexico; NE = not endemic to state or country; and NN = non-native. The numbers suffixed to the NE category signify the distributional categories developed by Wilson et al. (2017) and implemented in the taxonomic list at the Mesoamerican Herpetology website (http://mesoamericanherpetology.com), as follows: 3 (species distributed only in Mexico and the United States); 6 (species ranging from Mexico to South America); 7 (species ranging from the United States to Central America); and 8 (species ranging from the United States to South America). Environmental Vulnerability Score categories (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20). IUCN categorization: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; NE = Not Evaluated. SEMARNAT Status: A = Threatened; P = Endangered; Pr = Special Protection; and NS = No Status. See Alvarado-Díaz et al. (2013), Johnson et al. (2015a), and Mata-Silva et al. (2015) for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Species	Distributional status	Environmental Vulnerability Category (score)	IUCN categorization	SEMARNAT status
*Anaxyrus compactilis**	CE	H (14)	LC	NS
Anaxyrus punctatus	NE3	L (5)	LC	NS
Incilius nebulifer	NE3	L (6)	LC	NS
*Incilius occidentalis**	CE	M (11)	LC	NS
Rhinella horribilis	NE7	L (3)	NE	NS
Craugastor augusti	NE3	L (8)	LC	NS
*Craugastor occidentalis**	CE	M (13)	DD	NS
*Eleutherodactylus angustidigitorum**	CE	H (17)	VU	Pr
Eleutherodactylus guttilatus	NE3	M (11)	LC	NS
*Eleutherodactylus verrucipes**	CE	H (16)	VU	Pr
Dryophytes arenicolor	NE3	L (7)	LC	NS
*Dryophytes eximius**	CE	M (10)	LC	NS
*Dryophytes plicata**	CE	M (11)	LC	A
*Rheohyla miotympanum**	CE	L (9)	NT	NS
Smilisca baudinii	NE7	L (3)	LC	NS
Smilisca fodiens	NE3	L (8)	LC	NS
Hypopachus variolosus	NE7	L (4)	LC	NS
Lithobates berlandieri	NE3	L (7)	LC	Pr
Lithobates catesbeianus	NN	—	—	—
*Lithobates megapoda**	CE	H (14)	VU	Pr
*Lithobates montezumae**	CE	M (13)	LC	Pr
*Lithobates neovolcanicus**	CE	M (13)	NT	A
*Lithobates spectabilis**	CE	M (12)	LC	NS
Spea multiplicata	NE3	L (6)	LC	NS
*Ambystoma velasci**	CE	M (10)	LC	Pr
*Aquiloeurycea cephalica**	CE	H (14)	NT	A
*Isthmura bellii**	CE	M (12)	VU	A
*Abronia taeniata**	CE	H (15)	VU	Pr
*Barisia imbricata**	CE	H (14)	LC	Pr
Gerrhonotus infernalis	NE3	M (13)	LC	NS
Gerrhonotus liocephalus	NE3	L (6)	LC	Pr
*Norops nebulosus**	CE	M (13)	LC	NS
Norops sericeus	NE4	L (8)	NE	NS
*Hemidactylus frenatus***	NN	—	—	—
*Hemidactylus turcicus***	NN	—	—	—
Holbrookia maculata	NE3	M (10)	LC	NS
*Phrynosoma orbiculare**	CE	M (12)	LC	A
*Sceloporus aeneus**	CE	M (13)	LC	NS
*Sceloporus dugesii**	CE	M (13)	LC	NS
Sceloporus grammicus	NE3	L (9)	LC	Pr
*Sceloporus minor**	CE	H (14)	LC	NS
*Sceloporus scalaris**	CE	M (12)	LC	NS
*Sceloporus spinosus**	CE	M (12)	LC	NS
*Sceloporus torquatus**	CE	M (11)	LC	NS
Sceloporus variabilis	NE4	L (5)	LC	NS
*Plestiodon dugesii**	CE	H (16)	VU	Pr
*Plestiodon lynxe**	CE	M (10)	LC	Pr
Plestiodon tetragrammus	NE3	M (12)	LC	NS
*Scincella silvicola**	CE	M (12)	LC	A
Aspidoscelis gularis	NE3	L (9)	LC	NS
*Lepidophyma gaigeae**	CE	M (13)	VU	Pr
*Lepidophyma occulor**	CE	H (14)	LC	Pr
Boa imperator	NE6	M (10)	NE	NS

Table 7 (continued). Distributional and conservation status measures for members of the herpetofauna of Guanajuato, Mexico. Distributional status: CE = endemic to country of Mexico; NE = not endemic to state or country; and NN = non-native. The numbers suffixed to the NE category signify the distributional categories developed by Wilson et al. (2017) and implemented in the taxonomic list at the Mesoamerican Herpetology website (http://mesoamericanherpetology.com), as follows: 3 (species distributed only in Mexico and the United States); 6 (species ranging from Mexico to South America); 7 (species ranging from the United States to Central America); and 8 (species ranging from the United States to South America). Environmental Vulnerability Score categories (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20). IUCN categorization: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; NE = Not Evaluated. SEMARNAT Status: A = Threatened; P = Endangered; Pr = Special Protection; and NS = No Status. See Alvarado-Díaz et al. (2013), Johnson et al. (2015a), and Mata-Silva et al. (2015) for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Species	Distributional status	Environmental Vulnerability Category (score)	IUCN categorization	SEMARNAT status
*Conopsis lineata**	CE	M (13)	LC	NS
*Conopsis nasus**	CE	M (11)	LC	NS
Drymarchon melanurus	NE6	L (6)	LC	NS
*Lampropeltis mexicana**	CE	H (15)	LC	A
*Lampropeltis polyzona**	CE	M (11)	NE	NS
*Leptophis diplotropis**	CE	H (14)	LC	A
Masticophis flagellum	NE3	L (8)	LC	A
Masticophis mentovarius	NE6	L (6)	LC	A
Masticophis schotti	NE3	M (13)	LC	NS
Oxybelis microphthalmus	NE3	M (11)	NE	NS
Pantherophis emoryi	NE3	M (13)	LC	NS
*Pituophis deppei**	CE	H (14)	LC	A
*Pseudoficimia frontalis**	CE	M (13)	LC	NS
*Salvadora bairdi**	CE	H (15)	LC	Pr
Senticolis triaspis	NE7	L (6)	LC	NS
*Tantilla bocourti**	CE	L (9)	LC	NS
Tantilla rubra	NE4	L (5)	LC	Pr
*Trimorphodon tau**	CE	M (13)	LC	NS
Diadophis punctatus	NE3	L (4)	LC	NS
*Geophis dugesii**	CE	M (13)	LC	NS
*Geophis latifrontalis**	CE	H (14)	DD	Pr
*Geophis petersii**	CE	H (15)	DD	Pr
Geophis sartorii	NE4	L (9)	LC	Pr
Hypsiglena jani	NE3	L (6)	NE	NS
*Hypsiglena tanzeri**	CE	H (15)	DD	NS
Leptodeira septentrionalis	NE8	L (8)	NE	NS
*Rhadinaea gaigeae**	CE	M (12)	DD	NS
*Rhadinaea hesperia**	CE	M (10)	LC	Pr
*Rhadinaea taeniata**	CE	M (13)	LC	NS
Micrurus tener	NE3	M (11)	LC	NS
*Adelophis copei**	CE	H (15)	VU	Pr
Storeria dekayi	NE7	L (7)	LC	NS
*Storeria storerioides**	CE	M (11)	LC	NS
Thamnophis cyrtopsis	NE7	L (7)	LC	A
Thamnophis eques	NE3	L (8)	LC	A
*Thamnophis melanogaster**	CE	H (15)	EN	A
*Thamnophis pulchrilatus**	CE	H (15)	LC	NS
*Thamnophis scalaris**	CE	H (14)	LC	A
*Thamnophis scaliger**	CE	H (15)	VU	A
*Virgotyphlops braminus***	NN	—	—	—
*Crotalus aquilus**	CE	H (16)	LC	Pr
Crotalus atrox	NE3	L (9)	LC	Pr
Crotalus molossus	NE3	L (8)	LC	Pr
*Crotalus polystictus**	CE	H (16)	LC	Pr
Crotalus scutulatus	NE3	M (11)	LC	Pr
Trachemys scripta	NN	—	—	—
Kinosternon hirtipes	NE3	M (10)	LC	Pr
*Kinosternon integrum**	CE	M (11)	LC	Pr

Fig. 6. Small seasonal wetlands used to store water in the Central Plateau at San Jose del Llano, in the municipality of San Felipe, Guanajuato. *Photo by Yadira Fabiola Estrada-Sillas.*

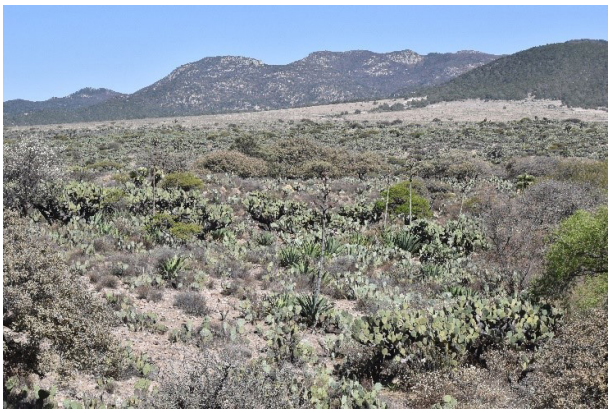


Fig. 7. Xeric scrub along the Central Plateau, in the municipality of San Felipe, Guanajuato. *Photo by Oscar Báez-Montes.*

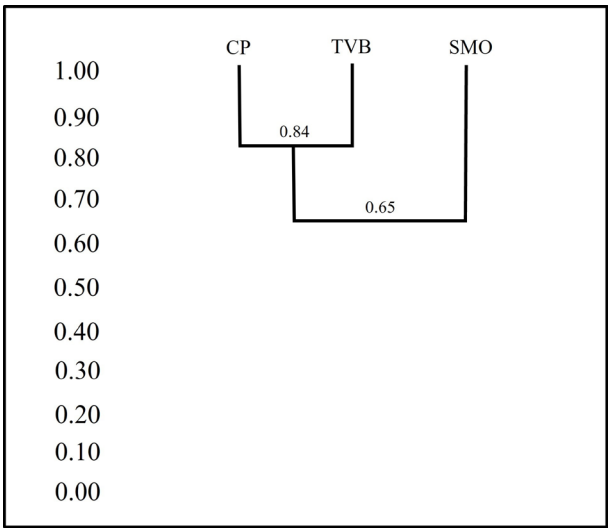
Fig. 8. An agricultural landscape with patches of native vegetation and isolated hills at Chicamito, in the municipality of Valle de Santiago, Guanajuato, Transmexican Volcanic Belt. *Photo by Oscar Báez-Montes.*

Fig. 9. A water pool and pine-oak vegetation at Charco Azul, Xichú, Guanajuato, in the Sierra Gorda-Guanajuato Biosphere Reserve, located in the Sierra Madre Oriental. *Photo by Adrian Leyte-Manrique.*

So, we would expect that the herpetofaunas of states more or less equidistant from both the USA and Central America (Guatemala and/or Belize) would have ratios closer to one. As noted in Torres-Hernández et al. (2021): "In the case of the three MCS states that border the USA, the ratios are 3.22 (100/31 in Coahuila; Lazcano et al. 2019), 2.44 (95/39 in Nuevo León; Navárez-de los Reyes et al. 2016), and 2.32 (130/56 in Tamaulipas; Terán-Juárez et al. 2016). In the case of the states or the region sharing a border with Central America, the ratios are 8.38 (268/32 in Chiapas; Johnson et al. 2015a) and 127.0 (127/1 in the Yucatan Peninsula; González-Sánchez et al. 2017). The extremely high ratio for the Yucatan Peninsula is due, at least in part, to this region lying adjacent to its southern portion lying in northern Guatemala."

The five non-native species reported as occurring in Guanajuato are *Lithobates catesbeianus*, *Hemidactylus frenatus*, *H. turcicus*, *Virgotyphlops braminus*, and *Trachemys scripta*. Two of these species (*H. frenatus* and *V. braminus*) are the most widespread of the non-native species recorded in the previous 14 MCS entries, inasmuch as they have been reported in 14 and 15 states, respectively.

Fig. 10. UPGMA generated dendrogram illustrating the similarity relationships of species richness among the herpetofaunal components in the three physiographic regions of Guanajuato (based on the data in Table 6; Sokal and Michener 1958). Similarity values were calculated using the Coefficient of Biogeographic Resemblance (CBR) of Duellman (1990).



No. 13. *Barisia imbricata* (Wiegmann, 1828). The Imbricate Alligator Lizard is a Mexican endemic inhabiting the mountains of the Transmexican Volcanic Belt and the Sierra Madre Occidental in the states of México, Distrito Federal, Querétaro, Hidalgo, Jalisco, Puebla, Michoacán, Morelos, and Tlaxcala; additional isolated populations have been recorded in Oaxaca and Veracruz (Ramírez-Bautista et al. 2014). This individual was found in Sierra del Tigre, in the municipality of Mazamitla. Wilson et al. (2013a) determined its EVS as 14, placing it at the lower limit of the high vulnerability category. IUCN has judged its conservation status as Least Concern, and SEMARNAT as a species of Special Protection (Pr). *Photo by Adrian Leyte-Manrique.*

No. 14. *Norops nebulosus* (Wiegmann, 1834). The Clouded Anole is a Mexican endemic distributed from "Sinaloa to the Isthmus of Tehuantepec on the Pacific coast, extending to the states of Morelos, Puebla, and Durango" (translation ours; Santiago-Pérez et al. 2012: 136). This individual was encountered at Cuchicuato, in the municipality of Irapuato. Wilson et al. (2013a) determined its EVS as 13, placing it at the upper limit of the medium vulnerability category. IUCN has assessed its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 15. *Sceloporus spinosus* (Wiegmann, 1828). The Eastern Spiny Lizard is a widespread endemic species found over much of central Mexico, at elevations from 1,500 to 2,300 m asl (Florez and Gerez 1994). This individual was photographed in Temascatio, in the municipality of Irapuato. Wilson et al. (2013a) ascertained its EVS as 12, placing it in the upper portion of the medium vulnerability category. IUCN has assessed its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 16. *Plestiodon lynxe* (Wiegmann, 1834). The Oak Forest Skink is a Mexican endemic distributed in southern San Luis Potosí, Guanajuato, Querétaro, Hidalgo, and the mountains of western Veracruz, with isolated populations occurring in southern Durango, southwestern Zacatecas, southeastern Nayarit, and Jalisco (Webb 1968; Ponce-Campos and Romero-Contreras 2006; Canseco-Márquez et al. 2007; Lemos-Espinal and Dixon 2013). This individual was encountered at Puente de Camotlán, in the municipality of La Yesca. Wilson et al. (2013a) determined its EVS as 10, placing it at the lower limit of the medium vulnerability category. IUCN has judged its conservation status as Least Concern, and SEMARNAT as a species of Special Protection (Pr). *Photo by Adrian Leyte-Manrique.*

Table 8. Summary of the distributional status of herpetofaunal families in Guanajuato, Mexico.

Family	Number of species	Distributional status		
		Non-endemic (NE)	Country Endemic (CE)	Non-native (NN)
Bufonidae	5	3	2	—
Craugastoridae	2	1	1	—
Eleutherodactylidae	3	1	2	—
Hylidae	6	3	3	—
Microhylidae	1	1	—	—
Ranidae	6	1	4	1
Scaphiopodidae	1	1	—	—
Subtotal	**24**	**11**	**12**	**1**
Ambystomatidae	1	—	1	—
Plethodontidae	2	—	2	—
Subtotal	**3**	**—**	**3**	**—**
Total	**27**	**11**	**15**	**—**
Anguidae	4	2	2	—
Dactyloidae	2	1	1	—
Gekkonidae	2	—	—	2
Phrynosomatidae	10	3	7	—
Scincidae	3	1	2	—
Sphenomorphidae	1	—	1	—
Teiidae	1	1	—	—
Xantusiidae	2	—	2	—
Subtotals	**25**	**8**	**15**	**2**
Boidae	1	1	—	—
Colubridae	18	8	10	—
Dipsadidae	11	4	7	—
Elapidae	1	1	—	—
Natricidae	9	3	6	—
Typhlopidae	1	—	—	1
Viperidae	5	3	2	—
Subtotals	**46**	**20**	**25**	**1**
Emydidae	1	—	—	1
Kinosternidae	2	1	1	—
Subtotal	**3**	**1**	**1**	**1**
Total	**74**	**29**	**41**	**4**
Sum Total	**101**	**40**	**56**	**5**

Wilson et al. (2017) originated a system for categorizing the distribution of the non-endemic species in the Mexican herpetofauna. The categorizations of the 40 non-endemic species in Guanajuato (Table 9) indicate that the largest number of these 40 species (26, or 65.0%) are MXUS species, i.e., those that occur in both Mexico and the United States. The next highest number (six, or 15.0%) are USCA species, i.e., species that range from the United States through Mexico to some point in Central America. The remaining eight species are MXCA species (four, or 10.0%), MXSA species (three, or 7.5%), or USSA species (one, or 2.5%).

Comparisons to the Herpetofaunas of Adjacent States

As noted above, Guanajuato is a state in central Mexico bordered by San Luis Potosí, Querétaro, Michoacán, Jalisco, and a small portion of Zacatecas. The herpetofaunas of three of these five states (Querétaro, Michoacán, and Jalisco) have been dealt with in the Mexican Conservation Series (see above). The herpetofauna of San Luis Potosí has been studied by Lemos-Espinal and Dixon (2013) and Lemos-Espinal et al. (2018). We have not dealt with the herpetofauna of Zacatecas, as the amount of the border shared between these states is very small compared to the length of the border in either state, and because this state has not been dealt with in either the MCS or the series of Lemos-Espinal et al.

In order to compare the herpetofaunas of the four neighboring states (San Luis Potosí, Querétaro, Michoacán, and Jalisco) to that of Guanajuato, a table was constructed (Table 10) that indicates the numbers of species in the various herpetofaunal groups for the five states, along with the numbers of endemic species, non-endemic species, and non-native species, as well as the respective proportions of endemic species in each state.

The numbers of herpetofaunal species per state range from a low of 101 in Guanajuato to a high of 223 in Jalisco. The numbers of non-endemic species range from a low of 40 in Guanajuato to a high of 105 in San Luis

Table 9. Summary of the distributional categories of the herpetofaunal families in Guanajuato, Mexico, that contain non-endemic species. The categorizations are as follows: MXUS = species distributed only in Mexico and the United States (except for a few perhaps found in Canada); MXCA = species found only in Mexico and Central America; MXSA = species ranging from Mexico to South America; USCA = species ranging from the United States to Central America (except for a few perhaps found in the Antilles); and USSA = species ranging from the United States to South America.

Family	Number of non-endemic species	Distributional status				
		MXUS species (3)	MXCA species (4)	MXSA species (6)	USCA species (7)	USSA species (8)
Bufonidae	3	2	—	—	1	—
Craugastoridae	1	1	—	—	—	—
Eleutherodactylidae	1	1	—	—	—	—
Hylidae	3	2	—	—	1	—
Microhylidae	1	—	—	—	1	—
Ranidae	1	1	—	—	—	—
Scaphiopodidae	1	1	—	—	—	—
Total	**11**	**8**	—	—	**3**	—
Anguidae	2	2	—	—	—	—
Dactyloidae	1	—	1	—	—	—
Phrynosomatidae	3	2	1	—	—	—
Scincidae	1	1	—	—	—	—
Teiidae	1	1	—	—	—	—
Subtotal	**8**	**6**	**2**	—	—	—
Boidae	1	—	—	1	—	—
Colubridae	8	4	1	2	1	—
Dipsadidae	4	2	1	—	—	1
Elapidae	1	1	—	—	—	—
Natricidae	3	1	—	—	2	—
Viperidae	3	3	—	—	—	—
Subtotals	**20**	**11**	**2**	**3**	**3**	**1**
Kinosternidae	1	1	—	—	—	—
Subtotal	**1**	**1**	—	—	—	—
Total	**29**	**18**	**4**	—	—	—
Sum Total	**40**	**26**	**4**	**3**	**6**	**1**

Potosí. The numbers of non-native species range from a low of three in Michoacán and Querétaro to a high of five in Guanajuato. The numbers of endemic species range from a low of 56 in Guanajuato to a high of 144 in Jalisco. Finally, the percentages of endemism range from a low of 40.1 in San Luis Potosí to a high of 66.0 in Michoacán. The average proportion of endemism in these five states is 55.8. Interestingly, the herpetofauna of Guanajuato is the smallest of those in the five states, but the percentage of endemism (55.4) is very close to that of the average for the five states (55.8).

Principal Environmental Threats

The state of Guanajuato is located in a highly commercialized region of Mexico, and this geographic entity connects the central portion of the country with the northern states. Guanajuato also encompasses an agro-industrial belt, beginning in the southern portion in Celaya, extending toward the northwest to the city of León, and toward the north to connect with the state of Aguascalientes, which represent the direction to the United States. Consequently, this area of Guanajuato also has a large number of people, constituting approximately 70% of the population. Unfortunately, because of these characteristics, significant impacts are seen on the flora and fauna of this area. Included among these organisms are the amphibians and reptiles, many of which tend to be more vulnerable to human-related activities. The effects of these factors can be noticed on the diversity and distribution of the herpetofauna across the state. For example, ongoing human activities in the last three decades have reduced significantly the original vegetation to isolated patches within a matrix

Table 10. Comparison of the numbers of endemic, non-endemic, and non-native species, and the percentage of endemism for Guanajuato, Mexico, and the states that surround it.

State	Total herpetofauna	Endemic species	% Endemism	Non-endemic species	Non-native species
Guanajuato	101	56	55.4	40	5
Jalisco	223	144	64.6	75	4
Michoacán	215	142	66.0	70	3
Querétaro	130	67	51.5	60	3
San Luis Potosí	182	73	40.1	105	4

Fig. 11. Agricultural activity takes place all over the state, but particularly in the south-central region. This image shows agroecosystems with secondary vegetation and remnants of low tropical forest in the vicinity of Urirero, Salvatierra, where seasonal crops are grown with the use of fertilizers and pesticides. *Photo by Adrian Leyte-Manrique.*

Fig. 12. This image taken in San Nicolás de los Agustinos, Municipio de Salvatierra, shows solid wastes which are a byproduct of industrial activities. A worn-out tire, empty bottles, and used cans of insecticides and fertilizers can be observed in the Lerma River in the southeastern portion of the state. *Photo by Adrian Leyte-Manrique.*

of cornfields, industrial parks, and continuous housing developments, particularly in the south-central portion of the state. However, Guanajuato is diverse with respect to all the sources that threaten its herpetofauna. Although the south-central region is presumably the most impacted, forestry and livestock activities have been intensive and continuous in the northern and northwestern portions of the state. In the southwest, however, agriculture is the most important factor, particularly the agave fields that involve considerable amounts of land that used to contain the native vegetation. Additionally, the pollution of streams, reservoirs, and the Lerma River (including its tributaries) are affecting populations of aquatic and semi-aquatic herpetofauna. Given the current situation, the herpetofauna of Guanajuato is represented by populations that are subjected to conditions impacted by five key human activities.

Agriculture. This activity takes place in approximately 70 to 80% of the state. In particular, fields are present in the south-central region, where the main crops traditionally have been corn, sorghum, and wheat, as well as legumes and other vegetables. Over the last five years, barley also has become an important crop, due to beer production by large companies such as Heineken (INEGI 2021). Traditional agricultural systems (seasonal) also are involved, but in smaller proportions, since these products are primarily produced for local consumption when compared to systems with intense irrigation. The latter systems have involved significant loss of the native vegetational cover (low tropical deciduous forest and scrub) and therefore, the loss of important shelter, feeding, and reproduction sites for amphibians and reptiles (Leyte-Manrique 2021). For instance, the distributions of frog species such as *Lithobates neovolcanicus*, *Dryophytes eximius*, and *D. arenicolor*, and the toads *Anaxyrus*

Fig. 13. Forestry activities inevitably result in the loss of vegetation cover. This image from El Varal, Guanajuato, shows patches of pine-oak forest. Trees are removed for construction and the production of charcoal. Currently, a reforestation program is being implemented at this site. *Photo by Adrian Leyte-Manrique.*

compactilis, *A. punctatus*, and *Incilius occidentalis* have decreased considerably, as indicated by fewer observations of these species in the past six years, especially in the south-central region of the state (Leyte-Manrique 2021). The pollution of reproduction sites for amphibians is associated with agricultural activity, due to the excessive use of chemicals in insecticides, herbicides, and fertilizers. Additionally, increasing ambient temperatures are reducing viable habitats (Corral et al. 2007; Guanajuato Produce 2022) due to the higher evaporation rates of seasonal ponds. With regards to reptiles, negative cultural perceptions have resulted in the indiscriminate killing of harmless species, such as the snakes *Pituophis deppei*, *Masticophis mentovarius*, and *Drymarchon melanurus*, locally known as Cencuate, Chirrionera, and Limpia Campos, respectively. Other snake species that also are affected include *Conopsis*

No. 17. *Conopsis nasus* (Günther, 1858). The Long-nosed Spotted Earthsnake ranges from the Sierra Madre Occidental of southern Chihuahua southward and eastward through much of the Mexican Plateau, occurring in the states of Chihuahua, Durango, Sinaloa, Zacatecas, Aguascalientes, San Luis Potosí, Jalisco, Michoacán, Guanajuato, Querétaro, Estado de México, Morelos, Distrito Federal, Hidalgo, and Puebla (Heimes 2016). This individual came from Guayabo de Santa Rita, in the municipality of Manuel Doblado. Wilson et al. (2013a) ascertained its EVS as 11, placing it in the lower portion of the medium vulnerability category. IUCN has assessed its conservation status as Least Concern, but SEMARNAT has not evaluated this species. *Photo by Adrian Leyte-Manrique.*

No. 18. *Drymarchon melanurus* (Duméril, Bibron, and Duméril, 1854). The Black-tailed Cribo is distributed "from south-central Texas, USA, on the Atlantic versant and from southern Sonora, Mexico, on the Pacific versant to northern Venezuela and northwestern Peru…It also occurs on the Islas Tres Marías, Nayarit, Mexico, and on the Islas de la Bahía and Isla del Tigre, Honduras" (McCranie 2011: 114). This individual was found in Área Natural Protegida Las Musas, in the municipality of Manuel Doblado. Wilson et al. (2013a) determined its EVS as 6, placing it in the middle of the low vulnerability category. IUCN has established its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Adrian Leyte-Manrique.*

No. 19. *Lampropeltis polyzona* (Cope, 1861). The Mexican Milksnake "ranges on the Pacific side from southern Sonora south to Guerrero, and across the southern part of the Mexican Plateau eastward to Veracruz and northern Oaxaca" (Heimes 2016: 89). This individual came from Janicho, in the municipality of Salvatierra. Mata-Silva et al. (2015) judged its EVS as 11, placing it in the lower portion of the medium vulnerability category. IUCN and SEMARNAT have not evaluated this species. *Photo by Adrian Leyte-Manrique.*

Fig. 20. *Masticophis mentovarius* (Duméril, Bibron, and Duméril, 1854). The Neotropical Whipsnake is distributed on the Pacific versant from Sonora and on the Atlantic versant from Tamaulipas south to Colombia and Venezuela. Its vertical distribution extends from near sea level to around 2,100 m (Johnson 1977, 1982 cited in Heimes 2016). This individual came from El Copal, in the municipality of Irapuato. Wilson et al. (2013a) ascertained its EVS as 6, placing it in the middle portion of the low vulnerability category. IUCN has not evaluated its conservation status, but SEMARNAT has assessed it as Threatened (A). *Photo by Adrian Leyte-Manrique.*

Fig. 14. Cows feeding in the vicinity of El Garbanzo, Irapuato, Guanajuato. Livestock production is common in the southeastern, south-central, and western portions of the state toward the Sierra Gorda. Cows can trample tadpoles (e.g., of *Anaxyrus compactilis*) living in the pools formed in these areas, consequently increasing the mortality rate of this amphibian developmental stage. (a) Cows feeding on grass, (b) an individual of *A. compactilis. Photo by Adrian Leyte-Manrique.*

lineata, *C. nasus*, *Trimorphodon tau*, and *Lampropeltis polyzona*, with the last species usually being mistaken for the venomous coralsnake *Micrurus tener*. With respect to turtles, the pollution of bodies of water, uncontrolled collection of individuals, and the presence of highly traveled roads contribute to the continuous decimation of local populations of *Kinosternon* (Leyte-Manrique 2021b).

Industrial activity. At the national level, Guanajuato is well known for its industrial sector. This includes vehicle assembly and the production of vehicle parts by companies such as Honda in the south (municipality of Celaya), Mazda in Silao, Toyota in Apaseo El Alto, and Volkswagen near the capital in the Celaya-León belt. Another large-scale activity is the production of agro-industrial chemicals, such as fertilizers, insecticides, and herbicides, particularly in the south-central region of the state. Likewise, the textile and fur industries are major activities taking place in the northwestern portion, in the municipality of León. Not surprisingly, all of these large-scale activities contribute significantly to the pollution of water bodies. Guanajuato contains 29 reservoirs that are important for fish farming and agriculture (Walter and Brooks 2009). One of the most important water sources is Laguna Yuriria, a natural protected area considered as a RAMSAR site due to its high bird diversity and abundance of amphibians and reptiles, such as *Lithobates montezumae* (POEGG 2005). All of the waste generated by these industrial businesses is discarded in these water sources in liquid and solid forms in both dams and rivers, particularly the Río Lerma, which transects the southeastern and northwestern regions of the state and runs through the industrial belt and the most populated region of the state. The flora and fauna present in reservoirs such as La Purísima have been affected significantly by the vehicle-related industries, but also by intense water extraction to satisfy the needs of nearby cities such as Guanajuato and Irapuato. Furthermore, nearby farming activities and recreational events, such as nautical regattas, also have an impact on these sites. All of these processes affect amphibians more directly, since species such as *Lithobates montezumae*, *L. megapoda*, and *L. neovolcanicus*, require water for accomplishing their reproductive cycles and their presence in La Purísima appears to be less evident (Leyte-Manrique et al. 2015). Conversely, it is encouraging to have a natural protected area such as Cuenca La Esperanza that provides protection to the herpetofauna present in the central portion of the state where reptiles, particularly snakes, seem to be more abundant (Instituto de Ecología del Estado de Guanajuato 1998).

Forestry. The exploitation of forests is regulated in the north, and this activity also takes place inside natural protected areas such as Cuenca La Esperanza, Sierra de Lobos, Sierra de los Agustinos, Sierra de Pénjamo, and Reserva de la Biosfera Sierra Gorda-Guanajuato (Ortiz-Mantilla et al. 2022). The exploitation of trees such as conifers and oaks is important in the state (INANPEG 2020). Although the extraction of lumber is regulated in the cold forests of the state, this is not the case for unprotected areas with low tropical deciduous forest. The latter forests experience illegal exploitation associated with the production of wood and charcoal, and the removal of vegetation for increasing housing development, as well as livestock and agricultural activities. For instance, the natural protected area Cerro de Arandas, in the municipality of Irapuato, has a low diversity of amphibians and reptiles likely due to the loss of native vegetation, even though this area has a management program. The herpetofauna of this area is forced to adapt

Fig. 15. Mining activity in Guanajuato takes place primarily in two areas, the city of Guanajuato and the Sierra Gorda (Reserva de la Biosfera Sierra Gorda-Guanajuato) in the municipality of Xichú. In general, the productivity in the city of Guanajuato is low, and only remnants of minerals were being extracted by 2013 in the Sierra Gorda. The pollution resulting from this activity, however, is evident in the air, soil, and water. (a) the mining area in the east, (b) an individual of *Lithobates berlandieri* found dead in a stream within the mining area, and tadpoles in a pool. *Photo by Adrian Leyte-Manrique.*

to the surrounding agroecosystems, especially during the dry season. Amphibians such as *Dryophytes arenicolor* and *D. eximius*, the snakes *Conopsis nasus*, *Masticophis mentovarius*, and *Senticolis triaspis*, and the turtle *K. integrum* have been recorded in agricultural areas near the city of Irapuato (Leyte-Manrique et al. 2021).

Livestock. This activity is more common in the northwestern and southwestern parts of the state, such as in the Sierra Gorda and the municipality of Manuel Doblado, where production is mostly at the regional and state levels. Observations indicate that the most visible impact of this activity is on populations of frogs and toads that use seasonal water sources for reproduction. At these sites, horses and cows can step on the eggs and tadpoles of these amphibians, and the toads *Anaxyrus compactilis* and *Spea multiplicata* are the species most commonly affected (Leyte-Manrique 2018). The same situation is expected to exist in other parts of the state that remain unstudied.

Mining. This activity is of great significance in the municipalities of Guanajuato and Xichú, in the northern portion of the state. One consequence of mining is the loss of native arboreal vegetation. Additionally, a high concentration of residues, such as lead and silver, eventually reach streams and ponds and affect a variety of aquatic organisms, including fish, amphibians, and freshwater turtles. Although the actual effect of this process on amphibians has not been examined, we assume that it is impacting the health and survival of the eggs and larval stages (Leyte-Manrique and Dominguez-Laso 2014; A. Leyte-Manrique, pers. obs.). Additionally, it is noteworthy that the impacts of mining on the populations of salamanders have been poorly studied, as we are aware of few salamander records from regions that are well known for their mining activity, such as Guanajuato and Xichú. Species such as *Isthmura bellii*, *Aquiloeurycea cephalica*, and *Ambystoma velasci* have been reported from these areas. Regarding *A. velasci*, there is information on its ecology and reproduction in Xichú, and it was determined that one of the main factors affecting its survival is the pollution of their aquatic

habitats by phosphates and other chemicals used in agriculture. Additionally, these organisms are unlawfully collected and sold on the black market (Leyte-Manrique et al. 2016; De la Cruz-Beltrán et al. 2018).

Conservation Status

This study employed the three systems of conservation assessment that were used in all the entries in the Mexican Conservation series (see above), i.e., the systems of SEMARNAT (2010), the IUCN Red List (http://www.iucnredlist.org), and the EVS (Wilson et al. 2013a, b). The assessments from these three systems were updated as necessary.

The SEMARNAT System

Torres-Hernández et al. (2021: 117) stated that "the SEMARNAT system for assessing conservation status was developed and implemented by the Secretaría del Medio Ambiente y Recursos Naturales of the federal government of Mexico (SEMARNAT 2010)," and the status ratings for the native herpetofaunal species in Guanajuato are provided in Table 7 and summarized in Table 11. Three categories of assessment are established in the SEMARNAT system, including Endangered (P), Threatened (A), and Under Special Protection (Pr); and those species that are not assessed are allocated to a "No Status" (NS) category (Tables 7 and 11).

As in previous MCS entries, one frequently asked question is why so few species in any given state herpetofauna have been assessed using this system. Perhaps the personnel at SEMARNAT favor listing species endemic to Mexico and not those that also are shared with either the USA or countries in Central America (i.e., the non-endemics). If so, then it might be possible to ascertain an answer to this question by comparing the SEMARNAT assignments in the endemic and non-endemic categories. In an effort to determine whether such a bias might exist, these comparisons are shown in Table 12. The data in Table 12 demonstrate that of the 96 total native species in Guanajuato, only 44 species (45.8%) have been assessed to date, with 16 placed in the Threatened (A) category and 28 in the

Table 11. SEMARNAT categorizations for herpetofaunal species in Guanajuato, Mexico, arranged by families. Non-native species are excluded.

Family	Number of species	SEMARNAT categorization			
		Endangered (P)	Threatened (A)	Special protection (Pr)	No status (NS)
Bufonidae	5	—	—	—	5
Craugastoridae	2	—	—	—	2
Eleutherodactylidae	3	—	—	2	1
Hylidae	6	—	1	—	5
Microhylidae	1	—	—	—	1
Ranidae	5	—	1	3	1
Scaphiopodidae	1	—	—	—	1
Subtotal	**23**	**—**	**2**	**5**	**16**
Ambystomatidae	1	—	—	1	—
Plethodontidae	2	—	2	—	—
Subtotal	**3**	**—**	**2**	**1**	**—**
Total	**26**	**—**	**4**	**6**	**16**
Anguidae	4	—	—	3	1
Dactyloidae	2	—	—	—	2
Phrynosomatidae	10	—	1	1	8
Scincidae	3	—	—	2	1
Sphenomorphidae	1	—	1	—	—
Teiidae	1	—	—	—	1
Xantusiidae	2	—	—	2	—
Subtotal	**23**	**—**	**2**	**8**	**13**
Boidae	1	—	—	—	1
Colubridae	18	—	5	2	11
Dipsadidae	11	—	—	4	7
Elapidae	1	—	—	—	1
Natricidae	9	—	5	1	3
Viperidae	5	—	—	5	—
Subtotal	**45**	**—**	**10**	**12**	**23**
Kinosternidae	2	—	—	2	—
Subtotal	**2**			**2**	**—**
Total	**70**	**—**	**12**	**22**	**36**
Sum total	**96**	**—**	**16**	**28**	**52**

No. 21. *Pituophis deppei* (Duméril, 1853). The Mexican Bullsnake occurs in the states of Aguascalientes, Chihuahua, Coahuila, Durango, Guanajuato, Hidalgo, Jalisco, México, Michoacán, Nuevo León, Oaxaca, Puebla, San Luis Potosí, Querétaro, Tlaxcala, Veracruz, Zacatecas, and Ciudad de México (Ramírez-Bautista et al. 2014). This individual was encountered in the municipality of Mineral El Chico. Wilson et al. (2013a) calculated its EVS as 14, placing it at the lower limit of the high vulnerability category. IUCN has determined its conservation status as Least Concern, and SEMARNAT as Threatened (A). *Photo by Adrian Leyte-Manrique.*

No. 22. *Salvadora bairdi* (Jan, 1860). Baird's Patch-nosed Snake occurs throughout much of the Sierra Madre Occidental and the Mexican Plateau, ranging from southwestern Chihuahua and adjacent eastern Sonora to the Transverse Volcanic Cordillera as far south as southeastern Puebla (Valle de Tehuacán) and northwestern Oaxaca (Heimes 2016). This individual came from Campamento las Palomas, in the municipality of Guanajuato. Wilson et al. (2013a) estimated its EVS as 15, placing it in the lower portion of the high vulnerability category. IUCN has assessed its conservation status as Least Concern, and SEMARNAT as a species of Special Protection (Pr). *Photo by Adrian Leyte-Manrique.*

No. 23. *Trimorphodon tau* (Cope, 1869). The Mexican Lyre Snake is widely distributed along the coastal slopes and foothills of the Sierra Madre Oriental, the Sierra Madre Occidental, and the Sierra Madre del Sur, and across the Mexican Plateau and the Mesa de Oaxaca (Heimes 2016). This individual was photographed in the vicinity of Aldama, in the municipality of Guanajuato. Wilson et al. (2013a) determined its EVS as 13, placing it at the upper limit of the medium vulnerability category. IUCN evaluated its conservation status as Least Concern, but SEMARNAT has not listed this species. *Photo by Samuel Cadena-Rico.*

No. 24. *Thamnophis melanogaster* (Peters, 1864). The Black-bellied Gartersnake is a Mexican endemic occurring from "southwestern Chihuahua and adjacent Sonora south-southeastward to the Valley of Mexico, western Querétaro, and southern San Luis Potosí" (Lemos-Espinal and Dixon 2013). This individual came from San Nicolás de los Agustinos, in the municipality of Salvatierra. Wilson et al. (2013a) calculated its EVS as 15, placing it in the lower portion of the high vulnerability category. IUCN has evaluated its conservation status as Endangered, and SEMARNAT as Threatened (A). *Photo by Adrian Leyte-Manrique.*

Table 12. Comparison of SEMARNAT and distributional categorizations for the Guanajuato herpetofauna. Non-native species are excluded.

Distributional category	SEMARNAT category			
	Threatened (A)	Special Protection (Pr)	No Status (NS)	**Total**
Non-endemic species (NE)	4	9	27	**40**
Country-endemic species (CE)	12	19	25	**56**
Total	**16**	**28**	**52**	**96**

Special Protection (Pr) category. No species are placed in the Endangered (P) category. The data indicate that of the 16 species allocated to the Threatened (A) category, four (25.0%) are non-endemic species and 12 (75.0%) are country endemics (Table 12). Of the 28 species placed in the Special Protection (Pr) category, nine (32.1%) are non-endemics and 19 (67.9%) are country endemics. Apparently, some favor has been given to the assessment of country endemic species. Conversely, however, since 52 (54.2%) of the 96 species that could be allocated using the SEMARNAT categories have not been assessed, the conservation assessment of the Guanajuato herpetofauna using this system is seriously deficient and of little value in our effort to determine the conservation status of the herpetofauna of this state.

The IUCN System

The IUCN system of conservation assessment is applied primarily to vertebrate animals and flowering plants, leaving the conservation status of the major swath of organisms, including prokaryotes, algae, fungi, and invertebrates largely unassessed. This system has been applied to amphibians and reptiles to some degree, and it

Table 13. IUCN Red List categorizations for herpetofaunal families in Guanajuato, Mexico. Non-native species are excluded. The shaded columns to the left are the "threat categories," and those to the right the categories for which too little information on conservation status exists to allow the taxa to be placed in any other IUCN category, or they have not been evaluated.

Family	Number of species	IUCN Red List categorization						
		Critically Endangered	Endangered	Vulnerable	Near Threatened	Least Concern	Data Deficient	Not Evaluated
Bufonidae	5	—	—	—	—	4	—	1
Craugastoridae	2	—	—	—	—	1	1	—
Eleutherodactylidae	3	—	—	2	—	1	—	—
Hylidae	6	—	—	—	1	5	—	—
Microhylidae	1	—	—	—	—	1	—	—
Ranidae	5	—	—	1	1	3	—	—
Scaphiopodidae	1	—	—	—	—	1	—	—
Subtotal	**23**	—	—	**3**	**2**	**16**	1	**1**
Ambystomatidae	1	—	—	—	—	1	—	—
Plethodontidae	2	—	—	1	1	—	—	—
Subtotal	**3**	—	—	**1**	**1**	**1**	—	—
Total	**26**	—	—	**4**	**3**	**17**	1	**1**
Anguidae	4	—	—	1	—	3	—	—
Dactyloidae	2	—	—	—	—	1	—	1
Phrynosomatidae	10	—	—	—	—	10	—	—
Scincidae	3	—	—	1	—	2	—	—
Sphenomorphidae	1	—	—	—	—	1	—	—
Teiidae	1	—	—	—	—	1	—	—
Xantusiidae	2	—	—	1	—	1	—	—
Subtotal	**23**	—	—	**3**	—	**19**	—	**1**
Boidae	1	—	—	—	—	—	—	1
Colubridae	18	—	—	—	—	16	—	2
Dipsadidae	11	—	—	—	—	5	4	2
Elapidae	1	—	—	—	—	1	—	—
Natricidae	9	—	1	2	—	6	—	—
Viperidae	5	—	—	—	—	5	—	—
Subtotal	**45**	—	**1**	**2**	—	**33**	**4**	**5**
Kinosternidae	2	—	—	—	—	2	—	—
Subtotal	**2**	—	—	—	—	**2**	—	—
Total	**70**	—	**1**	**5**	—	**54**	**4**	**6**
Sum total	**96**	—	**1**	**9**	**3**	**71**	**5**	**7**
Category total	**96**	**10**			**74**		**12**	

Table 14. Environmental Vulnerability Scores (EVS) for the herpetofaunal species in Guanajuato, Mexico, arranged by family. The shaded area on the left encompasses low vulnerability scores, and the one on the right indicates the high vulnerability scores. Non-native species are excluded.

Family	Number of species	Environmental Vulnerability Score (EVS)														
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Bufonidae	5	1		1	1					1			1			
Craugastoridae	2						1					1				
Eleutherodactylidae	3									1					1	1
Hylidae	6	1				1	1	1	1	1						
Microhylidae	1		1													
Ranidae	5					1					1	2	1			
Scaphiopodidae	1				1											
Subtotal	**23**	**2**	**1**	**1**	**2**	**2**	**2**	**1**	**1**	**3**	**1**	**3**	**2**		**1**	1
Ambystomatidae	1								1							
Plethodontidae	2										1		1			
Subtotal	**3**								**1**		**1**		**1**			
Total	**26**	**2**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**2**	**3**	**3**		**1**	**1**
Anguidae	4				1							1	1	1		
Dactyloidae	2						1					1				
Phrynosomatidae	10			1				1	1	1	3	2	1			
Scincidae	3								1		1				1	
Sphenomorphidae	1										1					
Teiidae	1							1								
Xantusiidae	2											1	1			
Subtotal	**23**			**1**	**1**		**1**	**2**	**2**	**1**	**5**	**5**	**3**	**1**	**1**	
Boidae	1								1							
Colubridae	18			1	3		1	1		3		5	2	2		
Dipsadidae	11		1		1		1	1	1		1	2	1	2		
Elapidae	1									1						
Natricidae	9					2	1			1			1	4		
Viperidae	5						1	1		1					2	
Subtotal	**45**		**1**	**1**	**4**	**2**	**4**	**3**	**2**	**6**	**1**	**7**	**4**	**8**	**2**	
Kinosternidae	2								1	1						
Subtotal	**2**								**1**	**1**						
Total	**70**		**1**	**2**	**5**	**2**	**5**	**5**	**5**	**8**	**6**	**12**	**7**	**9**	**3**	
Sum total	**96**	**2**	**2**	**3**	**7**	**4**	**7**	**6**	**7**	**11**	**8**	**15**	**10**	**9**	**4**	**1**
Category total	**96**	**31**							**41**				**24**			

Table 15. Comparison of Environmental Vulnerability Scores (EVS) and IUCN categorizations for the members of the herpetofauna of Guanajuato, Mexico. Non-native species are excluded. The shaded area at the top encompasses the low vulnerability category scores, and the shaded area at the bottom indicates the high vulnerability category scores.

EVS	IUCN category							Total
	Critically Endangered	Endangered	Vulnerable	Near Threatened	Least Concern	Data Deficient	Not Evaluated	
3	—	—	—	—	1	—	1	2
4	—	—	—	—	2	—	—	2
5	—	—	—	—	3	—	—	3
6	—	—	—	—	6	—	1	7
7	—	—	—	—	4	—	—	4
8	—	—	—	—	5	—	2	7
9	—	—	—	1	5	—	—	6
10	—	—	—	—	6	—	1	7
11	—	—	—	—	9	—	2	11
12	—	—	1	—	6	1	—	8
13	—	—	1	1	12	1	—	15
14	—	—	1	1	7	1	—	10
15	—	1	3	—	3	2	—	9
16	—	—	2	—	2	—	—	4
17	—	—	1	—	—	—	—	1
Total	—	**1**	**9**	**3**	**71**	**5**	**7**	**96**

No. 25. *Crotalus aquilus* (Klauber, 1952). The Dusky Rattlesnake is found "from the region of Lake Chapala, Jalisco, eastward through Michoacán, Guanajuato, Querétaro, central San Luis Potosí, and southeastward through northern Hidalgo and northwestern Veracruz" (Lemos-Espinal and Dixon 2013: 249). This individual was encountered in Cuenca Baja del Río Temascatio, in the municipality of Irapuato. Wilson et al. (2013a) ascertained its EVS as 16, placing it in the middle portion of the high vulnerability category. IUCN has assessed this species as Least Concern, and SEMARNAT as in the Special Protection (Pr) category. *Photo by Mará Fernanda Rodríguez-Gutiérrez.*

No. 26. *Crotalus molossus* (Baird and Girard, 1853). The Black-tailed Rattlesnake occurs from northwestern Arizona and southwestern New Mexico on the west, southward along the Pacific Coastal Plain, Sierra Madre Occidental, and Mexican Plateau to Michoacán, and from Coahuila and Nuevo León on the east, southward along the Sierra Madre Oriental and Mexican Plateau to northwestern Oaxaca (Anderson and Greenbaum 2012). This individual came from El Garbanzo, in the municipality of Irapuato. Wilson et al. (2013a) calculated its EVS as 8, placing it in the upper portion of the low vulnerability category. IUCN has determined its conservation status as Least Concern, and SEMARNAT as a species of Special Protection (Pr). *Photo by Adrian Leyte-Manrique.*

consists of six categories (Table 13), including three so-called "threat categories" of Critically Endangered (CR), Endangered (EN), and Vulnerable (VU). Two categories of so-called "lesser risk," i.e., Near Threatened (NT) and Least Concern (LC), also are involved. A sixth category, called Data Deficient (DD) is established, and it is assigned to species which lack sufficient information for placement into another category. Finally, another category of Not Evaluated (NE) is used here for species that the IUCN has not evaluated thus far. Two other categories exist for species thought to be either Extinct (EX) or Extinct in the Wild (EW), but these are seldom applicable to herpetofaunal species.

The data for allocating the species that comprise the Guanajuato herpetofauna are shown in Table 7 and summarized in Table 13. The data in Table 13 demonstrate that only 10 species are allocated to two of the three "threat categories." A single species (*Thamnophis melanogaster**) is placed in the Endangered (EN) category, and nine species are in the Vulnerable (VU) category (*Eleutherodactylus angustidigitorum**, *E. verrucipes**, *Lithobates megapoda**, *Isthmura bellii**, *Abronia taeniata**, *Plestiodon dugesii**, *Lepidophyma gaigeae**, *Adelophis copei**, and *Thamnophis scaliger**). These 10 species are all country endemics. No species are allocated to the Critically Endangered (CR) category. Of the 74 species placed in the "lesser risk" categories, three country endemics (*Rheohyla miotympanum**, *Lithobates neovolcanicus**, and *Aquiloeurycea cephalica**) are considered as Near Threatened (NT), and 71 species are classified as Least Concern (LC). The five Data Deficient (DD) species are *Craugastor occidentalis**, *Geophis*

No. 27. *Kinosternon integrum* (Le Conte, 1854). The Mexican Mud Turtle is endemic to Mexico, and it is distributed from central Sonora to Oaxaca, as well as from southwestern Tamaulipas and the central and southern portions of the Mexican Plateau (Lemos-Espinal and Dixon 2013). This individual was found at Presa La Galera, in the municipality of Abasolo. Wilson et al. (2013a) determined its EVS as 11, placing it in the lower portion of the medium vulnerability category. IUCN has assessed its conservation status as Least Concern, and SEMARNAT has placed it in the Special Protection (Pr) category. *Photo by Adrian Leyte-Manrique.*

*latifrontalis**, *G. petersii**, *Hypsiglena tanzeri**, and *Rhadinaea gaigeae**. As with the EN and VU species, all of these five species are country endemics.

Seven species have not been evaluated by the IUCN, as follows: *Rhinella horribilis*, *Norops sericeus*, *Boa imperator*, *Lampropeltis polyzona**, *Oxybelis microphthalmus*, *Hypsiglena jani*, and *Leptodeira*

Table 16. Environmental Vulnerability Scores (EVS) for members of the herpetofauna of Guanajuato, Mexico, that are allocated to the IUCN Data Deficient category. * = country endemic.

Taxon	Environmental Vulnerability Score (EVS)			
	Geographic distribution	Ecological distribution	Reproductive mode/Degree of persecution	Total score
*Craugastor occidentalis**	5	4	4	13
*Geophis latifrontalis**	5	7	2	14
*Geophis petersii**	5	8	2	15
*Hypsiglena tanzeri**	5	8	2	15
*Rhadinaea gaigeae**	5	5	2	12

septentrionalis. Only one of these seven species is a country endemic, and the others are relatively widespread non-endemic species (two are NE3 species, and one each are NE4, NE6, NE7, and NE8 species).

The 71 species allocated to the LC category comprise 74.0% of the 96 native species in Guanajuato. Thirty-seven of these 71 species (52.1%) are country endemics and the remaining 34 (47.9%) are non-endemics. Given that almost three-quarters of the herpetofauna has been judged as Least Concern by using the IUCN system of conservation assessment, it might seem that the herpetofauna of Guanajuato is in reasonably good shape from a conservation perspective. However, since such a status has not been the case in the other MCS studies, this assumption is subjected to further analysis using the EVS system.

The EVS System

Initially, the Environmental Vulnerability Score (EVS) system of conservation assessment was developed to examine the herpetofauna of Honduras (Wilson and McCranie 2003), inasmuch as the population status of species in this herpetofauna was not sufficiently understood for assessment using the IUCN system. Since that time, the EVS has been applied to all of the Mexican and Central American herpetofaunas (Wilson et al. 2013a,b; Johnson et al. 2015a), as well as all 14 of the previously-published Mexican Conservation Series (MCS) studies (see above). In addition, this system is becoming increasingly applied in studies by other workers on the Mexican herpetofauna, especially by J. Lemos-Espinal and his co-authors.

In this study, we calculated the EVS values for the 96 native species of the Guanajuato herpetofauna, and they are shown in Table 7 and summarized in Table 14. The EVS values range from 3 to 17, three fewer than the total theoretical range of values (3–20). The most frequent values (i.e., those associated with 10 or more species) are 11 (11 species), 13 (15), and 14 (10). Note that these three values apply to 36 of the 96 native species in Guanajuato. The lowest score of 3 was determined only for two anuran species (*Rhinella horribilis* and *Smilisca baudinii*). The highest value of 17 was applied to only a single anuran species (*Eleutherodactylus angustidigitorum**).

As with all the previous MCS studies, the EVS values were grouped into the categories of low (3–9), medium (10–13), and high (14–17) vulnerability. Based on this categorization, the resulting figures increase from low vulnerability (31 species) through medium (41), and then decrease to high vulnerability (24). In both of these states, the native herpetofaunas consist essentially of non-endemic and country endemic species, with the exception being that Querétaro harbors a single state endemic, i.e., *Sceloporus exsul*. In the Querétaro herpetofauna, there are 60 non-endemics and 67 country endemics, while the respective figures in Guanajuato are 40 and 56.

In an effort to assess how the IUCN ratings relate to those for the EVS, the categorizations of these two systems are compared in Table 15. Only 10 of the 24 high vulnerability species (41.7%) are allocated to the IUCN "threat categories." At the other extreme, 31 of the low vulnerability species (by EVS) account for only 43.7% of the 71 LC species (by IUCN). Thus, as generally seen in the other MCS studies, there is little correspondence between the conservation evaluations provided by the IUCN and the EVS categorizations.

Table 17. Environmental Vulnerability Scores (EVS) for members of the herpetofauna of Guanajuato, Mexico, that are currently Not Evaluated (NE) by the IUCN. Non-native taxa are excluded. * = country endemic.

Taxon	Environmental Vulnerability Score (EVS)			
	Geographic distribution	Ecological distribution	Reproductive mode/Degree of persecution	Total score
Rhinella horribilis	1	1	1	3
Norops sericeus	2	3	3	8
Boa imperator	3	1	6	10
*Lampropeltis polyzona**	1	3	5	9
Oxybelis microphthalmus	2	6	3	11
Hypsiglena jani	1	3	2	6
Leptodeira septentrionalis	2	2	4	8

Table 18. Environmental Vulnerability Scores (EVS) for members of the herpetofauna of Guanajuato, Mexico, that are assigned to the IUCN Least Concern (LC) category. Non-native taxa are excluded. * = country endemic.

Taxon	Environmental Vulnerability Score (EVS)			
	Geographic distribution	Ecological distribution	Reproductive mode/Degree of persecution	Total score
*Anaxyrus compactilis**	5	8	1	14
Anaxyrus punctatus	1	3	1	5
Incilius nebulifer	1	4	1	6
*Incilius occidentalis**	5	5	1	11
Craugastor augusti	2	2	4	8
Eleutherodactylus guttilatus	2	5	4	11
Dryophytes arenicolor	2	4	1	7
*Dryophytes eximius**	5	4	1	10
*Dryophytes plicata**	5	5	1	11
Smilisca baudinii	1	1	1	3
Smilisca fodiens	2	5	1	8
Hypopachus variolosus	2	1	1	4
Lithobates berlandieri	4	2	1	7
*Lithobates montezumae**	5	7	1	13
*Lithobates spectabilis**	5	6	1	13
Spea multiplicata	1	4	1	6
*Ambystoma velasci**	5	4	1	10
*Barisia imbricata**	5	6	3	14
Gerrhonotus infernalis	5	5	3	13
Gerrhonotus liocephalus	2	1	3	6
*Norops nebulosus**	5	5	3	13
Holbrookia maculata	1	6	3	10
*Phrynosoma orbiculare**	5	4	3	12
*Sceloporus aeneus**	5	5	3	13
*Sceloporus dugesii**	5	5	3	13
Sceloporus grammicus	2	4	3	9
*Sceloporus minor**	5	6	3	14
*Sceloporus scalaris**	5	4	3	12
Sceloporus serrifer	2	1	3	6
*Sceloporus spinosus**	5	4	3	12
*Sceloporus torquatus**	5	3	3	11
Sceloporus variabilis	1	1	3	5
*Plestiodon lynxe**	5	2	3	10
Plestiodon tetragrammus	4	5	3	12
*Scincella silvicola**	5	4	3	12
Aspidoscelis gularis	2	4	3	9
*Lepidophyma occulor**	5	7	2	14
*Conopsis lineata**	5	6	2	13
*Conopsis nasus**	5	4	2	11
Drymarchon melanurus	1	1	4	6
Leptophis mexicanus	1	1	4	6
*Leptophis diplotropis**	5	5	4	14
Masticophis flagellum	1	3	4	8
Masticophis mentovarius	1	1	4	6
Masticophis schotti	4	5	4	13
Pantherophis emoryi	3	6	4	13
*Pituophis deppei**	5	5	4	14
*Pseudoficimia frontalis**	5	5	3	13
*Salvadora bairdi**	5	6	4	15
Senticolis triaspis	2	1	3	6
*Tantilla bocourti**	5	2	2	9
Tantilla rubra	2	1	2	5
*Trimorphodon tau**	5	4	4	13
Diadophis punctatus	1	1	2	4
*Geophis dugesii**	5	6	2	13
Geophis sartorii	2	2	5	9

Table 18 (continued). Environmental Vulnerability Scores (EVS) for members of the herpetofauna of Guanajuato, Mexico, that are assigned to the IUCN Least Concern (LC) category. Non-native taxa are excluded. * = country endemic.

Taxon	Environmental Vulnerability Score (EVS)			
	Geographic distribution	Ecological distribution	Reproductive mode/Degree of persecution	Total score
*Rhadinaea hesperia**	5	3	2	10
*Rhadinaea taeniata**	5	6	2	13
Micrurus tener	1	5	5	11
Storeria dekayi	1	4	2	7
*Storeria storerioides**	5	4	2	11
Thamnophis cyrtopsis	2	1	4	7
Thamnophis eques	2	2	4	8
*Thamnophis pulchrilatus**	5	6	4	15
*Thamnophis scalaris**	5	5	4	14
*Crotalus aquilus**	5	6	5	16
Crotalus atrox	1	3	5	9
Crotalus molossus	2	1	5	8
*Crotalus polystictus**	5	6	5	16
Crotalus scutulatus	2	4	5	11
Kinosternon hirtipes	2	5	3	10
*Kinosternon integrum**	5	3	3	11

As shown in previous MCS studies, the principal reason for the poor correspondence between the two systems of conservation evaluation is the large number of species allocated to the IUCN LC, DD, and NE categories. In the case of the Guanajuato herpetofauna, this applies to 83 of the 96 total native species (86.5%). Of these 83 species, five are allocated to the DD category (Table 16); one is an anuran and four are snakes. All five species are country endemics, and their EVS values range from 12 to 15. Leaving these five species in the DD category consigns them to a status of being ignored. In our opinion, the two species with EVS values of 12 (*Rhadinaea gaigeae**) and 13 (*Craugastor occidentalis**) should be placed in the NT category. The species with an EVS of 14 (*Geophis latifrontalis**) should be allocated to the VU category, and the two species with an EVS of 15 (*Geophis petersii** and *Hypsiglena tanzeri**) should be relegated to the EN category.

Seven species remain unassessed by the IUCN (Table 17). These species include one anuran, one lizard, and five snakes. Only one of these species (*Lampropeltis polyzona**) is a country endemic, and the remaining are non-endemics. Their EVS values range from three to 11. The six species with an EVS from 3 to 10 can be allocated to the LC category and the remaining species (*Oxybelis microphthalmus*), with an EVS of 11, should be placed in the NT category.

The highest number of species in the Guanajuato herpetofauna (71) is allocated to the LC category (Table 18). Comprising this group of 71 species are 16 anurans, one salamander, 19 lizards, 33 snakes, and two turtles. Of these species, 37 are country endemics and 34 are non-endemics. Their EVS values range from 3–16, just one less than the entire range for the Guanajuato herpetofauna (3–17). Thirty-two of these species have EVS scores from 3 to 10, and in our opinion, they can be retained in the Least Concern category. Twenty-seven species have EVS values ranging from 11 to 13, and thus they could be placed in the NT category. Seven species have an EVS of 14 and could be allocated to the VU category. The three species with an EVS of 15 (*Barisia imbricata**, *Salvadora bairdi**, and *Thamnophis pulchrilatus**) and the two species with an EVS of 16 (*Crotalus aquilus** and *C. polystictus**) should be allocated to the EN category.

Relative Herpetofaunal Priority

The concept of Relative Herpetofaunal Priority (RHP) was developed by Johnson et al. (2015a) in the MCS paper on the state of Chiapas. This method involves a simple means of ascertaining the relative conservation importance of the herpetofauna of any geographical entity (e.g., a physiographic region, a municipality, or a state), and consists of two parts: (1) determining the proportion of country endemic species (and in some

Table 19. Number of herpetofaunal species in three distributional status categories among the three physiographic regions of Guanajuato, Mexico. Rank is based on the number of country endemics.

Physiographic region	Distributional category			Total	Rank order
	Non-endemic	Country endemic	Non-native		
Central Plateau	23	36	1	60	3
Transmexican Volcanic Belt	27	43	4	74	1
Sierra Madre Oriental	38	37	—	75	2

Table 20. Number of herpetofaunal species in the three EVS categories among the three physiographic regions in Guanajuato, Mexico. Rank order is determined by the relative number of high EVS species. Non-native species are excluded.

Physiographic province	EVS category			Total	Rank order
	Low	Medium	High		
Central Plateau	18	27	14	59	3
Transmexican Volcanic Belt	20	31	18	69	1
Sierra Madre Oriental	27	32	15	74	2

cases, state endemic species) relative to the entire regional herpetofauna; and (2) calculating the absolute number of high EVS category species in each regional herpetofauna. The pertinent data for these two approaches are presented in Tables 19 and 20.

Based on the number of country endemic species in each of the three physiographic regions and the rank each region occupies (Table 19), this measure indicates that the most important region is, interestingly enough, the Transmexican Volcanic Belt with 43 country endemic species. In most cases, the Sierra Madre Oriental occupies the first rank in the states that encompass a portion of this biodiverse range, including Puebla (Woolrich-Piña et al. 2017), Hidalgo (Ramírez-Bautista et al. 2020), Veracruz (Torres-Hernández et al. 2021), and Querétaro (Cruz-Elizalde et al. 2022). In the case of Guanajuato, the likely reason for this shift in rank for the Sierra Madre Oriental is that the Transmexican Volcanic Belt segment is several times larger than the Sierra Madre Oriental segment.

Based on the relative numbers of high vulnerability species (Table 20), the first rank is occupied by the Transmexican Volcanic Belt, with 18 high vulnerability species out of a total of 69 native species (26.1%). The second rank is occupied by the Sierra Madre Oriental, with 15 high vulnerability species out of a total of 74 native species (20.3%). Finally, the third rank is held by the Central Plateau, with 14 high vulnerability species out of a total of 59 native species (23.7%).

The rankings based on the country endemic species numbers are the same as for the high vulnerability species numbers, i.e., first rank is the Transmexican Volcanic Belt; second rank is the Sierra Madre Oriental; and third rank is the Central Plateau. Thus, the Transmexican Volcanic Belt is the most important physiographic region because it contains the second highest number of native species (70), the highest number of country endemic species (43), and the highest number of high vulnerability species (18). As noted above, this result was a bit surprising, although the Sierra Madre Oriental herpetofauna, which was often was the most important in several other MCS studies, occupies the smallest amount of area in Guanajuato.

The 43 country endemic species in the TVB include 10 anurans, two salamanders, 30 squamates, and one turtle. The TVB also harbors 18 high vulnerability species (with their EVS scores in parentheses):

*Anaxyrus compactilis** (14)
*Eleutherodactylus angustidigitorum** (17)
*Lithobates megapoda** (14)
*Barisia imbricata** (14)
*Plestiodon dugesii** (16)
*Lampropeltis mexicana** (15)
*Leptophis diplotropis** (14)
*Pituophis deppei** (14)
*Salvadora bairdi** (15)
*Geophis petersi** (15)
*Hypsiglena tanzeri** (15)
*Adelophis copei** (15)
*Thamnophis melanogaster** (15)
*Thamnophis pulchrilatus** (15)
*Thamnophis scalaris** (14)
*Thamnophis scaliger** (15)
*Crotalus aquilus** (16)
*Crotalus polystictus** (16)

These 18 species include three anurans, two lizards, and 13 snakes. All of these species are country endemics and they have EVS values ranging from 14 to 17.

The Sierra Madre Oriental (rank two) contains 15 high vulnerability species:

*Eleutherodactylus angustidigitorum** (17)
*Eleutherodactylus verrucipes** (16)
*Aquiloeurycea cephalica** (14)
*Abronia taeniata** (15)
*Barisia imbricata** (14)
*Sceloporus minor** (14)
*Lepidophyma occulor** (14)
*Lampropeltis mexicana** (15)
*Pituophis deppei** (14)
*Salvadora bairdi** (15)
*Geophis latifrontalis** (14)
*Hypsiglena tanzeri** (15)
*Thamnophis pulchrilatus** (15)
*Thamnophis scalaris** (14)
*Crotalus aquilus** (16)

These 15 species include two anurans, one salamander, four lizards, and eight snakes. All 15 species are country endemics and are assigned EVS values from 14 to 17.

Finally, the Central Plateau (rank three) harbors 14 high vulnerability species:

*Anaxyrus compactilis** (14)
*Eleutherodactylus verrucipes** (16)
*Lithobates megapoda** (14)
*Barisia imbricata** (14)

*Sceloporus minor** (14)
*Leptophis diplotropis** (14)
*Pituophis deppei** (14)
*Salvadora bairdi** (15)
*Hypsiglena tanzeri** (15)
*Thamnophis melanogaster** (15)
*Thamnophis scalaris**
*Thamnophis scaliger** (15)
*Crotalus aquilus** (16)
*Crotalus polystictus** (16)

These 14 species include three anurans, two lizards, and nine snakes. All 14 species are country endemics and have EVS values ranging from 14 to 16.

Of the 101 species that comprise the Guanajuato herpetofauna (96 of which have calculable EVS), 24 are high vulnerability species and the proportions of these species in the three physiographic regions are as follows: TVB (75.0%), SMO (62.5%), and CP (58.3%). These data will be of considerable value in developing management plans for the protected areas in Guanajuato, as discussed in the next section.

Protected Areas in Guanajuato

Protected Areas and Worldview

Most humans appear to be afflicted with a social disease termed anthropocentrism, for which the symptoms arise from denying the reality of natural law. Briefly stated, life on Earth is entirely dependent on the functional interaction of the three abiotic spheres, i.e., the atmosphere, hydrosphere, and lithosphere. This relationship dates back to the origin of life on this planet, approximately 3.5 billion years ago. Since modern-day humans are socialized to support worldviews at odds with this reality, such a belief system has been the source of all current environmental problems. The most widespread worldviews adopted by humans are contrasted by Wilson and Lazcano (2019: 26), who promulgated the categorical ethical position that "what is good is defined in terms of what is right." Thus, these authors would argue that what is bad is defined in terms of what is wrong. Further, they argue, "What is right is that which enhances the survival of life on Earth" and "that which is wrong is that which compromises it." Their position, therefore, is that "with the right to enjoy life comes the responsibility to not endanger the lives of others" (Wilson and Lazcano 2019: 26).

Clearly, based on varying experiences, this view of life is not shared by most people. As noted by Miller (2006: 431), environmental worldviews are based on "how people think the world works, what they believe their environmental role in the world should be, and what they believe is right and wrong environmental behavior." Miller (2006: 432) identified three principal environmental worldviews: the Planetary Management Worldview, Stewardship Worldview, and Environmental Wisdom Worldview. The worldview adopted by the authors of this paper is characterized by the following ethical positions: (1) "we are a part of and totally dependent on nature and nature exists for all species"; (2) "resources are limited, should not be wasted, and are not all for us"; (3) "we should encourage earth-sustaining forms of economic growth and discourage earth-degrading forms"; and (4) "our success depends on learning how nature sustains itself and integrating such lessons from nature into the ways we think." Miller (2006: 431) also stated that "many people in today's industrial consumer societies have a planetary management worldview." This worldview, which clearly is at odds with our own, is based on the following ideas: (1) "we are apart from the rest of nature and can manage nature to meet our increasing needs and wants"; (2) "because of our ingenuity and technology we will not run out of resources"; (3) "the potential for economic growth is essentially unlimited"; and (4) "our success depends on how well we manage the earth's life-support systems mostly for our benefit."

The dangers associated with the Planetary Management Worldview are becoming more evident with the passing of time. Judging by the news of the day, climate change is becoming an issue that is more difficult to ignore than in the past. The latest (sixth) report of the Intergovernmental Panel on Climate Change (IPCC) appeared in March 2022 (Pörtner and Roberts, *Climate Change 2022: Impacts, Adaptation and Vulnerability*). This highly complicated and detailed report is not likely to become casual reading for the average person, but it probably should allow for an understanding and internalization of the bottom-line assessment offered by Robinson Meyer in a piece in *The Atlantic* entitled *There's no scenario in which 2050 is 'normal.'* Meyer concluded that, "We have been backed into a corner [by our inaction]. The scale of [climate] change headed our way is unimaginable. And it is also inevitable."

However, the latest IPCC report is not all "doom and gloom." The report also outlines the changes in the human way of "doing business" that have to occur to mitigate the "inevitable" effects of climate change, but these changes will have to be implemented over a distressingly short period of time. On 28 February 2022, António Guterres, the Secretary-General of the United Nations wrote that, "Nearly half of humanity is living in the danger zone—now. Many ecosystems are at the point of no return—now. Unchecked carbon pollution is forcing the world's most vulnerable on a frog march to destruction—now. The facts are undeniable. This abdication of leadership is criminal. The world's biggest polluters are guilty of arson of our only home…Today's report underscore[s] two core truths. First, coal and other fossil fuels are choking humanity. (Second,) investments in adaptation work…Delay means death" (https://media.un.org/en/asset/k1x/k1xcijxjhp; accessed 16 November 2022).

Table 21. Characteristics of the Natural Protected Areas in Guanajuato, Mexico. Abbreviations for Facilities available are as follows: A = Administrative services; R = Park guards; S = System of pathways; and V = Facilities for visitors.

Name	Category	Date of decree	Area (ha)	Municipalities	Jurisdiction	Physiographic region(s)	Area demarcated	Facilities available	Personnel present year-round	Occupied by landowners	Herpetofaunal survey completed	Management plan available
Sierra de Lobos	Sustainable use area	4 Nov 1997	127,058.0	León, San Felipe, Ocampo	State	Central Plateau	Yes	R, S, V	Yes	Yes	Partially	Yes
Cuenca Alta del Río Temascatio	Sustainable use area	29 Apr 1997	17,432.0	Salamanca, Juventino Rosas	State	Central Plateau	Yes	R, S, V	No	Yes	Partially	Yes (not updated)
Peña Alta	Sustainable use area	6 Jun 2000	13,270.2	San Diego de la Unión	State	Central Plateau	Yes	R, S	No	Yes	Partially	Yes (not updated)
Las Musas	Sustainable use area	14 May 2013	3,174.8	Manuel Doblado	State	Transmexican Volcanic Belt	Yes	R, S, V	Yes	Yes	Yes	Yes
Cerros el Culiacán y La Gavia	Sustainable use area	30 Jul 2002	32,661.5	Celaya, Cortazar, Jaral del Progreso, Salvatierra	State	Transmexican Volcanic Belt	Yes	R, S, V	Yes	Yes	Partially	Yes
Sierra de los Agustinos	Sustainable use area	17 Sep 2002	19,246.0	Tarimoro, Jerécuaro, Acámbaro	State	Transmexican Volcanic Belt	Yes	R, S, V	No	Yes	Partially	Yes (not updated)
Cerro de los Amoles	Sustainable use area	7 May 2004	6,987.0	Moroleón, Yuriria	State	Transmexican Volcanic Belt	Yes	S	No	Yes	Partially	Yes (not updated)
Cerro de Arandas	Sustainable use area	25 Nov 2005	4,816.2	Irapuato	State	Transmexican Volcanic Belt	Yes	A, S, V	No	Yes	Partially	Yes (not updated)
Presa La Purísima y su zona de influencia	Sustainable use area	26 Aug 2005	2,728.8	Guanajuato	State	Central Plateau, Transmexican Volcanic Belt	Yes	A, S, V	No	Yes	Partially	Yes (not updated)
Sierra de Pénjamo	Sustainable use area	29 May 2012	83,341.0	Cuerámaro, Manuel Doblado, Pénjamo	State	Transmexican Volcanic Belt	Yes	A, R, S, V	No	Yes	Partially	No
Cerro de Palenque	Sustainable use area	2 Nov 2012	2,030.7	Purísima del Rincón	State	Central Plateau	Yes	S	No	Yes	Partially	No
Megaparque de la Ciudad de Dolores, Hidalgo	Ecological Park	16 Dec 1997	28,44.0	Dolores Hidalgo	Stae	Central Plateau	Yes	S, V	Yes	No	Partially	Yes (not updated)
Las Fuentes	Ecological Park	26 Dec 1997	109, 03.0	Juventino Rosas	State	Transmexican Volcanic Belt	Yes	S	No	Yes	Partially	Yes (not updated)
Parque Metropolitano	Ecological Park	4 Sep 2000	337.0	León	State	Central Plateau	Yes	S, V	Yes	No	Partially	Yes (not updated)
Lago Cráter La Joya	Ecological Park	9 Apr 1999	1,479.0	Yuriria	State	Transmexican Volcanic Belt	Yes	S	No	Yes	Partially	No
Presa de Silva y áreas aledañas	Ecological Preservation Area	2 Dec 1997	8,801.0	San Francisco del Rincón, Purísima del Rincón	State	Transmexican Volcanic Belt	Yes	S	No	Yes	Partially	Yes (not updated)

Table 21 (continued). Characteristics of the Natural Protected Areas in Guanajuato, Mexico. Abbreviations for Facilities available are as follows: A = Administrative services; R = Park guards; S = System of pathways; and V = Facilities for visitors.

Name	Category	Date of decree	Area (ha)	Municipalities	Jurisdiction	Physiographic region(s)	Area demarcated	Facilities available	Personnel present year-round	Occupied by landowners	Herpetofaunal survey completed	Management plan available
Laguna de Yuriria y su zona de influencia	Ecological Preservation Area	9 Apr 1999	15.0	Yuriria	State/Federal	Transmexican Volcanic Belt	Yes	A, S, V	Yes	Yes	Partially	Yes (not updated)
Cerro del Cubilete	Ecological Preservation Area	18 Nov 2003	3,611.8	Silao, Guanajuato	State	Central Plateau, Transmexican Volcanic Belt	Yes	A, S, V	No	Yes	Partially	Yes (not updated)
Cuenca de la Soledad	Ecological Preservation Area	18 Aug 2006	2,782.0	Guanajuato	State	Central Plateau	Yes	A, S, V	No	Yes	Partially	Yes (not updated)
Presa de Neutla y su zona de influencia	Ecological Preservation Area	15 Sep 2006	2,102.4	Comonfort	State	Transmexican Volcanic Belt	Yes	S, V	No	Yes	Partially	Yes (not updated)
Región Volcánica Siete Luminarias	Natural Monument	21 Nov 1997	8,928.5	Valle de Santiago	State	Transmexican Volcanic Belt	Yes	S, V	No	Yes	Partially	Yes (not updated)
Cuenca de la Esperanza	Conservation Reserve	6 Mar 1998	1,832.7	Guanajuato	State	Central Plateau	Yes	A, R, S, V	Yes	Yes	Partially	Yes (not updated)
Pinal de Zamorano	Conservation Reserve	6 Jun 2000	13,862.0	Tierra Blanca, San José Iturbide	State	Central Plateau	Yes	S, V	No	Yes	Partially	Yes (not updated)
Sierra Gorda de Guanajuato	Biosphere Reserve	2 Feb 2007	236,882.8	Atarjea, San Luis de la Paz, Santa Catarina, Victoria, Xichú	State	Eastern Sierra Madre Oriental	Yes	A, S, V	No	Yes	Partially	No

The consideration of these dire warnings forces on us a somewhat altered viewpoint on the importance of protected areas in responding effectively to the problem of biodiversity decline. In one of the most recent entries in the Mexican Conservation Series, Cruz-Elizalde et al. (2022: 183) wrote the following: "Since humans apparently are not predisposed to deal with the threats posed to planetary biodiversity (Wilson and Lazcano 2019), i.e., to change the ways of thinking to promote the control of human population growth, conservation biologists generally propose the establishment of protected areas to ensure the safety of populations of organisms within those areas." Whereas the authors of this paper are fully in support of establishing, maintaining, and expanding the limits of such areas, under the best of circumstances this process is intended to hold at bay the encroachment of humanity on the remaining natural areas. So even if this effort is successful, these areas are cloaked by the same atmosphere that harbors the burgeoning populations of our own species. The damage to the atmosphere originating from human population centers obviously is not confined to these areas, but ultimately will impact the so-called protected areas. Again, this realization is not to be construed as an argument against setting up protected areas, but these steps alone will not guarantee protection from the ravages of humanity for an entire group of organisms, for perpetuity.

General Features of the Protected Areas in Guanajuato

Given this background, an analysis of the current level of protection offered by the areas that have been set aside in Guanajuato is presented here, beginning with the basic characteristics of these areas in Table 21. Twenty-four protected areas have been established in Guanajuato, and they fall into six categories: (1) sustainable use (11 areas); (2) ecological park (four areas); (3) ecological preservation area (five areas); (4) natural monument (one area); (5) conservation reserve (two areas); and (6) biosphere reserve (one area). These 24 areas were established from 1997 to 2013, and range in size from 15.0 to 236,882.8 ha. Most of these areas are administered at the state level, except for one at both the state and federal levels.

It is of major importance that 14 of the 24 areas are located within the Transmexican

Table 22. Distribution of herpetofaunal species in the Natural Protected Areas of Guanajuato, Mexico, based on herpetofaunal surveys. Abbreviations are as follows: * = species endemic to Mexico and ** = non-native species. The numbers of the Natural Protected Areas signify the following: 1 = Sierra de Lobos; 2 = Cuenca Alta del Río Temascatio; 3 = Peña Alta; 4 = Las Musas; 5 = Cerros el Culiacán y La Gavia; 6 = Sierra de los Agustinos; 7 = Cerro de los Amoles; 8 = Cerro de Arandas; 9 = Presa La Purísima y su zona de influencia; 10 = Sierra de Pénjamo; 11 = Cerro de Palenque; 12 = Megaparque de la Ciudad de Dolores, Hidalgo; 13 = Las Fuentes; 14 = Parque Metropolitano; 15 = Lago Cráter La Joya; 16 = Presa de Silva y áreas aledañas; 17 = Laguna de Yuriria y su zona de influencia; 18 = Cerro del Cubilete; 19 = Cuenca de la Soledad; 20 = Presa de Neutla y su zona de influencia; 21 = Región Volcánica Siete Luminarias; 22 = Cuenca de la Esperanza; 23 = Pinal de Zamorano; and 24 = Sierra Gorda de Guanajuato. Note. **Dryophytes plicata* (-) is found in the state and is part of the herpetofauna of Guanajuato, but at the moment has not been recorded in any of the natural protected areas. This species has been recorded the municipalities of Acámbaro, Salvatierra, Sa José Iturbide, and Tierra Blanca.

Taxon	Natural Protected Areas																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
AMPHIBIA (26 species)																								
Anura (23)																								
Bufonidae (5)																								
*Anaxyrus compactilis**	+	+		+	+		+	+	+	+						+		+		+				+
Anaxyrus punctatus	+	+	+		+		+	+		+			+	+						+	+		+	+
Incilius nebulifer																								+
*Incilius occidentalis**	+	+	+	+		+	+	+		+	+											+	+	+
Rhinella horribilis																								+
Craugastoridae (2)																								
Craugastor augusti		+	+	+				+		+							+	+		+				+
*Craugastor occidentalis**				+						+														
Eleutherodactylidae (3)																								
*Eleutherodactylus angustidigitorum**							+																	
Eleutherodactylus guttilatus	+	+	+	+	+								+							+				+
*Eleutherodactylus verrucipes**	+		+										+										+	+
Hylidae (5)																								
Dryophytes arenicolor				+							+		+					+	+	+	+	+	+	+
*Dryophytes eximius**	+	+	+	+	+	+	+	+	+	+	+	+					+	+	+		+	+	+	+
*Rheohyla miotympanum**																								+
Smilisca baudinii																								+
Smilisca fodiens				+																				
Microhylidae (1)																								
Hypopachus variolosus				+				+			+									+				
Ranidae (6)																								
Lithobates berlandieri	+	+	+											+									+	+
*Lithobates catesbeianus***	+													+			+							
*Lithobates megapoda**							+										+							
*Lithobates montezumae**	+	+	+		+	+	+		+								+		+				+	
*Lithobates neovolcanicus**	+	+		+	+	+	+	+	+	+	+		+		+	+	+	+		+			+	
*Lithobates spectabilis**																	+							+
Scaphiopodidae (1)																								
Spea multiplicata		+	+	+	+		+	+			+		+	+	+			+	+	+	+		+	+
Caudata (3)																								
Ambystomatidae (1)																								
*Ambystoma velasci**	+						+			+									+					+
Plethodontidae (2)																								
*Aquiloeurycea cephalica**																								+
*Isthmura bellii**						+	+															+		+
REPTILIA (71)																								
Squamata (68)																								
Lacertilia (24)																								
Anguidae (4)																								
*Abronia taeniata**																								+
*Barisia imbricata**		+	+		+		+	+			+			+	+			+	+	+	+		+	+
Gerrhonotus infernalis	+		+		+	+	+											+	+				+	

Table 22 (continued). Distribution of herpetofaunal species in the Natural Protected Areas of Guanajuato, Mexico, based on herpetofaunal surveys. Abbreviations are as follows: * = species endemic to Mexico and ** = non-native species. The numbers of the Natural Protected Areas signify the following: 1 = Sierra de Lobos; 2 = Cuenca Alta del Río Temascatio; 3 = Peña Alta; 4 = Las Musas; 5 = Cerros el Culiacán y La Gavia; 6 = Sierra de los Agustinos; 7 = Cerro de los Amoles; 8 = Cerro de Arandas; 9 = Presa La Purísima y su zona de influencia; 10 = Sierra de Pénjamo; 11 = Cerro de Palenque; 12 = Megaparque de la Ciudad de Dolores, Hidalgo; 13 = Las Fuentes; 14 = Parque Metropolitano; 15 = Lago Cráter La Joya; 16 = Presa de Silva y áreas aledañas; 17 = Laguna de Yuriria y su zona de influencia; 18 = Cerro del Cubilete; 19 = Cuenca de la Soledad; 20 = Presa de Neutla y su zona de influencia; 21 = Región Volcánica Siete Luminarias; 22 = Cuenca de la Esperanza; 23 = Pinal de Zamorano; and 24 = Sierra Gorda de Guanajuato. Note. **Dryophytes plicata* (-) is found in the state and is part of the herpetofauna of Guanajuato, but at the moment has not been recorded in any of the natural protected areas. This species has been recorded the municipalities of Acámbaro, Salvatierra, Sa José Iturbide, and Tierra Blanca.

Taxon	Natural Protected Areas																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Gerrhonotus ophiurus or *liocephalus?*																								+
Dactyloidae (2)																								
*Norops nebulosus**	+	+		+	+	+	+								+		+							
Norops sericeus																								+
Gekkonidae (1)																								
*Hemidactylus frenatus***					+																			
Phrynosomatidae (10)																								
Holbrookia maculata			+												+				+					+
*Phrynosoma orbiculare**	+	+	+										+									+	+	+
*Sceloporus aeneus**	+					+	+												+			+		
*Sceloporus dugesii**		+		+	+		+									+			+	+	+			
Sceloporus grammicus	+	+	+		+	+	+	+			+		+						+	+		+	+	+
*Sceloporus minor**	+		+								+											+	+	+
*Sceloporus scalaris**	+		+	+		+	+													+	+			+
*Sceloporus spinosus**	+	+	+	+	+			+	+	+	+		+	+	+			+	+	+			+	+
*Sceloporus torquatus**		+	+	+	+	+	+	+	+	+	+		+			+	+		+	+	+	+	+	+
Sceloporus variabilis																								+
Scincidae (3)																								
*Plestiodon dugesii**			+																					
*Plestiodon lynxe**	+		+																			+		+
Plestiodon tetragrammus																								+
Sphenomorphidae (1)																								
*Scincella selvicola**																								+
Teiidae (1)																								
Aspidoscelis gularis		+	+	+	+		+	+	+	+			+				+	+		+	+			+
Xantusiidae (2)																								
*Lepidophyma gaigeae**																								+
*Lepidophyma occulor**																								+
Serpentes (44)																								
Boidae (1)																								
Boa imperator																								+
Colubridae (18)																								
*Conopsis lineata**		+	+	+	+	+		+	+													+	+	+
*Conopisis nasus**	+	+	+		+	+	+	+		+										+		+	+	+
Drymarchon melanurus	+	+		+	+		+	+																+
*Lampropeltis mexicana**	+		+																					+
*Lampropeltis polyzona**		+		+	+	+	+	+		+	+					+	+			+	+			
*Lepthopis diplotropis**																								
Masticophis flagellum	+		+			+										+					+			+
Masticophis mentovarius	+	+		+	+	+	+	+		+	+						+			+		+	+	+
Masticophis schotti	+		+																				+	+
Oxybelis microphthalmus				+				+																+
Pantheropis emoryi																								
*Pituophis deppei**	+	+	+		+	+	+		+	+	+		+	+			+		+	+	+	+	+	+
*Pseudoficimia frontalis**	+									+														

Table 22 (continued). Distribution of herpetofaunal species in the Natural Protected Areas of Guanajuato, Mexico, based on herpetofaunal surveys. Abbreviations are as follows: * = species endemic to Mexico and ** = non-native species. The numbers of the Natural Protected Areas signify the following: 1 = Sierra de Lobos; 2 = Cuenca Alta del Río Temascatio; 3 = Peña Alta; 4 = Las Musas; 5 = Cerros el Culiacán y La Gavia; 6 = Sierra de los Agustinos; 7 = Cerro de los Amoles; 8 = Cerro de Arandas; 9 = Presa La Purísima y su zona de influencia; 10 = Sierra de Pénjamo; 11 = Cerro de Palenque; 12 = Megaparque de la Ciudad de Dolores, Hidalgo; 13 = Las Fuentes; 14 = Parque Metropolitano; 15 = Lago Cráter La Joya; 16 = Presa de Silva y áreas aledañas; 17 = Laguna de Yuriria y su zona de influencia; 18 = Cerro del Cubilete; 19 = Cuenca de la Soledad; 20 = Presa de Neutla y su zona de influencia; 21 = Región Volcánica Siete Luminarias; 22 = Cuenca de la Esperanza; 23 = Pinal de Zamorano; and 24 = Sierra Gorda de Guanajuato. Note. **Dryophytes plicata* (-) is found in the state and is part of the herpetofauna of Guanajuato, but at the moment has not been recorded in any of the natural protected areas. This species has been recorded the municipalities of Acámbaro, Salvatierra, Sa José Iturbide, and Tierra Blanca.

Taxon	Natural Protected Areas																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
*Salvadora bairdi**	+	+	+	+	+		+			+	+									+			+	+
Senticolis triaspis	+	+			+		+	+			+													+
*Tantilla bocourti**	+	+	+		+				+										+	+			+	
Tantilla rubra																								+
Trimorphodon tau		+	+	+	+	+	+	+	+	+									+	+	+		+	+
Dipsadidae (10)																								
Diadophis punctatus	+		+	+	+		+							+					+	+				
*Geophis dugesii**					+	+	+																	
*Geophis latifrontalis**																								+
*Geophis petersii**							+																	
Hypsiglena jani	+	+			+						+												+	+
*Hypsiglena tanzeri**																								+
Leptodeira septentrionalis																							+	+
*Rhadinaea gaigeae**																								+
*Rhadinaea hesperia**	+					+	+		+	+														
*Rhadinaea teaniata**																								+
Elapidae (1)																								
Micrurus tener		+	+	+	+		+	+					+				+		+				+	+
Natricidae (8)																								
Storeria dekayi																								+
*Storeria storerioides**	+	+	+		+	+												+				+	+	+
Thamnophis cyrtopisis	+	+	+	+		+	+				+									+				+
Thamnophis eques	+	+	+		+	+		+	+	+					+								+	+
*Thamnophis melanogaster**		+			+		+		+								+			+				
*Thamnophis pulchrilatus**																								+
*Thamnophis scalaris**	+						+															+		+
*Thamnophis scaliger**	+				+	+																		
Typhlopidae (1)																								
*Virgotyphlops braminus***	+	+		+				+											+					
Viperidae (5)																								
*Crotalus aquilus**	+	+	+		+	+	+	+			+								+			+	+	+
Crotalus atrox																								+
Crotalus molossus	+	+	+	+	+	+		+		+	+		+	+	+		+	+	+	+		+	+	+
*Crotalus polystictus**	+						+		+	+	+													
Crotalus scutulatus	+		+																					+
Testudines (3)																								
Kinosternidae (2)																								
Kinosternon hirtipes	+	+	+	+			+		+	+			+			+			+		+			
*Kinosternon integrum**	+	+	+	+	+		+	+	+	+	+		+			+			+	+		+	+	+
Emydidae (1)																								
*Trachemys scripta***																								+

Table 23. Summary of the distributional status of the herpetofaunal species in the protected areas in Guanajuato, Mexico. Total = total number of species recorded in all of the listed protected areas.

Protected area	Number of species	Distributional status		
		Non-endemic (NE)	Country Endemic (CE)	Non-native (NN)
Sierra de Lobos	47	17	28	2
Cuenca Alta del Río Temascatio	39	17	21	1
Peña Alta	40	19	21	—
Las Musas	31	16	14	1
Cerros el Culiacán y La Gavia	37	15	21	1
Sierra de los Agustinos	26	8	18	—
Cerro de los Amoles	40	13	27	—
Cerro de Arandas	27	14	12	1
Presa La Purísima y su zona de influencia	17	4	13	—
Sierra de Pénjamo	24	8	16	—
Cerro de Palenque	22	9	13	—
Megaparque de la Ciudad de Dolores, Hidalgo	1	—	1	—
Las Fuentes	16	9	7	—
Parque Metropolitano	9	5	3	1
Lago Cráter La Joya	8	4	4	—
Presa de Silva y áreas aledañas	8	2	6	—
Laguna de Yuriria y su zona de influencia	16	5	10	1
Cerro del Cubilete	12	6	6	—
Cuenca de la Soledad	23	10	12	1
Presa de Neutla y su zona de influencia	27	13	14	—
Región Volcánica Siete Luminarias	14	7	7	—
Cuenca de la Esperanza	19	4	15	—
Pinal de Zamorano	32	14	18	—
Sierra Gorda de Guanajuato	69	34	34	1
Total	97	38	55	4

Volcanic Belt, the physiographic region of greatest importance in Guanajuato, since the TVB contains a herpetofauna almost equivalent to that of the Sierra Madre Oriental, the largest number of country endemic species, and the greatest number of high vulnerability species.

In all 24 cases, the areas are demarcated. Only two of the 24 areas encompass the full range of services; while almost one-half of the areas provide either park guards, a system of pathways, and facilities for visitors (five areas) or administrative services, a system of pathways, and facilities for visitors (six areas). Unfortunately, personnel are present year-round in only seven of the 24 areas. Similarly, only two of the 24 areas are not occupied to some degree by private landowners.

Most herpetofaunal surveys in the protected areas only have been partially completed, and although management plans are available for most areas, they have not been updated. Currently, plans are available for 20 areas, but not for the other four areas.

Effectiveness of the Protected Areas in Guanajuato

In order to determine the effectiveness of the 24 protected areas in Guanajuato, the available herpetofaunal records have been assembled for each of these areas and the results are shown in Table 22, and summarized in Table 23.

Of the 101 species documented for the herpetofauna of Guanajuato, 97 (96.0%) have been recorded in the 24 protected areas in the state (Table 23). Thus, all but four species have been recorded for the compendium of the 24 protected areas. This favorable situation is far better than has been reported in some other Mexican Conservation Series entries.

The four species recorded for the state that have not been reported from one or more of the protected areas are: the hylid frog *Dryophytes plicatus*, the gekkonid lizard *Hemidactylus turcicus*, the dipsadid snake *Geophis sartorii*, and the natricid snake *Adelophis copei*. Fortunately, three of these four species are native to Guanajuato, while *H. turcicus* is a non-native species and thus not desirable within the natural protected areas.

The numbers of protected areas (of a total of 24) inhabited by the 97 species range from one to 19. The sizes of the herpetofaunas of these 24 areas range from one for the Megaparque de la Ciudad de Dolores, Hidalgo to 69 for the Sierra Gorda de Guanajuato (mean, 24.8). However, additional work is necessary to fully document the herpetofauna of these natural protected areas.

In most cases, the number of country endemic species in each area exceeds that of the non-endemic species (16 of 24 areas, or 66.7%). In the other eight cases, either the

numbers of these groups of species are the same (four of 24 areas, or 16.7%) or the number of non-endemic species is higher than the number of country endemic species (four of 24 areas, or 16.7%).

All 40 of the non-endemic species and 53 of the 56 country endemic species (94.6%) have been recorded in the compendium of the 24 protected areas. Although their presence in the protected areas is not desirable, four-fifths (9 species, or 80.0%) of the non-native species have been recorded in one or more of the 24 areas. The most widely distributed non-native species is *Virgotyphlops braminus*, which has been reported in five of the 24 areas. Not surprisingly, this fossorial snake is one of the two most widely distributed non-native species in Mexico (Cruz-Elizalde et al. 2022). What is surprising is that the other non-native species, *Hemidactylus frenatus* (Cruz-Elizalde et al. 2022), has been reported from only one of the 24 areas.

Conclusions and Recommendations

Conclusions

A. Presently, the herpetofauna of Guanajuato consists of 101 species, including 24 anurans, three salamanders, 71 squamates (25 lizards and 46 snakes), and three turtles.

B. The numbers of herpetofaunal species recorded from the three physiographic regions in Guanajuato range from 60 in the Central Plateau to 75 in the Sierra Madre Oriental.

C. The numbers of species shared among the physiographic regions range from 44 between the Central Plateau and the Sierra Madre Oriental to 56 between the Central Plateau and the Transmexican Volcanic Belt. The Coefficient of Biogeographic Resemblance values range from a low of 0.65 between the Central Plateau and the Sierra Madre Oriental to 0.84 between the Central Plateau and the Transmexican Volcanic Belt. The UPGMA dendrogram demonstrates that the Central Plateau (CP) and the Transmexican Volcanic Belt (TVB) cluster with one another at the 0.84 level and that the Sierra Madre Oriental (SM) region clusters with the other two regions at the 0.65 level. This clustering pattern is consistent with the fact that the CP and TVB regions are similarly large in size within the state (Fig. 10) and are located adjacent to one another, and that the SMO is the smallest region in the state and is adjacent only to the CP region.

D. The level of endemism in the Guanajuato herpetofauna is relatively high. Of the 101 species comprising the entire state herpetofauna, 56 (55.4%) are country endemics including 12 anurans (50.0% of 24 species), three salamanders (100% of three species), 15 lizards (60.0% of 25 species), 25 snakes (54.3% of 46 species), and one turtle (33.3% of three turtles). Thirty-nine percent of the state endemics in Guanajuato are squamates of the genera *Abronia* (one species), *Barisia* (one), *Norops* (one), *Phrynosoma* (one), *Sceloporus* (six), *Plestiodon* (two), *Scincella* (one), *Lepidophyma* (two), *Conopsis* (two), *Lampropeltis* (two), *Leptophis* (one), *Pituophis* (one), *Pseudoficimia* (one), *Salvadora* (one), *Tantilla* (one), *Geophis* (three), *Hypsiglena* (one), *Rhadinaea* (three), *Adelophis* (one), *Storeria* (one), *Thamnophis* (four), and *Crotalus* (two).

E. The distributional status of the 101 members of the Guanajuato herpetofauna is as follows (in order of decreasing species numbers): country endemics (56, 55.4%); non-endemics (40, 39.6%); and non-natives (5, 5.0%).

F. The 40 non-endemic species are placed in the following distributional categories: MXUS (26, 65.0%); USCA (six, 15.0%); MXCA (four, 10.0%); MXSA (three, 7.5%); and USSA (one, 2.5%).

G. The principal environmental threats to the herpetofauna of Guanajuato are agriculture, industry, forestry, cattle production, and mining.

H. The conservation status of the herpetofauna of Guanajuato was assessed using the SEMARNAT, IUCN, and EVS systems. As with all previous MCS studies, the SEMARNAT system was found to be of minimal utility, inasmuch as only 44 of 96 species have been evaluated using this system. Of these 44 species, 16 are allocated to the Threatened (A) category and 28 to the Special Protection (Pr) category. The use of the SEMARNAT system does not appear to be biased toward evaluating endemic species as opposed to non-endemic species; although it has not been applied to a sufficient segment of the Guanajuato herpetofauna to be of much use.

I. Application of the IUCN conservation system by category and the proportions of the 96 native species in Guanajuato are as follows: EN (one species, 1.0%); VU (nine, 9.4%); NT (three, 3.1%); LC (71, 74.0%); DD (five, 5.2%); and NE (seven, 7.3%).

J. Application of the EVS system of conservation assessment to the 96 native Guanajuato species indicates that the categorical values increase from low scores (31 species, 32.3%) to medium scores (41 species, 42.7%), and then decreases to high scores (24 species, 25.0%).

K. A comparison of the IUCN and EVS conservation status categorizations indicates that 41.7% of the 24 high vulnerability species (by EVS) are allocated to one of the two IUCN "threat categories" (EN or VU), and that 83.9% of the 31 low vulnerability species are placed in the LC category. As in all previous MCS studies, the correlation between the results of applying the IUCN and EVS systems is relatively poor.

L. An examination of the 83 native species (86.5% of all 96) placed into the IUCN DD, NE, and LC categories demonstrates that many of these species have been evaluated improperly when compared to their

respective EVS values, so we indicated how these species might be reassessed in the IUCN system to better reflect their prospects for survival in perpetuity.

M. The RHP measure was utilized to ascertain the conservation significance of the three regional herpetofaunas in Guanajuato. This analysis demonstrates that the most significant regional herpetofauna is that of the Transmexican Volcanic Belt, as it contains a herpetofauna only slightly smaller than that of the Sierra Madre Oriental, the largest number of country endemic species (43, 76.8% of 56 species), and the greatest number of high vulnerability species (18, 26.1% of 69 species).

N. Twenty-four protected areas are established in Guanajuato, most at the state level. Fourteen of these areas are in the Transmexican Volcanic Belt, two of which overlap onto the Central Plateau, and the Transmexican Volcanic Belt is the most important herpetofaunal region in the state. Unfortunately, landowners occupy most areas, most herpetofaunal surveys have only been partially completed, and management plans are generally available but seldom updated.

O. Collectively, the unusually high number of protected areas are shown to harbor 97.0% of the species recorded for the state of Guanajuato, which is a highly desirable situation. Even so, much work remains to be done to fully document the herpetofauna in these protected areas.

P. The 97 species recorded in the state's protected areas includes all 38 of the non-endemic species and 55 of the 56 country endemic species. In addition, although not desirable in these areas, four of the five non-native species also have been recorded. The most widely distributed of these non-native species is *Virgotyphlops braminus*.

Recommendations

A. This survey demonstrated that 97 of the 101 species that comprise the herpetofauna of Guanajuato have been recorded in the 24 protected areas established in the state thus far. This is a highly desirable state of affairs, and can be used as a starting point in securing a future for the herpetofauna of this rather highly urbanized state.

B. Evidently, however, the degree of completeness of the herpetofaunal surveys varies from one protected area to another. Thus, our most basic recommendation is to provide additional studies in each of these areas, especially those that are now the least studied.

C. Once reasonably complete herpetofaunal surveys are available for each of the 24 natural protected areas, monitoring programs can be established to continually assess the health of populations of the constituent species. Additionally, efforts should be made to determine whether the two native species (*Dryophytes plicatus* and *Adelophis copei*) that have not been recorded from any of the 24 areas can be found, so they can be included in ongoing monitoring programs.

D. These steps should be taken with urgency, given that the small state Guanajuato is the 6th most populous and the 5th most densely populated in the country.

"How to serve both humanity and the rest of life is the great challenge of the modern era."

Edward O. Wilson (2014)

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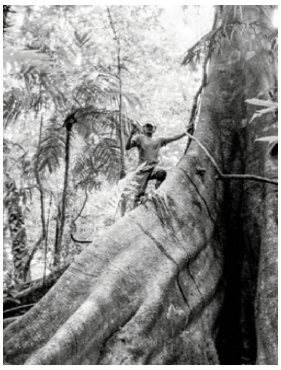
Óscar Báez-Montes received his B.S. and M.S. degrees from the Universidad de Guadalajara in Mexico. His interests include the ecology and conservation of terrestrial vertebrates and their relationships to human communities. Óscar has worked with diverse groups of fauna in areas of conservation importance, such as priority terrestrial regions, Ramsar sites, and natural protected areas in the Mexican Plateau and Western Mexico. He is currently a part-time professor at the Universidad Autónoma de Guadalajara in Mexico. He has three children, Ian, Max, and Regina, and a loving wife Faby (also a Biologist) who accompanies him during his fieldwork.

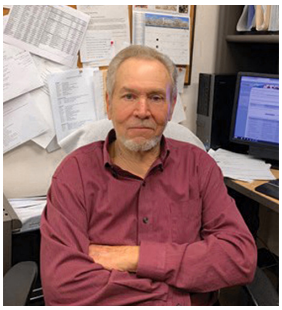
Lydia Allison Fucsko, who resides in Melbourne, Australia, is an environmental activist and amphibian conservationist. As a photographer with international publications, she has taken countless amphibian photographs, including photo galleries of frogs mostly from southeastern Australia. Lydia has a Bachelor of Humanities from La Trobe University (Bundoora, Victoria, Australia), a Diploma in Education from the University of Melbourne (Parkville, Victoria, Australia), and postgraduate diplomas in computer education and in vocational education and training from the University of Melbourne (Parkville). Additionally, Lydia has a Master's degree in Counseling from Monash University (Clayton, Victoria, Australia). She received her Ph.D. in Environmental Education, which promoted habitat conservation, species perpetuation, and global sustainable management, from Swinburne University of Technology (Hawthorn, Victoria, Australia), while being mentored by the late Australian herpetologist and scholar Michael James Tyler (Order of Australia recipient). As a sought-after educational consultant, Lydia has academic interests that include: clinical psychology, focusing on psychopathology; neuroscience and empathy; environmental education for sustainable development; sentient ecology; academic writing; and creative writing, which includes poetry and creative non-fiction books for children and young adults. Lydia is the senior author (with Boria Sax) of a chapter in the 2019 *Springer Encyclopedia of Sustainability in Higher Education* entitled "Learning activities for environmental education for sustainable development." Recently, she has co-authored an obituary of Jaime D. Villa, a study of the introduced Mesoamerican herpetofauna, a treatment of the conservation prospects of the Mesoamerican salamander fauna, papers on the herpetofauna of Veracruz and Querétaro, Mexico, a review of the books *Advances in Coralsnake Biology* and *Lizards of Mexico, Part 1*, and a study on the biological and cultural diversity of Oaxaca, Mexico, among several other academic papers. In 2020, the species *Tantilla lydia*, with the suggested common name of Lydia's Little Snake, was named in her honor.

Dominic L. DeSantis is an Assistant Professor of Biology at Georgia College and State University, Milledgeville, Georgia, USA, in the Department of Biological and Environmental Sciences. Dominic's research interests broadly include the behavioral ecology, conservation biology, and natural history of herpetofauna. In addition to ongoing collaborative projects associated with the Mesoamerican Research Group, much of Dominic's current research focuses on using novel animal-borne sensor technologies to study the behavior of snakes in the field. While completing his Ph.D. at the University of Texas at El Paso, Dominic accompanied Vicente Mata-Silva, Elí García-Padilla, and Larry David Wilson on survey and collecting expeditions to Oaxaca in 2015, 2016, and 2017, and is a co-author on numerous natural history publications produced from those visits, including an invited book chapter on the conservation outlook for herpetofauna in the Sierra Madre del Sur of Oaxaca.



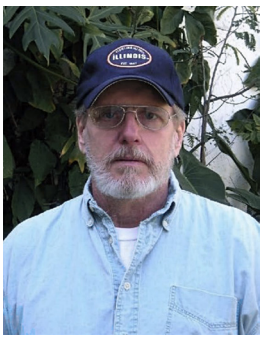
Elí García-Padilla is a Social Biologist and Professional Photographer with more than 12 years of experience in the formal study and photo documentation of the biological and cultural diversity of Mexico. He has published one book, entitled *Mexican Biodiversity: the Snake, the Jaguar and the Quetzal*, and more than 100 formal contributions on knowledge, the communication of science and the conservation of Mesoamerican biodiversity. Since 2006, Elí has been exploring Oaxaca and Chiapas, which are the most biodiverse and multicultural states in Mexico. In 2017, he began to enter the mythical region of Los Chimalapas in the Isthmus of Tehuantepec, which is the most biologically rich region in all of Mexico, under a community social conservation scheme. Elí has published his photographic work in prestigious magazines such as *National Geographic* in Spanish and *Cuartoscuro*. In 2020, he co-founded the Mesoamerican Biodiversity initiative with the aim of creating a community around the dissemination of the most important wealth of Mexico, which is its biodiversity and its culture. His writings are published regularly in *Oaxaca Media*, the *Jornada Ecológica* and the *Ojarasca Supplement* of *La Jornada*.

Arturo Rocha is a Ph.D. student in the Ecology and Evolutionary Biology program at the University of Texas at El Paso. His interests include the study of the biogeography, physiology, and ecology of amphibians and reptiles in the southwestern United States and Mexico. A graduate of the University of Texas at El Paso, his thesis centered on the spatial ecology of the Trans-Pecos Rat Snake (*Bogertophis subocularis*) in the northern Chihuahuan Desert. To date, he has authored or co-authored over 20 peer-reviewed scientific publications.



Jerry D. Johnson is Professor of Biological Sciences at The University of Texas at El Paso, and has extensive experience studying the herpetofauna of Mesoamerica, especially southern Mexico. Jerry is the Director of the 40,000-acre Indio Mountains Research Station, was a co-editor on *Conservation of Mesoamerican Amphibians and Reptiles* and co-author of four of its chapters. He is also the senior author of the recent paper "A conservation reassessment of the Central American herpetofauna based on the EVS measure" and is the Mesoamerica/Caribbean editor for the Geographic Distribution section of *Herpetological Review.* Jerry has authored or co-authored over 142 peer-reviewed papers, including two 2010 articles, "Geographic distribution and conservation of the herpetofauna of southeastern Mexico" and "Distributional patterns of the herpetofauna of Mesoamerica, a Biodiversity Hotspot." One species, *Tantilla johnsoni*, has been named in his honor. Presently, Jerry is Co-chair of the Taxonomic Board for the journal *Mesoamerican Herpetology*.

Louis W. Porras graduated with a degree in Biology in 1971 from what today is known as Miami-Dade College in Florida, USA. Over his career, he has authored or co-authored over 60 academic publications, including the descriptions of two new species, and two taxa have been named in his honor. Louis developed an interest in herpetology at an early age in his native Costa Rica. His passion for the field led him to travel to many remote areas, including sites throughout the Bahamas, the United States, Mesoamerica, and parts of South America. In 1968, he worked at the Houston Zoological Gardens, and from 1982 to 1984 at Utah's Hogle Zoo. In 1976, he attended the inaugural meeting of the International Herpetological Symposium (IHS), and later served the group as Vice-President and President. In 1993, along with Gordon W. Schuett, he helped launch the journal *Herpetological Natural History*, and for the 20th anniversary of IHS, in recognition of his contributions, three former Presidents dedicated the book *Advances in Herpetoculture* in his honor. Louis' career in publishing began in 1995, when he helped publish *Fauna* magazine as a member of Canyonlands Publishing Group. In 2002, he founded Eagle Mountain Publishing, LC, which has published such herpetological titles as *Biology of the Vipers* (2002), *Biology of the Boas and Pythons* (2007), *Amphibians, Reptiles, and Turtles in Kansas* (2010), *Conservation of Mesoamerican Amphibians and Reptiles* (2010), and *Amphibians and Reptiles of San Luis Potosí* (2013). From 2014 to 2018 Louis was the Publisher and Managing Editor of the journal *Mesoamerican Herpetology*, and recently he was the Publisher and Co-editor of the book *Advances in Coralsnake Biology: with an Emphasis on South America*.



Larry David Wilson is a herpetologist with lengthy experience in Mesoamerica. He was born in Taylorville, Illinois, USA, and received his university education at the University of Illinois at Champaign-Urbana (B.S. degree) and at Louisiana State University in Baton Rouge (M.S. and Ph.D. degrees). He has authored or co-authored more than 470 peer-reviewed papers and books on herpetology. Larry is the senior editor of *Conservation of Mesoamerican Amphibians and Reptiles* (2010) and the co-author of seven of its chapters. His other books include *The Snakes of Honduras* (1985), *Middle American Herpetology* (1988), *The Amphibians of Honduras* (2002), *Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras* (2005), *The Amphibians and Reptiles of the Honduran Mosquitia* (2006), and *Guide to the Amphibians & Reptiles of Cusuco National Park, Honduras* (2008). He is also the co-author of 14 previous entries in the Mexican Conservation Series dealing with the herpetofauna of the states of Michoacán, Oaxaca, Chiapas, Tamaulipas, Nayarit, Nuevo León, Jalisco, Puebla, Coahuila, Hidalgo, Veracruz, Querétaro, and Tabasco, as well as the tri-state Mexican Yucatan Peninsula. In addition, he is a co-author of several significant publications on the development and extensive application of the EVS measure and on conservation issues related to the Mexican herpetofauna at the national level. To date, he has authored or co-authored the descriptions of 76 currently-recognized herpetofaunal species, and seven species have been named in his honor, including the anuran *Craugastor lauraster*, the lizard *Norops wilsoni*, and the snakes *Oxybelis wilsoni*, *Myriopholis wilsoni*, and *Cerrophidion wilsoni*, as well as the oligochaete annelid *Pheretima wilsoni*, and the coccidian parasite *Caryospora wilsoni*. In 2005, he was designated a Distinguished Scholar in the Field of Herpetology at the Kendall Campus of Miami-Dade College by the then-campus president Dr. Wasim Shomar. Currently, Larry is a Co-chair of the Taxonomic Board for the website *Mesoamerican Herpetology*.