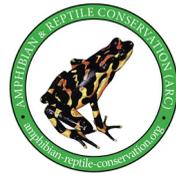




Introductory page. *Xenosaurus mendozai* Nieto-Montes de Oca, García-Vázquez, Zúñiga-Vega, and Schmidt-Ballardo, 2013. The Granular-Scaled Lizard occurs in the states of Querétaro, from where it was first described, and Hidalgo. The species was dedicated to Fernando Mendoza Quijano, a Mexican herpetologist who contributed substantially to the herpetofauna of the states in the central region of Mexico. In this study, and according to Wilson et al. (2013a), we determined its EVS as 16, placing it in the high vulnerability category. According to IUCN, its conservation status is unknown, and this species is not listed by SEMARNAT. This individual was found in the municipality of Jacala de Ledezma, Hidalgo, near the type locality in the state of Querétaro. *Photo by Christian Berriozabal-Islas.*



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

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Abstract.—The herpetofauna of the state of Querétaro, Mexico, consists of 129 species, including 27 anurans, seven caudates, 92 squamates, and three turtles. Regarding the distribution of the herpetofaunal species among the three recognized physiographic regions in the state, the total number of species ranges from 43 in the Transmexican Volcanic Belt to 102 in the Sierra Madre Oriental. The individual species inhabit from one to three regions ($\bar{x} = 1.6$). The majority (78.3%) of the native herpetofauna of Querétaro is found in one or two of the three regions, which is of conservation significance. The majority of the remaining single-region species inhabit the Sierra Madre Oriental (54), followed by 15 in the Central Plateau and eight in the Transmexican Volcanic Belt. The Coefficient of Biogeographic Resemblance (CBR) indicates that the Sierra Madre Oriental and the Central Plateau share the largest number of species (45) due to their adjacent positions, relatively large areas, and because they contain the first and second largest numbers of species. A similarity dendrogram based on the Unweighted Pair Group Method with Arithmetic Averages (UPGMA) demonstrates that the Central Plateau and the Transmexican Volcanic Belt share the highest level of herpetofaunal resemblance (0.60). Within the distributional categories, the largest numbers of species are the country endemics (67 of 129), followed by the non-endemics (60) and the non-natives (2). The principal environmental threats to the herpetofauna of Querétaro are the increasing and unregulated clearing of forests for farming and raising livestock, road construction, the ever-increasing pollution of bodies of water, and the cultural perceptions of various herpetofauna. The conservation status of the native species was evaluated by employing the SEMARNAT (NOM-059), IUCN, and EVS systems, of which the EVS was the most useful. Using the two Relative Herpetofaunal Priority (RHP) methods to designate the rank order significance of the physiographic regions, the highest ranks were obtained for the Sierra Madre Oriental. In considering the features of the three protected areas in Querétaro, we determined that two are located in the Transmexican Volcanic Belt, which is the least important region from a conservation perspective. We also determined that only 79 of the 127 native species recorded from Querétaro are known to occur in any of the three protected areas. Finally, we provide a set of conclusions and recommendations in an effort to ensure the future protection of the herpetofauna of Querétaro.

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

Resumen.—La herpetofauna de Querétaro, México, consta de 129 especies, incluyendo 27 anuros, siete caudados, 92 escamosos y tres tortugas. Documentamos la distribución de las especies de herpetofauna entre las tres regiones fisiográficas que reconocemos. El número total de especies varía de 43 en la Faja Volcánica Transmexicana a 102 en la Sierra Madre Oriental. Las especies individuales habitan de una a tres regiones ($\bar{x} = 1,6$). Una proporción del 78.3% de la herpetofauna nativa de Querétaro se encuentra en una o dos de las tres regiones, lo cual es de gran importancia para la conservación. El mayor número de especies de una sola región habita en la Sierra Madre Oriental (54), seguido de 15 en la Meseta Central y ocho en la Faja Volcánica Transmexicana. Un coeficiente de semejanza biogeográfica (CBR) indica que la Sierra Madre Oriental y la Meseta Central comparten el mayor número de especies (45), debido a su ubicación

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adyacente, su área relativamente grande y su albergue del primer y segundo mayor número de especies. Un dendrograma de similitud basado en el método de grupos de pares no ponderados con promedios aritméticos (UPGMA) demuestra la Meseta Central y la Faja Volcánica Transmexicana comparten la mayor semejanza de herpetofauna (nivel 0.60). Con referencia a las categorías de distribución, la mayor cantidad de especies es la de las endémicas del país (67 de 129), seguidas de las no endémicas (60) y las no nativas (2). Las principales amenazas ambientales para la herpetofauna de Querétaro son la creciente y desmedida tala de bosques para la agricultura y la ganadería, la construcción de caminos, la constante y creciente contaminación de los cuerpos de agua, y la percepción cultural de los miembros de la herpetofauna. Evaluamos el estado de conservación de las especies nativas empleando los sistemas SEMARNAT (NOM-059), UICN y EVS, de los cuales el sistema EVS fue el más útil. También utilizamos los dos métodos de Prioridad relativa de la herpetofauna (RHP) para designar la importancia del orden de clasificación de las regiones fisiográficas y determinamos los valores más altos para la región de la Sierra Madre Oriental. Examinamos las características de las tres áreas protegidas en Querétaro y determinamos que dos de las tres están ubicadas en la Faja Volcánica Transmexicana, que es la región menos importante desde una perspectiva de conservación. También determinamos que solo 79 de las 127 especies nativas registradas en Querétaro, se registran en total de las tres áreas protegidas. Finalmente, emitimos un conjunto de conclusiones y recomendaciones para la futura protección de la herpetofauna de Querétaro.

Palabras Claves. Anfibios, anuros, áreas protegidas, caudados, escamosos, regiones fisiográficas, reptiles, recomendaciones de protección, tortugas

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“It was an event that changed the course of natural history—wiping out three-quarters of all species, including anything on land larger than the size of a domestic dog. It ended the 175-million-year reign of the dinosaurs. Life would have to rebuild... For 66 million years since then, nature has been at work reconstructing the living world, recreating and redefining a new diversity of species. And one of the products of this rebooting of life was humanity.”

David Attenborough (2020)

Introduction

Querétaro, a relatively small state in north-central Mexico, is positioned in a northwest to southeast direction at the intersection of three major physiographic regions: the Sierra Madre Oriental in the northeast, the Central Plateau in the middle, and the Transmexican Volcanic Belt in the southwest (Fig. 1). To the north, Querétaro is bounded by San Luis Potosí, to the east by Hidalgo, to the south by México and Michoacán, and to the west by Guanajuato. The area of Querétaro is 11,699 km², which ranks 27th in size among the 32 federal entities in Mexico (<http://wikipedia.org>; accessed 22 July 2019); only Colima, Aguascalientes, Morelos, Tlaxcala, and Ciudad de México are smaller. Querétaro’s area represents only 0.6% of the country, while the human population of the state in 2015 was reported as

2,038,372, which ranks 22nd (16.0%) in the country. The population density is indicated as 170/km², or 7th in the country (<http://wikipedia.org>; accessed 22 July 2019), which is 2.8 times the average density for Mexico. The state of Querétaro, therefore, lies within the most densely populated region of Mexico (i.e., the area surrounding the Mexican metropolitan area), which includes the states of México, Morelos, Tlaxcala, Aguascalientes, Guanajuato, and Puebla. Only Aguascalientes is slightly removed from the other states in this heavily-populated region. Although a significant amount of environmental deterioration is expected to occur in Querétaro, the state still supports “a diversity of undisturbed environments... such as cloud forest, pine forest, oak [forest], and tropical deciduous forest” (Cruz-Elizalde et al. 2019).

The highest elevation in the state is 3,360 m (<http://wikipedia.org>; accessed 22 July 2019) on Cerro el Zamorano, along the border with Guanajuato in the Central Plateau, and a communications facility is present on this peak (<http://googlemaps.com>; accessed 22 July 2019). Elevations over 3,000 m also occur in the two other physiographic regions of the state (<http://wikipedia.org>; accessed 22 July 2019).

Since Querétaro encompasses portions of three major physiographic regions in Mexico as described above, it could be expected to have a herpetofauna somewhat comparable to those of Puebla and/or Hidalgo. However, Querétaro is significantly smaller than either Puebla (34,306 km²; Woolrich-Piña et al. 2017) or Hidalgo

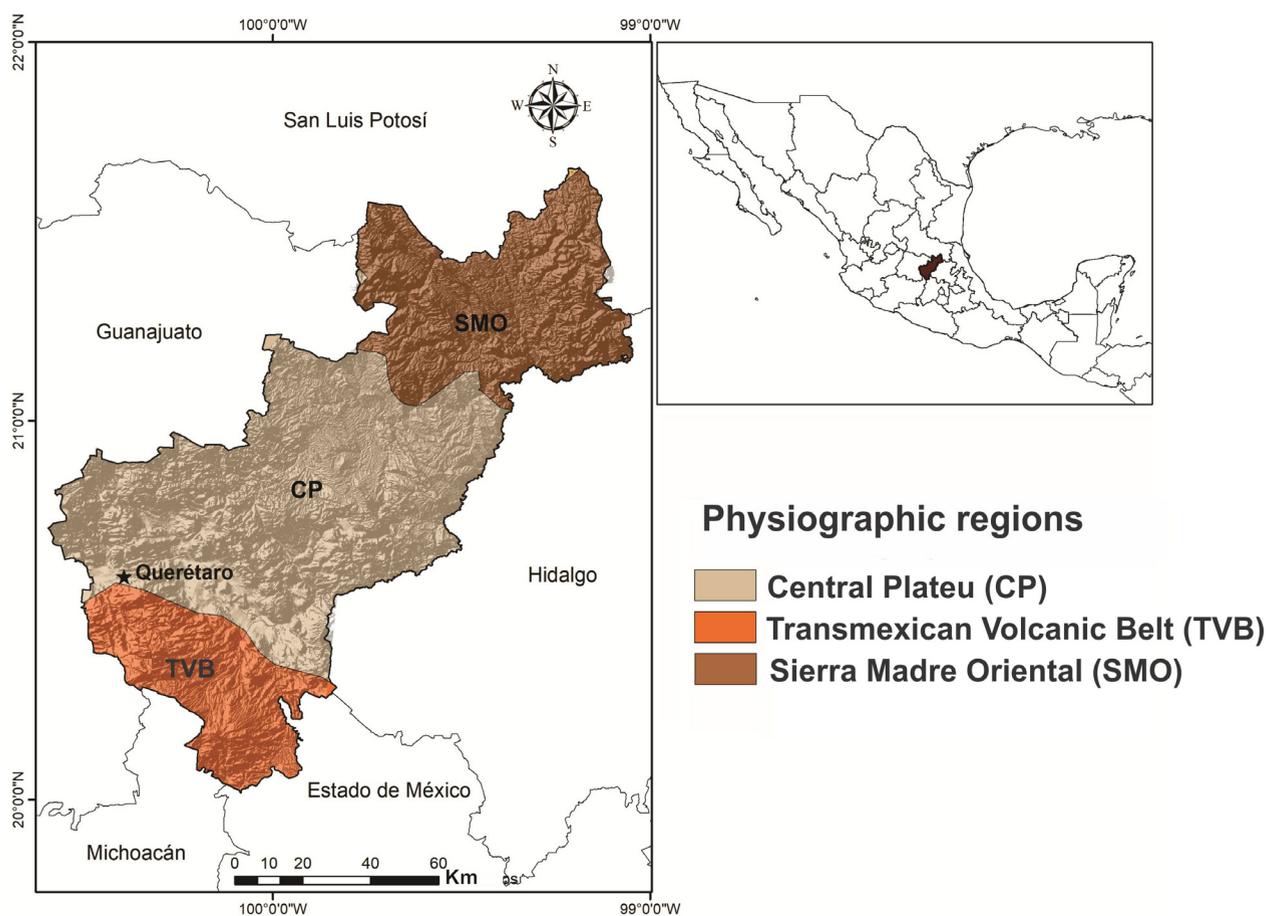


Fig. 1. Physiographic regions in the state of Querétaro, Mexico, and location of the state of Querétaro in Mexico. The map is based on INEGI (2000).

(20,813 km²; Ramírez-Bautista et al. 2020). Furthermore, Hidalgo contains portions of four physiographic regions, including the Gulf coastal lowlands, and Puebla contains six regions, including the Gulf coastal lowlands and two valley regions. Accordingly, it is more useful to compare the herpetofaunas recorded in the same physiographic regions in Puebla and Hidalgo, which also are represented in Querétaro (see below).

Materials and Methods

Our Taxonomic Position

In this study we follow the taxonomic position regarding the subspecies concept that was described 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; Nevárez-de los Reyes et al. 2016; Cruz-Sáenz et al. 2017; González-Sánchez et al. 2017; Woolrich-Piña et al. 2017; Lazcano et al. 2019; Ramírez-Bautista et al. 2020). Johnson et al. (2015a) can be consulted for a detailed statement on this position.

Construction of the Species List

We made some corrections to the recent species list published for the state of Querétaro, as noted by Cruz-Elizalde et al. (2019). That list consisted of 138 species, including 34 amphibians and 104 reptiles. In the interim, however, questions arose regarding the presence of 17 species in the state, whose status was reevaluated when preparing this paper. We discuss the status of these species below.

System for Determining Distributional Status

We used the system developed by Alvarado-Díaz et al. (2013) for the herpetofauna of Michoacán to determine the distributional status of members of the herpetofauna of Querétaro. Subsequently, various other studies (Mata-Silva et al. 2015; Johnson et al. 2015a; Terán-Juárez et al. 2016; Woolrich-Piña et al. 2016; Nevárez-de los Reyes et al. 2016; Cruz-Sánchez et al. 2017; González-Sánchez et al. 2017; Woolrich-Piña et al. 2017; Lazcano et al. 2019; Ramírez-Bautista et al. 2020) have used this system, which consists of the following four categories: SE =



No. 1. *Incilius occidentalis* (Camerano, 1879). The Pine Toad occurs in the mountains of Durango, Jalisco, Nayarit, Aguascalientes, Querétaro, Hidalgo, and Veracruz, southward through the highlands west of the Isthmus of Tehuantepec, Mexico. This individual was found in Huimilpan, Querétaro. Wilson et al. (2013b) determined its EVS as 11, placing it in the medium vulnerability category. Its conservation status was assessed as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 2. *Rhinella horribilis* (Wiegmann, 1833). The Cane Toad, an introduced species, occurs in most regions of Mexico, and has a great effect on the native fauna. This individual was found in Jacalilla, Querétaro. Wilson et al. (2013a) determined its EVS as 3, placing it in the low vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 3. *Eleutherodactylus verrucipes* (Cope, 1885). The Big-eared Chirping Frog is known from moderate elevations (200–1,300 m asl) in pine-oak woodland and cloud forest located in southeastern San Luis Potosí, Querétaro, Guanajuato, and northwestern Hidalgo, Mexico (Frost 2021). Wilson et al. (2013b) determined its EVS as 16, placing it in the middle portion of the high vulnerability category. Its conservation status has been assessed as Vulnerable by the IUCN, and in the Special Protection (Pr) category by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 4. *Dryophytes arenicolor* (Cope, 1866). The Canyon Treefrog occurs in the mountains and plateau regions of the United States (southern Utah and southern Colorado southward through eastern Arizona, western and northern New Mexico, as well as in Nevada to about Las Vegas, and the Trans-Pecos region of Texas); and southward in Mexico to Michoacán, Colima, México, Guerrero, Hidalgo, Querétaro, and Oaxaca. This individual was found in Huimilpan, Querétaro. Wilson et al. (2013b) determined its EVS as 7, placing it in the low vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*

endemic to Querétaro; CE = endemic to Mexico; NE = not endemic to Mexico; NN = non-native in Mexico.

Systems for Determining Conservation Status

To assess the conservation status of the herpetofauna of Querétaro, we 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), Nevárez-de los Reyes et al. (2016), Cruz-Sánchez et al. (2017), González-Sánchez et al. (2017), Woolrich-Piña et al. (2017), Lazcano et al. (2019), and Ramírez-Bautista et al. (2020). Detailed descriptions of these three systems have appeared in earlier papers in this series (listed below) and are not repeated here.

The Mexican Conservation Series

The Mexican Conservation Series (MCS) was initiated in 2013, with a study of the herpetofauna of Michoacán (Alvarado-Díaz et al. 2013) that appeared in *Amphibian & Reptile Conservation*, in an issue that included five related papers and was designated as the Special Mexico Issue. The basic format for entries in the MCS was established in that 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 resumed with two studies on the herpetofauna of Oaxaca (Mata-Silva et al. 2015) and Chiapas (Johnson et al. 2015a). The following 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). In 2017, three more entries in this series were published on Jalisco (Cruz-Sáenz et al. 2017), the Mexican Yucatan Peninsula (González-Sánchez et al. 2017), and Puebla (Woolrich-Piña et al. 2017). More recently, entries were published on Coahuila (Lazcano et al. 2019), Hidalgo (Ramírez-Bautista et al. 2020), and most recently on Veracruz (Torres-Hernández et al. 2021). Thus, this study on the herpetofauna of Querétaro is the 13th entry in the MCS series.

Physiography and Climate

Physiographic Regions

Sierra Madre Oriental (SMO). This region (Figs. 2–7) is located parallel to the Gulf coastal region of Mexico, and it is connected to the Central Plateau and the Transmexican Volcanic Belt. The SMO has been assigned to the Neotropical Realm and covers 2.84% of the area of the country (Morrone 2001; CONABIO 2008). This province is composed mostly of sedimentary and metamorphic rocks from the Cretaceous and Jurassic periods, which makes this province a complex area

from a geological perspective (CONABIO 2008). The SMO encompasses parts of Coahuila, Nuevo León, Tamaulipas, San Luis Potosí, Hidalgo, Puebla, Querétaro, Tlaxcala, and Veracruz (CONABIO 2008). In the state of Querétaro, this province extends into the municipalities of Pinal de Amoles, Arroyo Seco, Jalpan de Serra, Landa de Matamoros, and the region north of Cadereyta de Montes and San Joaquín (Figs. 2–3; CONABIO 2008). The mean annual precipitation is 731 mm, with a greater intensity of rainfall in September, and the mean annual temperature is 23.5 °C, with intervals of 10.6–33.5 °C (Luna Soria and Suzán Azpiri 2016). The climate is classified as semi-warm subhumid, and the predominant types of vegetation are tropical deciduous forest, oak forest, pine-oak, and portions of cloud forest (Bayona Celis 2016).

Central Plateau (CP). This region (Figs. 8–9) lies within the more inclusive Nearctic Region (Morrone 2001; CONABIO 2008), extends through the central area of Mexico at elevations from 1,700 to 4,000 m asl, and is located between the Sierra Madre Occidental and Sierra Madre Oriental. Portions of the CP fall within the boundaries of Chihuahua, Coahuila, Durango, Guanajuato, Hidalgo, Jalisco, Michoacán, Puebla, Querétaro, San Luis Potosí, Tlaxcala, and Zacatecas. In the state of Querétaro, this province extends into the municipalities of Peñamiller, Tolimán, San Joaquín, Cadereyta de Montes, Colón, Ezequiel Montes, El Marqués, Querétaro, Tequisquiapan, Pedro Escobedo, and San Juan del Río (CONABIO 2008). The climate is temperate semi-dry steppe, with rainfall occurring in summer; the average annual precipitation is 460 mm; the average annual temperature is 17.8 °C; and the temperature ranges from 4.5 to 30 °C (Luna Soria and Suzán Azpiri 2016). The predominant types of vegetation are crasicaule scrub, rosetophilous scrub, microphilous desert scrub, and gallery forest, but these regions contain extensive areas devoted to agriculture, as well as grasslands (Bayona Celis 2016).

Transmexican Volcanic Belt (TVB). The TVB lies in the Neotropical Region (Morrone 2001; CONABIO 2008) and forms a volcanic arc located in central Mexico. The TVB is oriented from east to west, from the state of Veracruz (Gulf of Mexico) to Nayarit (Pacific Ocean; Ferrusquía-Villafranca 2007; CONABIO 2008). In the state of Querétaro, this province extends into the municipalities of Amealco de Bonfil, Corregidora, and Huimilpan (CONABIO 2008). The predominant climate is temperate subhumid, with rain occurring in summer, and with its greatest intensity from May to October; the mean annual rainfall is 861 mm, and the mean annual temperature is 14.4 °C, with intervals from 3.8 to 24.8 °C (Luna Soria and Suzán Azpiri 2016). The predominant vegetation types are oak and pine forests (Figs. 5–6), in addition to such



Fig. 2. View of the Sierra Madre Oriental at the Mirador Cuatro Palos. *Photo by Erick Daniel Velasco Esquivel.*



Fig. 3. Sierra Madre Oriental, in the Sierra Gorda Biosphere Reserve, Jalpan de Serra, Querétaro. *Photo by Erick Daniel Velasco Esquivel.*

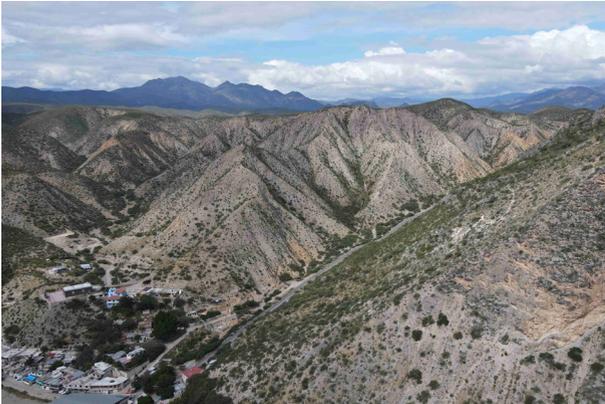


Fig. 4. Xerophilous scrub in mountains of the Central Plateau, locality of Peñamiller. *Photo by Erick Daniel Velasco Esquivel.*



Fig. 5. Pine-oak forest, Tolimán, Querétaro. *Photo by Erick Daniel Velasco Esquivel.*



Fig. 6. Oak forest, Mirador Cuatro Palos, Querétaro. *Photo by Erick Daniel Velasco Esquivel.*



Fig. 7. Deciduous forest, Las Adjuntas, Arroyo Seco, Querétaro. *Photo by Erick Daniel Velasco Esquivel.*



Fig. 8. *Juniperus* forest, San Juan del Río–Jalpan de Serra, Pinal de Amoles, Querétaro. *Photo by Erick Daniel Velasco Esquivel.*



Fig. 9. Riparian vegetation, Río Jalpan, Jalpan de Serra, Querétaro. *Photo by Erick Daniel Velasco Esquivel.*



No. 5. *Rheohyla miotympanum* (Cope, 1863). The Small-eared Treefrog is a country endemic distributed from “Nuevo León and Coahuila (Sierra Madre Oriental) to Guanajuato (Sierra Santa Rosa), Hidalgo, and Oaxaca, adjacent Veracruz, and central Chiapas” (Frost 2020). This individual was found in Pinal de Amoles, Querétaro. Wilson et al. (2013b) determined its EVS as 9, placing it at the upper limit of the low vulnerability category. Its conservation status has been judged as Near Threatened by the IUCN, but this species has not been evaluated by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 6. *Smilisca baudinii* (Duméril and Bibron, 1841). Baudin's Treefrog occurs in extreme southern Texas (United States), and southern Sonora and southwestern Chihuahua (Mexico) southward (including the Balsas Depression of Mexico) in the tropical lowlands to Costa Rica on the Pacific slope; Tres Marias Islands off the coast of Nayarit, Mexico; and seemingly introduced into Bexar and Refugio counties in southeast-central Texas, United States (Frost 2021). This individual was found in Jacalilla, Querétaro. Wilson et al. (2013a) determined its EVS as 3, placing it in the low vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 7. *Ambystoma velasci* (Dugès, 1888). The Plateau Tiger Salamander ranges from northwestern Chihuahua southward along the eastern slope of the Sierra Madre Occidental and southern Nuevo León to Hidalgo in the Sierra Madre Oriental, west to Zacatecas, and south into the Transverse Volcanic range of central Mexico (Frost 2019). This individual was found in Pinal de Amoles, Querétaro. Wilson et al. (2013b) determined its EVS as 10, placing it at the lower limit of the medium vulnerability category. Its conservation status is considered as Least Concern by the IUCN, and it has been placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 8. *Chiropterotriton chondrostega* (Taylor, 1941). The Gristle-headed Splayfoot Salamander is known from Northwestern Hidalgo and adjacent Querétaro, Mexico, in cloud forest (at elevations of 1,524–2,042 m asl); and has also been reported in the state of México (Frost 2021). This individual was found in Pinal de Amoles, Querétaro. Wilson et al. (2013b) determined its EVS as 17, placing it in middle portion of the high vulnerability category. Its conservation status is considered as Endangered by the IUCN, and it is in the Special Protection (Pr) category by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*

The herpetofauna of Querétaro, Mexico

Table 1. Monthly minimum, mean (in parentheses), maximum, and annual temperature data (in °C) for the physiographic regions of Querétaro, Mexico. The localities (and elevation) representing each of the regions are: Central Plateau—Tolimán (1,510 m); Transmexican Volcanic Belt—San Juan del Río (1,920 m); Sierra Madre Oriental—Jalpan (750 m). Data were taken from *Anuario Estadístico y Geográfico de Querétaro* (INEGI 2017).

| Physiographic region | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|----------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Central Plateau | 7.2 (14.9) 15.4 | 9.5 (16.5) 21.6 | 10.2 (19.5) 22.9 | 14.5 (21.9) 24.7 | 14.7 (23.2) 25.6 | 14.4 (23.2) 26.4 | 15.3 (22.3) 26.2 | 15.5 (21.6) 25.6 | 14.6 (21.0) 23.5 | 10.1 (18.8) 19.3 | 9.4 (17.0) 17.4 | 8.5 (15.2) 17.8 | 12.0 (19.6) 22.2 |
| Transmexican Volcanic Belt | 7.7 (13.5) 16.3 | 9.0 (14.9) 17.4 | 9.0 (17.3) 19.8 | 12.9 (19.5) 22.6 | 13.6 (20.5) 22.9 | 14.3 (20.1) 22.6 | 13.6 (18.9) 22.6 | 13.1 (18.8) 20.9 | 13.7 (18.2) 19.9 | 11.8 (16.7) 18.9 | 11.0 (15.4) 16.0 | 10.2 (14.0) 15.8 | 11.7 (17.3) 19.6 |
| Sierra Madre Oriental | 10.3 (17.9) 20.3 | 15.4 (19.7) 20.5 | 17.6 (23.4) 25.7 | 19.1 (26.1) 26.3 | 17.8 (27.6) 31.3 | 20.0 (26.9) 30.2 | 20.9 (25.4) 29.4 | 20.4 (25.6) 29.1 | 20.9 (24.6) 26.9 | 18.5 (22.9) 24.2 | 14.3 (20.4) 19.2 | 15.4 (18.9) 18.1 | 17.6 (23.3) 25.1 |

transformed environments as introduced grasslands and agricultural areas (Bayona Celis 2016).

Climate

Temperature. Information on the monthly minimum, mean, and maximum temperatures are given in Table 1 for one locality in each of the three physiographic regions we recognize in Querétaro. The elevations for these localities range from 750 m in the Sierra Madre Oriental (SMO) at Jalpan, to 1,920 m in the Transmexican Volcanic Belt (TVB) at San Juan del Río.

The mean annual temperature (MAT) for Jalpan (elevation 750 m asl) in the SMO is 23.3 °C, while the MAT for Tolimán in the Central Plateau (CP) is 19.6 °C, and the MAT for San Juan del Río in the TVB is 17.3 °C. The minimum annual temperatures range from 11.7 °C in the CP to 17.6 °C in the SMO, the maximum annual temperatures range from 19.6 °C in the TVB to 25.1 °C in the SMO, and in the three physiographic regions, the minimum annual temperatures are 7.5–10.2 °C lower than the maximum annual temperatures (Table 1). The mean monthly temperatures peak in May or June (most often in May), and reach their lowest point in January.

Precipitation. The monthly precipitation is lowest during the dry season from November to April, and highest during the rainy season from May to October which includes

76.0–87.5% (\bar{x} = 83.5) of the annual precipitation (Table 2). The annual rainfall ranges from 291.3 mm in the CP to 662.8 mm in the SMO, noting that the latter value is 2.3 times greater than the former (Table 2).

Comments on the Species List

As noted above, we reevaluated the status of 17 species after Cruz-Elizalde et al. (2019) placed them on the state list. These 17 species were allocated to the three categories of (1) species currently documented as occurring in Querétaro; (2) species that likely occur in Querétaro but remain undocumented in the state; and (3) species that, insofar as we are aware, are not known to occur in Querétaro.

Eight species whose status was previously in doubt are now documented as occurring in Querétaro. The presence of these species in the state, and the literature that documents their presence, is as follows: (1) *Eleutherodactylus nitidus* (recorded by Nieto-Montes de Oca and Pérez-Ramos [1999]; Informe de CONABIO, locality Mesa de León, el Arbolito, near Hidalgo, in project H250-CONABIO); (2) *Gerrhonotus infernalis* (appears in the H250 report, for which collecting coordinates are provided); (3) *Hemidactylus turcicus* (reported by Tepos-Ramírez et al. [2019]); (4) *Scincella lateralis* (reported in the H250 report, based on a collected specimen); (5) *Scincella silvicola* (reported

Table 2. Monthly and annual precipitation data (in mm) for the physiographic regions of Querétaro, Mexico. The localities (and elevation) representing each of the regions are: Central Plateau—Tolimán (1,510 m); Transmexican Volcanic Belt—San Juan del Río (1,920 m); Sierra Madre Oriental—Jalpan (750 m). Data taken from *Anuario Estadístico y Geográfico de Querétaro* (INEGI 2017). The shaded area indicates the months of the rainy season.

| Physiographic region | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|----------------------------|------------------------|-----------------------|----------------------|-----------------------|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|-------------------------|------------------------|-----------------------|-----------------------------|
| Central Plateau | 0.0 (9.1) 26.0 | 0.0 (3.4) 12.0 | 8.0 (7.2) 31.0 | 0.0 (12.2) 41.0 | 0.0 (35.4) 87.5 | 0.0 (57.4) 89.0 | 0.0 (57.1) 148.0 | 0.0 (51.2) 97.5 | 0.0 (59.6) 21.0 | 0.0 (30.6) 110.5 | 0.0 (8.4) 20.1 | 0.0 (4.5) 19.0 | 8.0 (334.9) 663.5 |
| Transmexican Volcanic Belt | 33.7 (11.4) 89.5 | 0.0 (1.1) 8.8 | 8.0 (9.5) 11.0 | 1.0 (19.4) 4.9 | 64.5 (39.5) 126.7 | 59.6 (96.6) 127.4 | 6.5 (108.9) 150.8 | 1.9 (99.1) 75.8 | 7.5 (88.0) 166.1 | 2.7 (42.7) 52.1 | 29.5 (12.7) 49.8 | 7.8 (6.4) 9.3 | 222.7 (542.9) 853.5 |
| Sierra Madre Oriental | 1.3 (8.0) 13.0 | 2.5 (10.8) 14.6 | 0.0 (0.4) 13.0 | 0.0 (27.9) 32.1 | 5.0 (45.0) 47.4 | 21.6 (23.5) 146.4 | 75.8 (155.0) 435.5 | 78.7 (149.6) 172.5 | 59.1 (195.2) 645.0 | 80.3 (94.5) 158.8 | 0.0 (25.4) 37.0 | 8.4 (15.5) 24.9 | 447.6 (872.2) 1,503.4 |

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

| Order | Families | Genera | Species |
|-----------------|-----------|-----------|------------|
| Anura | 7 | 15 | 27 |
| Caudata | 2 | 4 | 7 |
| Subtotal | 9 | 19 | 34 |
| Squamata | 19 | 57 | 92 |
| Testudines | 1 | 1 | 3 |
| Subtotal | 20 | 58 | 95 |
| Total | 29 | 77 | 129 |

in the H250 report, based on a collected specimen); (6) *Epictia wynnii* (reported in Querétaro by Wallach [2016]); (7) *Rena dulcis* (reported in Querétaro, see The Reptile Database, <http://www.reptile-database.org/>; accessed 22 August 2019); and (8) *Crotalus polystictus* (reported in Querétaro by Cruz-Pérez et al. [2014]). Thus, these eight species are included in the following analyses.

Four species which have not been formally documented from Querétaro thus far, but are expected to be documented for the state eventually, are: (1) *Coluber constrictor* (recorded in Querétaro by the IUCN, but with no locality provided); (2) *Conopsis biserialis* (not confirmed for the state, but with a high probability of occurrence, according to the IUCN and Goyenechea and Flores-Villela [2006]); (3) *Ficimia streckeri* (a high probability of occurrence in the state, based on a record found 3 km from the state line by Lara-Tufiño et al. [2013]); and (4) *Masticophis taeniatus* (reported in the H250 project as having a high probability of occurrence, but without confirmation). Given the ambiguity of their actual occurrence in the state at this point, we do not consider these four species in the subsequent analyses.

Five species reported previously by Cruz-Elizalde et al. (2019) are not currently believed to occur in Querétaro, so they are not included in the analyses in this paper. These species are: (1) *Gerrhonotus liocephalus* (According to Good [1994], this species does not occur in central Mexico, but reports might be based on a misidentified *G. infernalis*; also, it is not listed by the IUCN or in the H250 project as reported in Nieto-Montes de Oca and Pérez-Ramos [1999]); (2) *Lepidophyma flavimaculatum* (recorded in the H250 project, but this requires confirmation; its distribution appears to lie farther south in the states of Veracruz and Oaxaca); (3) *Leptodeira maculata* (not present in Querétaro based on its known distribution, and not listed by the IUCN or the H250 report); (4) *Thamnophis marcianus* (not present in Querétaro, neither recorded by Rossman et al. (1996) nor listed in the state by the IUCN; although it appears in the H250 report, no locality information or references were provided); and (5) *Crotalus ravus* (not known to occur in Querétaro; its distribution lies farther to the south; this taxon was not reported for the state by Campbell and Lamar [2004]). We do not consider these five species in the subsequent analyses in this paper.

Composition of the Herpetofauna

Families

The herpetofaunal species known to occur in Querétaro are in 29 families, and include seven families of anurans, two families of salamanders, 19 families of squamates, and one family of turtles (Table 3). This total represents 47.5% of the 61 herpetofaunal families known to occur in Mexico (Wilson et al. 2013a,b). No caecilian or crocodylian families are represented in the state. Of the nine amphibian families known to occur in the state, 58.8% of the species (Tables 4–5) are classified in the Bufonidae (six), Hylidae (eight), and Plethodontidae (six). Among the 20 remaining herpetofaunal families, 67 (70.5%) of the 95 species are categorized in the families Phrynosomatidae (12), Colubridae (22), Dipsadidae (15), Natricidae (eight), and Viperidae (10; see Table 5).

Genera

Seventy-seven herpetofaunal genera are known to occur in Querétaro, which includes 15 genera of anurans, four genera of salamanders, 57 genera of squamates, and one genus of turtles (Table 3). These 77 taxa comprise 35.8% of the 212 genera known to occur in Mexico (J. Johnson, unpub. data, 24 December 2020). Among the amphibians (Table 4), the largest numbers of species are in the genera *Eleutherodactylus* (four) and *Lithobates* (four); among the reptiles (Table 4), the most speciose genera are *Sceloporus* (11), *Thamnophis* (six), and *Crotalus* (seven).

Species

The herpetofauna of Querétaro is comprised of 129 species, including 27 anurans, seven salamanders, 92 squamates, and three turtles (Table 3). The current numbers of native species in these four groups in Mexico are, respectively, 253, 155, 896, and 51 (J. Johnson, unpub. data, 24 December 2020). The 129 herpetofaunal species in Querétaro represent 9.5% of the 1,361 species in all of Mexico (J. Johnson, unpub. data, 29 May 2021). Thus far, one state sharing a common border with Querétaro has been assessed in the Mexican Conservation Series—the state of Hidalgo (Ramírez-Bautista et al.

The herpetofauna of Querétaro, Mexico

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

| Taxon | Physiographic regions of Querétaro | | | Number of regions occupied |
|---|------------------------------------|-----|-----|----------------------------|
| | CP | TVB | SMO | |
| Anura (27 species) | | | | |
| Bufonidae (6 species) | | | | |
| <i>Anaxyrus compactilis</i> * | + | + | + | 3 |
| <i>Anaxyrus punctatus</i> | + | | | 1 |
| <i>Anaxyrus speciosus</i> | | | + | 1 |
| <i>Incilius nebulifer</i> | | | + | 1 |
| <i>Incilius occidentalis</i> * | + | + | + | 3 |
| <i>Rhinella horribilis</i> | + | + | + | 3 |
| Craugastoridae (2 species) | | | | |
| <i>Craugastor augusti</i> | + | + | + | 3 |
| <i>Craugastor decoratus</i> * | | | + | 1 |
| Eleutherodactylidae (4 species) | | | | |
| <i>Eleutherodactylus guttilatus</i> | + | | | 1 |
| <i>Eleutherodactylus longipes</i> * | | | + | 1 |
| <i>Eleutherodactylus nitidus</i> * | | | + | 1 |
| <i>Eleutherodactylus verrucipes</i> * | | + | + | 2 |
| Hylidae (8 species) | | | | |
| <i>Dryophytes arenicolor</i> | + | + | + | 3 |
| <i>Dryophytes eximius</i> * | + | + | + | 3 |
| <i>Rheohyla miotympanum</i> * | + | | + | 2 |
| <i>Scinax staufferi</i> | | | + | 1 |
| <i>Smilisca baudinii</i> | | | + | 1 |
| <i>Tlalocohyla godmani</i> * | | | + | 1 |
| <i>Tlalocohyla picta</i> | | | + | 1 |
| <i>Trachycephalus vermiculatus</i> | | | + | 1 |
| Microhylidae (1 species) | | | | |
| <i>Hypopachus variolosus</i> | | | + | 1 |
| Ranidae (4 species) | | | | |
| <i>Lithobates berlandieri</i> | + | + | + | 3 |
| <i>Lithobates montezumae</i> * | + | + | + | 3 |
| <i>Lithobates neovolcanicus</i> * | + | + | + | 3 |
| <i>Lithobates spectabilis</i> * | + | + | + | 3 |
| Scaphiopodidae (2 species) | | | | |
| <i>Scaphiopus couchii</i> | | | + | 1 |
| <i>Spea multiplicata</i> | + | + | + | 3 |
| Caudata (7 species) | | | | |
| Ambystomatidae (1 species) | | | | |
| <i>Ambystoma velasci</i> * | + | + | + | 3 |
| Plethodontidae (6 species) | | | | |
| <i>Aquiloerycea cephalica</i> * | + | | + | 2 |
| <i>Aquiloerycea scandens</i> * | | | + | 1 |
| <i>Chiropterotriton chondrostega</i> * | + | | + | 2 |
| <i>Chiropterotriton magnipes</i> * | | | + | 1 |
| <i>Chiropterotriton multidentatus</i> * | | | + | 1 |
| <i>Isthmura bellii</i> * | | | + | 1 |
| Squamata (92 species) | | | | |
| Anguidae (4 species) | | | | |
| <i>Abronia taeniata</i> * | | | + | 1 |
| <i>Barisia ciliaris</i> * | + | | + | 2 |
| <i>Gerrhonotus infernalis</i> | | + | | 1 |
| <i>Gerrhonotus ophiurus</i> * | + | | + | 2 |

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

| Taxon | Physiographic regions of Querétaro | | | Number of regions occupied |
|-------------------------------------|------------------------------------|-----|-----|----------------------------|
| | CP | TVB | SMO | |
| Corytophanidae (2 species) | | | | |
| <i>Corytophanes hernandezii</i> | | | + | 1 |
| <i>Laemancus serratus</i> | | | + | 1 |
| Dactyloidae (1 species) | | | | |
| <i>Norops sericeus</i> | | | + | 1 |
| Dibamidae (1 species) | | | | |
| <i>Anelytropsis papillosus</i> * | | | + | 1 |
| Gekkonidae (1 species) | | | | |
| <i>Hemidactylus frenatus</i> ** | | | + | 1 |
| Phrynosomatidae (12 species) | | | | |
| <i>Phrynosoma orbiculare</i> * | + | + | + | 3 |
| <i>Sceloporus aeneus</i> * | + | + | + | 3 |
| <i>Sceloporus dugesii</i> * | + | + | | 2 |
| <i>Sceloporus exsul</i> * | + | | | 1 |
| <i>Sceloporus grammicus</i> | + | + | + | 3 |
| <i>Sceloporus minor</i> * | + | | + | 2 |
| <i>Sceloporus parvus</i> * | + | | + | 2 |
| <i>Sceloporus scalaris</i> * | | + | + | 2 |
| <i>Sceloporus serrifer</i> | | | + | 1 |
| <i>Sceloporus spinosus</i> * | + | + | + | 3 |
| <i>Sceloporus torquatus</i> * | + | + | + | 3 |
| <i>Sceloporus variabilis</i> | + | | + | 2 |
| Scincidae (2 species) | | | | |
| <i>Plestiodon lynxe</i> * | + | | + | 2 |
| <i>Plestiodon tetragrammus</i> | | | + | 1 |
| Sphenomorphidae (3 species) | | | | |
| <i>Scincella gemmingeri</i> * | | | + | 1 |
| <i>Scincella lateralis</i> | | | + | 1 |
| <i>Scincella silvicola</i> * | | | + | 1 |
| Teiidae (2 species) | | | | |
| <i>Aspidoscelis gularis</i> | + | + | + | 3 |
| <i>Holcosus amphigrammus</i> * | + | | + | 2 |
| Xantusiidae (3 species) | | | | |
| <i>Lepidophyma gaigeae</i> * | + | | + | 2 |
| <i>Lepidophyma occulor</i> * | | | + | 1 |
| <i>Lepidophyma sylvaticum</i> * | | | + | 1 |
| Xenosauridae (1 species) | | | | |
| <i>Xenosaurus mendozai</i> * | | | + | 1 |
| Boidae (1 species) | | | | |
| <i>Boa imperator</i> | | | + | 1 |
| Colubridae (22 species) | | | | |
| <i>Conopsis lineata</i> * | + | + | + | 3 |
| <i>Conopsis nasus</i> * | + | + | + | 3 |
| <i>Drymarchon melanurus</i> | + | | + | 2 |
| <i>Drymobius margaritiferus</i> | | | + | 1 |
| <i>Ficimia olivacea</i> * | | | + | 1 |
| <i>Gyalopion canum</i> | + | | | 1 |
| <i>Lampropeltis polyzona</i> * | | | + | 1 |
| <i>Lampropeltis ruthveni</i> * | | + | | 1 |
| <i>Leptophis mexicanus</i> | | | + | 1 |
| <i>Masticophis mentovarius</i> | + | | | 1 |

The herpetofauna of Querétaro, Mexico

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

| Taxon | Physiographic regions of Querétaro | | | Number of regions occupied |
|-------------------------------------|------------------------------------|-----|-----|----------------------------|
| | CP | TVB | SMO | |
| <i>Masticophis schotti</i> | + | + | + | 3 |
| <i>Mastigodryas melanolomus</i> | | | + | 1 |
| <i>Oxybelis potosiensis</i> | | | + | 1 |
| <i>Pituophis deppei</i> * | + | + | + | 3 |
| <i>Pseudelaphe flavirufa</i> | + | | | 1 |
| <i>Salvadora bairdi</i> * | + | | + | 2 |
| <i>Salvadora grahamiae</i> | | + | | 1 |
| <i>Senticolis triaspis</i> | + | | + | 2 |
| <i>Spilotes pullatus</i> | | | + | 1 |
| <i>Tantilla bocourti</i> * | | + | | 1 |
| <i>Tantilla rubra</i> | + | | + | 2 |
| <i>Trimorphodon tau</i> * | + | + | + | 3 |
| Dipsadidae (15 species) | | | | |
| <i>Adelphicos quadrivirgatum</i> | | | + | 1 |
| <i>Amastridium sapperi</i> | | | + | 1 |
| <i>Chersodromus rubriventris</i> * | | | + | 1 |
| <i>Coniophanes fissidens</i> | | | + | 1 |
| <i>Coniophanes piceivittis</i> | | | + | 1 |
| <i>Conophis lineatus</i> | + | + | + | 3 |
| <i>Diadophis punctatus</i> | + | + | | 2 |
| <i>Geophis latifrontalis</i> * | | | + | 1 |
| <i>Geophis mutitorques</i> * | | + | + | 2 |
| <i>Hypsiglena jani</i> | + | + | + | 3 |
| <i>Imantodes gemmistratus</i> | | | + | 1 |
| <i>Leptodeira septentrionalis</i> | | + | | 1 |
| <i>Ninia diademata</i> | | | + | 1 |
| <i>Rhadinaea gaigeae</i> * | + | | + | 2 |
| <i>Tropidodipsas sartorii</i> | | | + | 1 |
| Elapidae (1 species) | | | | |
| <i>Micrurus tener</i> | + | | + | 2 |
| Leptotyphlopidae (2 species) | | | | |
| <i>Epictia wynni</i> * | + | | | 1 |
| <i>Rena dulcis</i> | + | + | | 2 |
| Natricidae (8 species) | | | | |
| <i>Storeria hidalgoensis</i> * | | | + | 1 |
| <i>Storeria storerioides</i> * | | | + | 1 |
| <i>Thamnophis cyrtopsis</i> | + | + | + | 3 |
| <i>Thamnophis eques</i> | + | + | | 2 |
| <i>Thamnophis melanogaster</i> * | | + | | 1 |
| <i>Thamnophis pulchrilatus</i> * | + | | | 1 |
| <i>Thamnophis scalaris</i> * | + | | | 1 |
| <i>Thamnophis sumichrasti</i> * | | | + | 1 |
| Typhlopidae (1 species) | | | | |
| <i>Virgotyphlops braminus</i> ** | + | | | 1 |
| Viperidae (10 species) | | | | |
| <i>Agkistrodon taylori</i> * | | | + | 1 |
| <i>Bothrops asper</i> | | | + | 1 |
| <i>Crotalus aquilus</i> * | + | + | + | 3 |
| <i>Crotalus atrox</i> | + | | | 1 |
| <i>Crotalus molossus</i> | + | | | 1 |
| <i>Crotalus polystictus</i> * | + | | | 1 |

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

| Taxon | Physiographic regions of Querétaro | | | Number of regions occupied |
|-----------------------------------|------------------------------------|-----------|------------|----------------------------|
| | CP | TVB | SMO | |
| <i>Crotalus scutulatus</i> | + | | | 1 |
| <i>Crotalus totonacus</i> * | | | + | 1 |
| <i>Crotalus triseriatus</i> * | + | | | 1 |
| <i>Metlapilcoatlus borealis</i> * | | | + | 1 |
| Kinosternidae (3 species) | | | | |
| <i>Kinosternon hirtipes</i> | | + | | 1 |
| <i>Kinosternon integrum</i> * | + | + | + | 3 |
| <i>Kinosternon scorpioides</i> | | + | | 1 |
| Total | 64 | 43 | 102 | — |

2020). The herpetofauna of Hidalgo consists of 203 species, which is about 1.6 times the number of species in Querétaro (129). This proportion is similar to the relative areas of the two states. The surface area of Hidalgo is 20,813 km² (Ramírez-Bautista et al. 2020) and that of Querétaro, as noted above, is 11,699 km²; therefore, Hidalgo is 1.8 times the size of Querétaro. Thus, the state area/species richness ratio is 90.7 for Querétaro compared to 102.5 for Hidalgo.

Patterns of Physiographic Distribution

A system of three physiographic regions (Fig. 1) was used to analyze the distribution patterns of the amphibians and reptiles of Querétaro, and the physiographic distribution data for the 129 species are tabulated in Table 4 and summarized in Table 5.

The total number of species in each region ranges from 43 in the Transmexican Volcanic Belt (TVB) to 102 species in the Sierra Madre Oriental (SMO). The value for the remaining area (Central Plateau) is 64. The low value of 43 for TVB in Querétaro is 42.2% of the high value of 102 for SMO in Querétaro. The reason for this disparity is that the TVB is the smallest of the three regions in the state, and although it is a significant montane region in Mexico, it contains less herpetofaunal diversity than the SMO (Canseco-Márquez et al. 2004; Flores-Villela et al. 2010), i.e., 139 vs. 207, respectively.

Four herpetofaunal groups (anurans, salamanders, squamates, and turtles) are known to occur in Querétaro, while caecilians and crocodylians have not been recorded in the state and are not likely to be found in the future. In three of these groups (anurans, salamanders, and squamates), the largest number of species occurs in the SMO; while all three species of turtles are found in the TVB (Table 5). Twenty-five of the 27 anuran species (92.6%), all seven of the salamander species (100%), and 69 of the 92 squamates (75.0%) occur in the SMO.

The members of the Querétaro herpetofauna are distributed in either one, two, or three physiographic regions as follows: one region (77 of 129 species, 59.7%);

two regions (24, 18.6%); and three regions (28, 21.7%). The mean regional occupancy is 1.6, which lies outside the range of 1.9 to 3.7 for the other states examined thus far in the MCS (Alvarado-Díaz et al. 2013; Mata-Silva et al. 2015; Johnson et al. 2015a; Terán-Juárez et al. 2016; Woolrich-Piña et al. 2016; 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). Of the 129 species found in Querétaro, a large proportion (101, or 78.3%) occurs in one or two of the three physiographic regions, which is significant from a conservation perspective (see below). The number of species inhabiting a single physiographic region ranges from eight (in the TVB) to 54 (in the SMO).

The 54 single-region species in the SMO are as follows, with the numbers referring to the distributional categories developed by Wilson et al. (2017), country endemics indicated by single asterisks, and non-native species by double asterisks:

Anaxyrus speciosus 3
Incilius nebulifer 3
*Craugastor decoratus**
*Eleutherodactylus longipes**
*Eleutherodactylus nitidus**
Scinax staufferi 4
Smilisca baudinii 7
*Tlalocohyla godmani**
Tlalocohyla picta 4
Trachycephalus vermiculatus 6
Hypopachus variolosus 7
Scaphiopus couchii 3
*Aquiloerycea scandens**
*Chiropterotriton magnipes**
*Chiropterotriton multidentatus**
*Isthmura bellii**
*Abronia taeniata**
Corytophanes hernandezii 4
Laemanctus serratus 4
Norops sericeus 4



No. 9. *Norops sericeus* Hallowell, 1856. The Silky Anole occurs in the states of Tamaulipas, Hidalgo, San Luis Potosí, Veracruz, Tabasco, Campeche, Quintana Roo, northern Oaxaca, Querétaro, and Puebla. This individual was found in the municipality of Pisaflores, Hidalgo, near the state of Querétaro. Wilson et al. (2013a) determined its EVS as 8, placing it in the low vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Daniel Lara Tufiño.*



No. 10. *Phrynosoma orbiculare* (Linnaeus, 1758). The Mountain Horned Lizard is known from the states of Chihuahua, Aguascalientes, Hidalgo, Querétaro, San Luis Potosí, Michoacán, Ciudad de México, Estado de México, Jalisco, Morelos, Tlaxcala, and Guanajuato (Ramírez-Bautista et al. 2014). This individual was located in the city of Querétaro, Querétaro. Wilson et al. (2013a) determined its EVS as 12, placing it in the upper portion of the medium vulnerability category. Its conservation status has been considered as Least Concern by the IUCN, and as Threatened (A) by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 11. *Sceloporus grammicus* Wiegmann, 1828. The Mesquite Lizard occurs in the states of Chihuahua, Durango, Zacatecas, Coahuila, San Luis Potosí, Nuevo León, Tamaulipas, Oaxaca, Guerrero, Querétaro, Hidalgo, Aguascalientes, and Nayarit. This individual was found in Huimilpan, Querétaro. Wilson et al. (2013a) determined its EVS as 9, placing it in the low vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, and it has been placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 12. *Plestiodon lynxe* (Wiegmann, 1834). The Oak Forest Skink occurs in central and western Mexico, in the states of Hidalgo, Veracruz, San Luis Potosí, Tamaulipas, Puebla, Aguascalientes, Querétaro, Guanajuato, Jalisco, and Nayarit. This individual was found in Pinal de Amoles, Querétaro. Wilson et al. (2013a) determined its EVS as 10, placing it in the medium vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, and it has been placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*

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

| Family | Number of species | Distributional occurrence | | |
|---------------------|-------------------|---------------------------|-----------|------------|
| | | CP | TVB | SMO |
| Bufonidae | 6 | 4 | 3 | 5 |
| Craugastoridae | 2 | 1 | 1 | 2 |
| Eleutherodactylidae | 4 | 1 | 1 | 3 |
| Hylidae | 8 | 3 | 2 | 8 |
| Microhylidae | 1 | — | — | 1 |
| Ranidae | 4 | 4 | 4 | 4 |
| Scaphiopodidae | 2 | 1 | 1 | 2 |
| Subtotal | 27 | 14 | 12 | 25 |
| Ambystomatidae | 1 | 1 | 1 | 1 |
| Plethodontidae | 6 | 2 | — | 6 |
| Subtotal | 7 | 3 | 1 | 7 |
| Total | 34 | 17 | 13 | 32 |
| Anguidae | 4 | 2 | 1 | 3 |
| Corytophanidae | 2 | — | — | 2 |
| Dactyloidae | 1 | — | — | 1 |
| Dibamidae | 1 | — | — | 1 |
| Gekkonidae | 1 | — | — | 1 |
| Phrynosomatidae | 12 | 10 | 7 | 10 |
| Scincidae | 2 | 1 | — | 2 |
| Sphenomorphidae | 3 | — | — | 3 |
| Teiidae | 2 | 2 | 1 | 2 |
| Xantusiidae | 3 | 1 | — | 3 |
| Xenosauridae | 1 | — | — | 1 |
| Subtotal | 32 | 16 | 9 | 29 |
| Boidae | 1 | — | — | 1 |
| Colubridae | 22 | 12 | 8 | 16 |
| Dipsadidae | 15 | 4 | 5 | 13 |
| Elapidae | 1 | 1 | — | 1 |
| Leptotyphlopidae | 2 | 2 | 1 | — |
| Natricidae | 8 | 4 | 3 | 4 |
| Typhlopidae | 1 | 1 | — | — |
| Viperidae | 10 | 6 | 1 | 5 |
| Subtotal | 60 | 30 | 18 | 40 |
| Kinosternidae | 3 | 1 | 3 | 1 |
| Subtotal | 3 | 1 | 3 | 1 |
| Total | 95 | 47 | 30 | 70 |
| Sum total | 129 | 64 | 43 | 102 |

*Anelytropsis papillosus**
*Hemidactylus frenatus***
Sceloporus serrifer 4
Plestiodon tetragrammus 3
*Scincella gemmingeri**
Scincella lateralis 3
*Scincella silvicola**
*Lepidophyma occulor**
*Lepidophyma sylvaticum**
*Xenosaurus mendozai**
Boa imperator 6
Drymobius margaritiferus 8
*Ficimia olivacea**

*Lampropeltis polyzona**
Leptophis mexicanus 4
Mastigodryas melanolomus 4
Oxybelis potosiensis 8
Spilotes pullatus 6
Adelpicos quadrivirgatum 4
Amastridium sapperi 4
*Chersodromus rubriventris**
Coniophanes fissidens 6
Coniophanes piceivittis 4
*Geophis latifrontalis**
Imantodes gemmistratus 6
Ninia diademata 4



No. 13. *Scincella gemmingeri* (Cope, 1864). Cope's Forest Ground Skink occurs in southeastern Mexico, in Chiapas, eastern Hidalgo, central and southern Veracruz, Querétaro, Oaxaca, southward to Tehuantepec, and on the slopes of the plateau and in lowland areas of Tabasco and Puebla. This individual was found in Pinal de Amoles, Querétaro. Wilson et al. (2013a) determined its EVS as 11, placing it in the medium vulnerability category. Its conservation status has been regarded as Least Concern by the IUCN, and it has been placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 14. *Xenosaurus mendozai* Nieto-Montes de Oca, García-Vázquez, Zúñiga-Vega, and Schmidt-Ballardo, 2013. The Granular-Scaled Lizard occurs in the states of Querétaro, from where it was first described, and Hidalgo. This individual was found in the municipality of Jacala de Ledezma, Hidalgo, near the state of Querétaro. In this study, and according to Wilson et al. (2013a), we determined its EVS as 16, placing it in the high vulnerability category. According to IUCN, its conservation status is unknown, and this species is not listed by SEMARNAT. *Photo by Christian Berriozabal-Islas.*



No. 15. *Conopsis lineata* (Kennicott, 1859). The Lined Toluca Ground Snake occurs in the central Mexican states of Guanajuato, Guerrero, Jalisco, Estado de México, Michoacán, Morelos, Oaxaca, Puebla, Querétaro, Hidalgo, San Luis Potosí, Tlaxcala, Veracruz, and Ciudad de México (Ramírez-Bautista et al. 2014). This individual was found near the city of Querétaro. Wilson et al. (2013a) determined its EVS as 13, placing it at the upper limit of the medium vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 16. *Amastridium sapperi* (Werner, 1903). The Rusty-headed Snake occurs in the states of Chiapas, Oaxaca, Hidalgo, and Querétaro. This individual was found in La Cueva, Pisaflores, Hidalgo, near the state of Querétaro. Wilson et al. (2013a) determined its EVS as 10, placing it in the medium vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Daniel Lara Tufiño.*

Tropidodipsas sartorii 4
*Storeria hidalgoensis**
*Storeria storerioides**
*Thamnophis sumichrasti**
*Agkistrodon taylori**
Bothrops asper 6
*Crotalus totonacus**
*Metlapilcoatlus borealis**

Twenty-five of these 54 species (46.3%) are country endemics and 28 of the remaining 29 are non-endemics, apart from the single non-native *Hemidactylus frenatus*. The distribution ranges of the 28 non-endemic species are thus: five range to the north, including the United States; 13 range farther south into Central America; six range through Central America and into South America; two range from the United States to Central America; and two occur from the United States to South America.

The 15 single-region species in the CP are as follows, using the same asterisk and numbering identifiers as above:

Anaxyrus punctatus 3
Eleutherodactylus guttillatus 3
*Sceloporus exsul**
Gyalopion canum 3
Masticophis mentovarius 6
Pseudoelaphe flavirufa 4
*Epictia wynnii**
*Thamnophis pulchrilatus**
*Thamnophis scalaris**
*Virgotyphlops braminus***
Crotalus atrox 3
Crotalus molossus 3
*Crotalus polystictus**
Crotalus scutulatus 3
*Crotalus triseriatus**

Six of these 15 species (40.0%) are country endemics and the remaining nine are non-endemics, except for the non-native *Virgotyphlops braminus*. Six of the eight non-native species also range to the north, including the United States, while one ranges farther south into Central America, and another one ranges through Central America and into South America.

Table 6. Pair-wise comparison matrix of Coefficient of Biogeographic Resemblance (CBR) data of the herpetofaunal relationships for the three physiographic regions in Querétaro, 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>64</u> | 32 | 45 |
| Transmexican Volcanic Belt | 0.60 | <u>43</u> | 31 |
| Sierra Madre Oriental | 0.54 | 0.43 | <u>102</u> |

The eight single-region species in the TVB are as follows, using the same asterisk and numbering identifiers as above:

Gerrhonotus infernalis 3
*Lampropeltis ruthveni**
Salvadora grahamiae 3
*Tantilla bocourti**
Leptodeira septentrionalis 8
*Thamnophis melanogaster**
Kinosternon hirtipes 3
Kinosternon scorpioides 6

Three of these eight species (37.5%) are country endemics and the remaining five are non-endemics. Three of these five species also range to the north, including the United States, one species ranges through Central America and into South America, and one species occurs from the United States to South America.

In summary, of the 77 single-region species found in Querétaro, 34 (44.2%) are country endemics, 41 (53.2%) are non-endemics, and two are non-natives (2.6%). Of the three physiographic regions in the state, the SMO is of greatest conservation significance, inasmuch as it encompasses the largest overall number of species (102), the largest number of single-region species (54), and the largest number of country endemics (25).

A Coefficient of Biogeographic Resemblance (CBR) matrix was assembled for examining the herpetofaunal similarity relationships of the three physiographic regions in Querétaro (Table 6). The SMO contains the most species richness (102 species) and the TVB the least (43 species). The mean species richness value for all three regions is 69.7. The number of shared species between each of the regional pairs ranges from 31 between the TVB and SMO regions to 45 between the Central Plateau and the SMO. The mean value of shared species among all three regions is 36.0.

The CBR values in Table 6 range from 0.43 to 0.59. The lowest value is that between the Sierra Madre Oriental and the Transmexican Volcanic Belt. These two regions lie at opposite extremes in the state (Fig. 1). The highest value is that between the Transmexican Volcanic Belt and the Central Plateau, which are contiguous regions

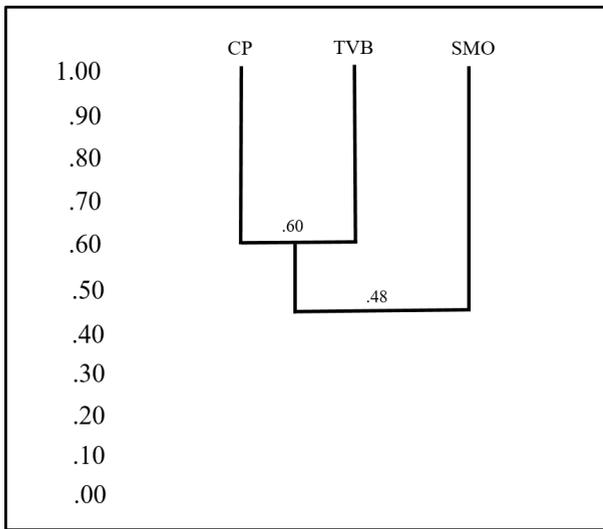


Fig. 10. UPGMA-generated dendrogram illustrating the similarity relationships of species richness among the herpetofaunal components in the three physiographic regions of Querétaro (based on the data in Table 7; Sokal and Michener 1958). Similarity values were calculated using Duellman’s (1990) Coefficient of Biogeographic Resemblance (CBR).

located in the south-central part of the state. The overall CBR values among the three physiographic regions are as follows, arranged from the highest to the lowest value (with species numbers in parentheses):

Transmexican Volcanic Belt (43) – 0.59 – Central Plateau (65)
Sierra Madre Oriental (102) – 0.54 – Central Plateau (65)

Based on the data in Table 6, a UPGMA dendrogram (Fig. 10) was developed to illustrate the herpetofaunal resemblance patterns among the three physiographic regions of Querétaro (Fig. 1). The diagram demonstrates that two regions in Querétaro, the CP and the TVB, share the higher herpetofaunal resemblance (0.60 level). Both of these regions are largely montane and broadly contact one another in the southern portion of the state. These two regions are more distinguished (0.43 level) from the Sierra Madre Oriental (SMO).

As indicated in the Introduction, we consider it useful to compare the herpetofaunal representation of the two physiographic regions in Querétaro with those of the same two regions represented in Puebla (Woolrich-Piña et al. 2017) and Hidalgo (Ramírez-Bautista et al. 2020). We placed the comparative data in Table 7. Most of the species in the two physiographic regions we examined are either Mexican endemic or non-endemic species, while few state endemics and non-native species occur in either region. As expected, the number of species in the two regions examined increases along with the size of the herpetofauna in each of the three states, i.e., from Querétaro (129 species) to Hidalgo (202 species) to Puebla (267 species). In each of the three states the number of country endemics is greater than the number of non-endemics. The proportions of country endemics

Table 7. Species comparison of three distributional categories recorded in the two physiographic regions common to the three states of Querétaro, Hidalgo, and Puebla in Mexico.

| | Sierra Madre Oriental | | | | | Transmexican Volcanic Belt | | | | |
|-----------|-----------------------|----------------|--------------|-------------|----------------|----------------------------|----------------|--------------|-------------|----------------|
| | Country endemics | State endemics | Non-endemics | Non-natives | Regional total | Country endemics | State endemics | Non-endemics | Non-natives | Regional total |
| Querétaro | 57 | — | 44 | 1 | 102 | 23 | — | 20 | — | 43 |
| Hidalgo | 87 | 3 | 74 | 1 | 165 | 59 | 4 | 20 | 2 | 85 |
| Puebla | 102 | 2 | 79 | 2 | 185 | 77 | 2 | 46 | — | 125 |

compared to the regional totals for the Sierra Madre Oriental in each of the three states are similar (55.9%, 52.7%, and 55.1% for Querétaro, Hidalgo, and Puebla, respectively). Likewise, each of the proportions for the Transmexican Volcanic Belt are reasonably similar to one another (53.5%, 69.4%, and 61.6%, respectively). The proportions of the non-endemics compared to the regional totals for the Sierra Madre Oriental in the same three states also are similar to one another (43.4%, 44.8%, and 42.7%, respectively), whereas those for the Transmexican Volcanic Belt are less consistent (46.5%, 23.5%, and 36.8%, respectively).

Distribution Status Categorizations

In discussing the distribution status of the members of the Querétaro herpetofauna, we used the system developed by Alvarado-Díaz et al. (2013) which was used in all the other entries of the Mexican Conservation Series (see above). The categories in this system are non-endemic, country endemic, state endemic (only *Sceloporus exsul*), and non-native. The categorizations for each species are listed in Table 8 and these data are summarized in Table 9.

The numbers of species in each of the three applicable categories, in decreasing order, are: country endemics, 67 (51.5%); non-endemics, 60 (46.2%); and non-natives, 3 (2.3%). As with the states of Michoacán (Alvarado-Díaz et al. 2013), Nayarit (Woolrich-Piña et al. 2016), Jalisco (Cruz-Sáenz et al. 2017), Puebla (Woolrich-Piña et al. 2017), and Hidalgo (Ramírez-Bautista et al. 2020), the largest number of herpetofaunal species in Querétaro is in the country endemic category. In other states, the largest number falls within the non-endemic category, i.e., Oaxaca (Mata-Silva et al. 2015), Tamaulipas (Terán-Juárez et al. 2016), Nuevo León (Nevárez-de los Reyes et al. 2016), and Chiapas (Johnson et al. 2015a).

Only one endemic species occurs in Querétaro (*Sceloporus exsul*), and in the 10 previous individual-state entries in the Mexican Conservation Series the number of state endemics was found to be variable, ranging from one in Nayarit and Nuevo León (Woolrich-Piña et al. 2016; Nevárez-de los Reyes 2016) to 93 in Oaxaca (Mata-Silva et al. 2015).

Two non-native species are found in Querétaro, *Hemidactylus frenatus* and *Virgotyphlops braminus*. These two taxa are the most widespread of the non-native species recorded in the 12 entries in the Mexican Conservation Series (Ramírez-Bautista et al. 2020), and as of this contribution, they now have been recorded in 11 and 12 states or tri-state regions, respectively.

Wilson et al. (2017) developed a system for categorizing the distribution of the herpetofauna of Mesoamerica, and applying those categories to this study, the data are summarized in Table 10. Previously, we noted that 67 species in Querétaro are endemic to Mexico, and thus 60 native species are not. These 60 species are allocated to five of the categories established

by Wilson et al. (2017): MXUS, MXCA, MXSA, USCA, and USSA. As expected, the largest number of species falls into the MXUS category (26, 43.3%), which is followed by MXCA (17, 28.3%), MXSA (9, 15.0%), USCA (5, 8.3%), and finally USSA (3, 5.0%).

Principal Environmental Threats

In this section we discuss the problems affecting the sustainability of the amphibian and reptile populations in Querétaro that we consider to be of greatest significance. Several negative factors apply, such as the increasing and unregulated clearing of forests for farming and raising livestock (for grazing areas), the construction of roads, the constant and increasing pollution in bodies of water, emerging diseases, forest fires, and strongly ingrained cultural factors (Cruz-Elizalde et al. 2016, 2019). Humans have caused all these factors, either directly or indirectly, so they should be considered “anthropogenic effects.”

Deforestation. Despite the fact that Querétaro is substantially covered with vegetation, primarily in the northern part of the state where oak forests, pine forests, tropical vegetation, and cloud forest still remain, many of these areas have been highly deforested for their timber resources. Sawmills for wood extraction are common in many places, and woodlands often are transformed into areas for agriculture and livestock use. Forested areas in the state consist of 737,821 ha, of which 51.4% corresponds to arid areas such as chaparral and shrubland, 24.1% to temperate forest dominated by conifers, 9.1% to various forests (low, medium, and high), and 15.1% to disturbed areas with various degrees of effect, without vegetation cover, or of little importance.

The areas of natural vegetation, whether with forests or other types of cover, have been deforested to create agricultural areas, urban settlements, industrial parks, gas pipelines, aquaculture, or roads (Fig. 11). About 80% of all forest fires have been intentional. Accordingly, federal agencies such as the National Forestry Commission (CONAFOR) and state agencies such as the Forest Department of the Querétaro Secretariat for Agricultural Development (SEDEA) have devoted resources, personnel, and campaigns to the mitigation of these fires. In addition, reforestation programs have focused on regions with temperate forest sites, where large portions of the area have been reforested, such as in the municipalities of Cadereyta de Montes, Colón, and Peñamiller, where 1,555 ha in these three municipalities have been reforested since 2016.

Deforestation has been more extensive in areas of northern Querétaro, both in temperate environments and forests. This destruction has largely affected the amphibians and reptiles that primarily inhabit these environments, such as salamanders of the genera *Chiropterotriton* and *Pseudoeurycea*; anurans such



No. 17. *Thamnophis eques* (Reuss, 1834). The Mexican Garter Snake occurs in Mexico from the vicinity of the Pico de Orizaba northwestward to and south to Aguascalientes, Sonora and Chihuahua, Querétaro, Oaxaca, Nuevo León, Hidalgo, San Luis Potosí, Guanajuato, Puebla, Guerrero, Nayarit, and Morelos. This individual was found in the locality of Mesa de León, Querétaro. Wilson et al. (2013a) determined its EVS as 8, placing it in the low vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, and it has been placed in the Endangered (A) category by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 18. *Thamnophis sumichrasti* (Cope, 1866). Sumichrast's Garter Snake occurs in the states of Oaxaca, Chiapas, Querétaro, San Luis Potosí, Tabasco, Puebla, Veracruz, and Hidalgo. This individual was found in Landa de Matamoros, Querétaro. Wilson et al. (2013a) determined its EVS as 15, placing it in the high vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, and it has been placed in the Endangered (A) category by SEMARNAT. *Photo by Raciél Cruz-Elizalde.*



No. 19. *Micrurus tener* (Baird and Girard, 1853). The Texas Coralsnake occurs “from the Mississippi River westward into Texas, in the United States, and in Mexico, from Tamaulipas south to Veracruz...” (Lemos-Espinal and Dixon 2013: 240). This individual came from Zona Metropolitana de Querétaro in the municipality of El Marques. Wilson et al. (2013a) calculated its EVS as 11, placing it in the medium vulnerability category. Its conservation status has been determined as Least Concern by IUCN, and this species is not listed by SEMARNAT. *Photo by Diego Baez.*



No. 20. *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 the Área Natural de Peña Colorada, in the municipality of Querétaro. Wilson et al. (2013a) ascertained its EVS as 16, placing it in the middle portion of the high vulnerability category. This species has been assessed as Least Concern by IUCN, and placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Alejandro Peralta Robles.*

Table 8. Distributional and conservation status measures for members of the herpetofauna of Querétaro, 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 (EVS of 3–9); medium (M) vulnerability (EVS of 10–13); and high (H) vulnerability (EVS of 14–20). IUCN categories: 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.

| Taxon | Distributional status | Environmental Vulnerability Category (score) | IUCN categorization | SEMARNAT status |
|---|-----------------------|--|---------------------|-----------------|
| <i>Anaxyrus compactilis</i> * | CE | H (14) | LC | NS |
| <i>Anaxyrus punctatus</i> | NE3 | L (5) | LC | NS |
| <i>Anaxyrus speciosus</i> | NE3 | M (12) | LC | NS |
| <i>Incilius nebulifer</i> | NE3 | L (6) | LC | NS |
| <i>Incilius occidentalis</i> * | CE | M (11) | LC | NS |
| <i>Rhinella horribilis</i> | NE7 | L (3) | NE | NS |
| <i>Craugastor augusti</i> | NE3 | L (8) | LC | NS |
| <i>Craugastor decoratus</i> * | CE | H (15) | VU | Pr |
| <i>Eleutherodactylus guttillatus</i> | NE3 | M (11) | LC | NS |
| <i>Eleutherodactylus longipes</i> * | CE | H (15) | VU | NS |
| <i>Eleutherodactylus nitidus</i> * | CE | M (12) | LC | NS |
| <i>Eleutherodactylus verrucipes</i> * | CE | H (16) | VU | Pr |
| <i>Dryophytes arenicolor</i> | NE3 | L (7) | LC | NS |
| <i>Dryophytes eximius</i> * | CE | M (10) | LC | NS |
| <i>Rheohyla miotympanum</i> * | CE | L (9) | NT | NS |
| <i>Scinax staufferi</i> | NE4 | L (4) | LC | NS |
| <i>Smilisca baudinii</i> | NE7 | L (3) | LC | NS |
| <i>Tlalocohyla godmani</i> * | CE | M (13) | VU | A |
| <i>Tlalocohyla picta</i> | NE4 | L (8) | LC | NS |
| <i>Trachycephalus vermiculatus</i> | NE6 | L (4) | LC | NS |
| <i>Hypopachus variolosus</i> | NE7 | L (4) | LC | NS |
| <i>Lithobates berlandieri</i> | NE3 | L (7) | LC | Pr |
| <i>Lithobates montezumae</i> * | CE | M (13) | LC | Pr |
| <i>Lithobates neovolcanicus</i> * | CE | M (13) | NT | A |
| <i>Lithobates spectabilis</i> * | CE | M (12) | LC | NS |
| <i>Scaphiopus couchii</i> | NE3 | L (3) | LC | NS |
| <i>Spea multiplicata</i> | NE3 | L (6) | LC | NS |
| <i>Ambystoma velasci</i> * | CE | M (10) | LC | Pr |
| <i>Aquiloerycea cephalica</i> * | CE | H (14) | NT | A |
| <i>Aquiloerycea scandens</i> * | CE | H (17) | VU | Pr |
| <i>Chiropetrotriton chondrostega</i> * | CE | H (17) | EN | Pr |
| <i>Chiropetrotriton magnipes</i> * | CE | H (16) | CR | Pr |
| <i>Chiropetrotriton multidentatus</i> * | CE | H (15) | EN | Pr |
| <i>Isthmura bellii</i> * | CE | M (12) | VU | A |
| <i>Abronia taeniata</i> * | CE | H (15) | VU | Pr |
| <i>Barisia ciliaris</i> * | CE | H (14) | LC | Pr |
| <i>Gerrhonotus infernalis</i> | NE3 | M (13) | LC | NS |
| <i>Gerrhonotus ophiurus</i> * | CE | M (12) | LC | NS |
| <i>Corytophanes hernandezii</i> | NE4 | M (13) | LC | Pr |
| <i>Laemanctus serratus</i> | NE4 | L (8) | LC | Pr |
| <i>Norops sericeus</i> | NE4 | L (8) | NE | NS |
| <i>Anelytropsis papillosus</i> * | CE | M (10) | LC | A |
| <i>Hemidactylus frenatus</i> ** | NN | — | — | — |

The herpetofauna of Querétaro, Mexico

Table 8 (continued). Distributional and conservation status measures for members of the herpetofauna of Querétaro, 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 (EVS of 3–9); medium (M) vulnerability (EVS of 10–13); and high (H) vulnerability (EVS of 14–20). IUCN categories: 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.

| Taxon | Distributional status | Environmental Vulnerability Category (score) | IUCN categorization | SEMARNAT status |
|---------------------------------|-----------------------|--|---------------------|-----------------|
| <i>Phrynosoma orbiculare</i> * | CE | M (12) | LC | A |
| <i>Sceloporus aeneus</i> * | CE | M (13) | LC | NS |
| <i>Sceloporus dugesii</i> * | CE | M (13) | LC | NS |
| <i>Sceloporus exsul</i> * | CE | H (17) | CR | A |
| <i>Sceloporus grammicus</i> | NE3 | L (9) | LC | Pr |
| <i>Sceloporus minor</i> * | CE | H (14) | LC | NS |
| <i>Sceloporus parvus</i> * | CE | H (15) | LC | NS |
| <i>Sceloporus scalaris</i> * | CE | M (12) | LC | NS |
| <i>Sceloporus serrifer</i> | NE4 | L (6) | LC | NS |
| <i>Sceloporus spinosus</i> * | CE | M (12) | LC | NS |
| <i>Sceloporus torquatus</i> * | CE | M (11) | LC | NS |
| <i>Sceloporus variabilis</i> | NE4 | L (5) | LC | NS |
| <i>Plestiodon lynxe</i> * | CE | M (10) | LC | Pr |
| <i>Plestiodon tetragrammus</i> | NE3 | M (12) | LC | NS |
| <i>Scincella gemmingeri</i> * | CE | M (11) | LC | Pr |
| <i>Scincella lateralis</i> | NE3 | M (13) | LC | Pr |
| <i>Scincella silvicola</i> * | CE | M (12) | LC | A |
| <i>Aspidoscelis gularis</i> | NE3 | L (9) | LC | NS |
| <i>Holcosus amphigrammus</i> * | CE | M (11) | NE | NS |
| <i>Lepidophyma gaigeae</i> * | CE | M (13) | VU | Pr |
| <i>Lepidophyma occulor</i> * | CE | H (14) | LC | Pr |
| <i>Lepidophyma sylvaticum</i> * | CE | M (11) | LC | Pr |
| <i>Xenosaurus mendozai</i> * | CE | H (16) | NE | NS |
| <i>Boa imperator</i> | NE6 | M (10) | NE | NS |
| <i>Conopsis lineata</i> * | CE | M (13) | LC | NS |
| <i>Conopsis nasus</i> * | CE | M (11) | LC | NS |
| <i>Drymarchon melanurus</i> | NE6 | L (6) | LC | NS |
| <i>Drymobius margaritiferus</i> | NE8 | L (6) | NE | NS |
| <i>Ficimia olivacea</i> * | CE | L (9) | NE | NS |
| <i>Gyalopion canum</i> | NE3 | L (9) | LC | NS |
| <i>Lampropeltis polyzona</i> * | CE | M (11) | NE | NS |
| <i>Lampropeltis ruthveni</i> * | CE | H (16) | NT | A |
| <i>Leptophis mexicanus</i> | NE4 | L (6) | LC | A |
| <i>Masticophis mentovarius</i> | NE6 | L (6) | LC | A |
| <i>Masticophis schotti</i> | NE3 | M (13) | LC | NS |
| <i>Mastigodryas melanolomus</i> | NE4 | L (6) | LC | NS |
| <i>Oxybelis potosiensis</i> | NE8 | L (5) | NE | NS |
| <i>Pituophis deppei</i> * | CE | H (14) | LC | A |
| <i>Pseudelaphe flavirufa</i> | NE4 | M (10) | LC | NS |
| <i>Salvadora bairdi</i> * | CE | H (15) | LC | Pr |
| <i>Salvadora grahamiae</i> | NE3 | M (10) | LC | NS |
| <i>Senticolis triaspis</i> | NE7 | L (6) | LC | NS |
| <i>Spilotes pullatus</i> | NE6 | L (6) | NE | NS |

Table 8 (continued). Distributional and conservation status measures for members of the herpetofauna of Querétaro, 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 (EVS of 3–9); medium (M) vulnerability (EVS of 10–13); and high (H) vulnerability (EVS of 14–20). IUCN categories: 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.

| Taxon | Distributional status | Environmental Vulnerability Category (score) | IUCN categorization | SEMARNAT status |
|------------------------------------|-----------------------|--|---------------------|-----------------|
| <i>Tantilla bocourti</i> * | CE | L (9) | LC | NS |
| <i>Tantilla rubra</i> | NE4 | L (5) | LC | Pr |
| <i>Trimorphodon tau</i> * | CE | M (13) | LC | NS |
| <i>Adelphicos quadrivirgatum</i> | NE4 | M (10) | LC | Pr |
| <i>Amastridium sapperi</i> | NE4 | M (10) | LC | NS |
| <i>Chersodromus rubriventris</i> * | CE | H (14) | EN | Pr |
| <i>Coniophanes fissidens</i> | NE6 | L (7) | NE | NS |
| <i>Coniophanes piceivittis</i> | NE4 | L (7) | LC | NS |
| <i>Conophis lineatus</i> | NE4 | L (9) | LC | NS |
| <i>Diadophis punctatus</i> | NE3 | L (4) | LC | NS |
| <i>Geophis latifrontalis</i> * | CE | H (14) | DD | Pr |
| <i>Geophis mutitorques</i> * | CE | M (13) | LC | Pr |
| <i>Hypsiglena jani</i> | NE3 | L (6) | NE | NS |
| <i>Imantodes gemmistratus</i> | NE6 | L (6) | NE | Pr |
| <i>Leptodeira septentrionalis</i> | NE8 | L (8) | NE | NS |
| <i>Ninia diademata</i> | NE4 | L (9) | LC | NS |
| <i>Rhadinaea gaigeae</i> * | CE | M (12) | DD | NS |
| <i>Tropidodipsas sartorii</i> | NE4 | L (9) | LC | Pr |
| <i>Micrurus tener</i> | NE3 | M (11) | LC | NS |
| <i>Epictia wyanni</i> * | CE | M (13) | NE | NS |
| <i>Rena dulcis</i> | NE3 | M (13) | LC | NS |
| <i>Storeria hidalgoensis</i> * | CE | M (13) | VU | NS |
| <i>Storeria storerioides</i> * | CE | M (11) | LC | NS |
| <i>Thamnophis cyrtopsis</i> | NE7 | L (7) | LC | A |
| <i>Thamnophis eques</i> | NE3 | L (8) | LC | A |
| <i>Thamnophis melanogaster</i> * | CE | H (15) | EN | A |
| <i>Thamnophis pulchrilatus</i> * | CE | H (15) | LC | NS |
| <i>Thamnophis scalaris</i> * | CE | H (14) | LC | A |
| <i>Thamnophis sumichrasti</i> * | CE | H (15) | LC | A |
| <i>Virgotyphlops braminus</i> ** | NN | — | — | — |
| <i>Agkistrodon taylori</i> * | CE | H (17) | LC | A |
| <i>Bothrops asper</i> | NE6 | M (12) | NE | NS |
| <i>Crotalus aquilus</i> * | CE | H (16) | LC | Pr |
| <i>Crotalus atrox</i> | NE3 | L (9) | LC | Pr |
| <i>Crotalus molossus</i> | NE3 | L (8) | LC | Pr |
| <i>Crotalus polystictus</i> * | CE | H (16) | LC | Pr |
| <i>Crotalus scutulatus</i> | NE3 | M (11) | LC | Pr |
| <i>Crotalus totonacus</i> * | CE | H (17) | NE | NS |
| <i>Crotalus triseriatus</i> * | CE | H (16) | LC | NS |
| <i>Metlapilcoatlus borealis</i> * | CE | M (13) | NE | A |
| <i>Kinosternon hirtipes</i> | NE3 | M (10) | LC | Pr |
| <i>Kinosternon integrum</i> * | CE | M (11) | LC | Pr |
| <i>Kinosternon scorpioides</i> | NE6 | M (10) | NE | Pr |

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Table 9. Summary of the distributional status of the species in each herpetofaunal family in Querétaro, Mexico.

| Family | Number of species | Distributional status | | |
|---------------------|-------------------|-----------------------|----------------------|-----------------|
| | | Non-endemic (NE) | Country Endemic (CE) | Non-native (NN) |
| Bufonidae | 6 | 4 | 2 | — |
| Craugastoridae | 2 | 1 | 1 | — |
| Eleutherodactylidae | 4 | 1 | 3 | — |
| Hylidae | 8 | 5 | 3 | — |
| Microhylidae | 1 | 1 | — | — |
| Ranidae | 4 | 1 | 3 | — |
| Scaphiopodidae | 2 | 2 | — | — |
| Subtotal | 27 | 15 | 12 | — |
| Ambystomatidae | 1 | — | 1 | — |
| Plethodontidae | 6 | — | 6 | — |
| Subtotal | 7 | — | 7 | — |
| Total | 34 | 15 | 19 | — |
| Anguillidae | 4 | 1 | 3 | — |
| Corytophanidae | 2 | 2 | — | — |
| Dactyloidae | 1 | 1 | — | — |
| Dibamidae | 1 | — | 1 | — |
| Gekkonidae | 1 | — | — | 1 |
| Phrynosomatidae | 12 | 3 | 9 | — |
| Scincidae | 2 | 1 | 1 | — |
| Sphenomorphidae | 3 | 1 | 2 | — |
| Teiidae | 2 | 1 | 1 | — |
| Xantusiidae | 3 | — | 3 | — |
| Xenosauridae | 1 | — | 1 | — |
| Subtotal | 32 | 10 | 21 | 1 |
| Boidae | 1 | 1 | — | — |
| Colubridae | 22 | 13 | 9 | — |
| Dipsadidae | 15 | 11 | 4 | — |
| Elapidae | 1 | 1 | — | — |
| Leptotyphlopidae | 2 | 1 | 1 | — |
| Natricidae | 8 | 2 | 6 | — |
| Typhlopidae | 1 | — | — | 1 |
| Viperidae | 10 | 4 | 6 | — |
| Subtotal | 60 | 33 | 26 | 1 |
| Kinosternidae | 3 | 2 | 1 | — |
| Subtotal | 3 | 2 | 1 | — |
| Total | 95 | 45 | 48 | 2 |
| Sum Total | 129 | 60 | 67 | 2 |

as *Craugastor*, *Eleutherodactylus*, *Charadrahyla*, and *Plectrohyla*; lizards such as *Abronia*, *Norops*, and *Xenosaurus*; and snakes of the genera *Geophis*, *Thamnophis*, and *Crotalus*.

Livestock. Similar to deforestation, raising livestock also involves vegetation removal for short-term exploitation. Livestock activities are associated with the destruction of thousands of hectares of pristine forest, and mainly in areas of “matorral” (= scrub) in central Querétaro. In these areas, a high extension of cover is used to establish grazing areas. Likewise, the high demand for the production of food animals, such as cattle, goats, and pigs, has led to the transformation of many natural areas into grazing areas or the establishment of breeding sites,

primarily in mountainous areas of the municipalities of Landa de Matamoros, Cadereyta de Montes, and Jalpan. This type of activity also occurs in tropical areas in the northern part of the state, where extensive forested areas have been cut down to create grazing areas; however, these areas only support low numbers of livestock, thereby highlighting the lack of a comprehensive management plan for the production of cattle and goats in the state. A similar problem occurs in the central part of the state, where municipalities such as Pedro Escobedo and San Juan del Río contain the most land transformed for agricultural irrigation and grazing.

Roads. As occurs in other states, and mainly in the metropolitan area of Mexico City, the construction of

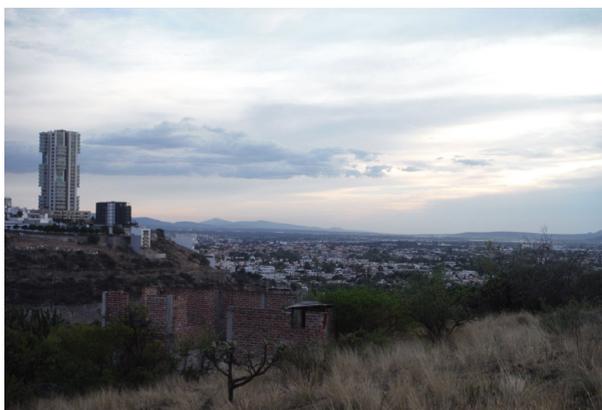


Fig. 11. Urban environment near the city of Querétaro. Photo by Cristhian Alejandro Peralta Robles.

highways and rural roads has increased significantly in order to facilitate commerce, and over time has destroyed large expanses of the natural vegetation.

These roads form barriers for individuals and populations of wildlife, thereby limiting the distribution of species, as well as the basic requirements (space and food) necessary for herpetofaunal populations to survive and reproduce. Concurrently, such events generate isolation, resulting in inbreeding and eventually the extinction of populations (Kattan et al. 2004). In this sense, rural roads and highways have become an important cause of the disturbance and mortality of animals (Fig. 12), affecting millions of individuals per year (Spellerberg 2002). In the state of Querétaro, highways facilitate commercial exchange, mainly with the states of Hidalgo, San Luis Potosí, Guanajuato, and the State of Mexico, in addition to being the primary route for the arrival of tourists to such important towns as Bernal, Tequisquiapan, Cadereyta, Jalpan de Serra, San Joaquín, and Amealco, located in the middle and northern parts of the state. This situation favors an increase in the influx of visitors to the state, which causes a greater amount of traffic, and thus increases wildlife mortality on the roads. This problem has become the general pattern in forested areas of neighboring states, such as Hidalgo (Puc Sánchez et al. 2013), and although a study of this important matter has not been conducted in Querétaro, increased highway mortality of wildlife is expected to become an issue of major concern in this state.

Pollution of water bodies. The state of Querétaro extends into part of the Metropolitan area of Mexico City, and is characterized by a high degree of urbanization that has caused significant modification of the natural landscape. These changes include the creation of human settlements, such as subdivisions or industrial zones, as well as the transformation of natural vegetation into grazing or agricultural areas, which has had a significant impact on environmental health and the contamination of bodies of water. In addition, a decrease in the number of bodies of water has caused declines in the populations of amphibian species of the genera *Lithobates*, *Dryophytes*,



Fig. 12. A *Crotalus molossus* killed by ranchers. Photo by Cristhian Alejandro Peralta Robles.

and *Ambystoma*.

This general pattern is evident in the central region of Mexico, since rivers and other bodies of water in northern Querétaro have been contaminated by fertilizers or pesticides, which are known to cause malformations in amphibians (Aguillón-Gutiérrez et al. 2018). The decreases in amphibian populations mean that their predators, including snakes, are lacking food, so these species and their populations also are affected. Presently, no conservation studies of the amphibians are available for the state of Querétaro, or even assessments of the status of their populations, since this is one of the least-explored states in the country. This situation highlights the need for studies evaluating the conservation status of members of Querétaro's herpetofauna.

Myths and other cultural factors. In many areas of Mexico, amphibians and reptiles often are underappreciated, since they are frequently considered to be poisonous or venomous, or otherwise harmful (Fig. 11).

In northern Querétaro, where various indigenous communities are located, many herpetofaunal species continue to be killed due to local beliefs. For example, some species of salamanders (genera *Aquiloerycea* and/or *Isthmura*) and lizards (genera *Abronia*, *Barisia*, and *Gerrhonotus*) are thought to be venomous, whereas all snakes are indiscriminately regarded as dangerous. Additionally, many people believe that the salamanders *Aquiloerycea cephalica* and *Bolitoglossa platyductyla*, and the snake *Pituophis deppei*, somehow impregnate women; therefore, encounters with these creatures frequently end up with them being killed (Ramírez-Bautista et al. 2014). On the other hand, the use and consumption of amphibians and reptiles in Mexico is not statistically well documented, since it is not a practice carried out on a daily basis (Lavín-Murcio and Lazcano 2010). However, in many parts of the state, particularly in rural communities, reptiles are used for medicinal purposes, as is the case with rattlesnakes (genus *Crotalus*) that are in very high demand for treating diseases such as cancer, although there are no scientific studies to prove

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Table 10. Summary of the distributional categories of herpetofaunal families in Querétaro, Mexico, that contain non-endemic species. Categorizations are as follows: MXUS, species distributed only in Mexico and the United States (except for a few also 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 also 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 | 4 | 3 | — | — | 1 | — |
| Craugastoridae | 1 | 1 | — | — | — | — |
| Eleutherodactylidae | 1 | 1 | — | — | — | — |
| Hylidae | 5 | 1 | 2 | 1 | 1 | — |
| Microhylidae | 1 | — | — | — | 1 | — |
| Ranidae | 1 | 1 | — | — | — | — |
| Scaphiopodidae | 2 | 2 | — | — | — | — |
| Total | 15 | 9 | 2 | 1 | 3 | — |
| Anguidae | 1 | 1 | — | — | — | — |
| Corytophanidae | 2 | — | 2 | — | — | — |
| Dactyloidae | 1 | — | 1 | — | — | — |
| Phrynosomatidae | 3 | 1 | 2 | — | — | — |
| Scincidae | 1 | 1 | — | — | — | — |
| Sphenomorphidae | 1 | 1 | — | — | — | — |
| Teiidae | 1 | 1 | — | — | — | — |
| Subtotal | 10 | 5 | 5 | — | — | — |
| Boidae | 1 | — | — | 1 | — | — |
| Colubridae | 13 | 3 | 4 | 3 | 1 | 2 |
| Dipsadidae | 11 | 2 | 6 | 2 | — | 1 |
| Elapidae | 1 | 1 | — | — | — | — |
| Leptotyphlopidae | 1 | 1 | — | — | — | — |
| Natricidae | 2 | 1 | — | — | 1 | — |
| Viperidae | 4 | 3 | — | 1 | — | — |
| Subtotal | 33 | 11 | 10 | 7 | 2 | 3 |
| Kinosternidae | 2 | 1 | — | 1 | — | — |
| Subtotal | 2 | 1 | — | 1 | — | — |
| Total | 45 | 17 | 15 | 8 | 2 | 3 |
| Sum Total | 60 | 26 | 17 | 9 | 5 | 3 |

this assumption (Fitzgerald et al. 2004). This belief has also spread in large cities, making this resource more exploited for the sale of powders and ointments derived from these organisms (Campbell and Lamar 2004).

Conservation Status

The three systems of conservation assessment used in the previous entries in the Mexican Conservation Series (see above) were applied here, i.e., the SEMARNAT (2010), IUCN Red List (<http://iucnredlist.org>), and Environmental Vulnerability Score (EVS) systems (Wilson et al. 2013a,b). The assessments from these three systems have been updated as necessary.

The SEMARNAT System. The SEMARNAT system is a method for assessing conservation status that was developed and implemented by the Secretaría del Medio Ambiente y Recursos Naturales of the federal government of Mexico (SEMARNAT 2010). Some of

the available ratings for herpetofaunal species inhabiting Querétaro are given in Table 8 and summarized in Table 11. The SEMARNAT system uses three categories of assessment: endangered (P), threatened (A), and under special protection (Pr). In this study, we placed the remaining unassessed species into a “no status” (NS) category.

The data in Table 11 show that only 55 (43.3%) of the 127 native species in Querétaro have been assessed by SEMARNAT, while 72 (56.7%) native species remain unassessed based on this system.

If one assumes that SEMARNAT personnel placed a greater emphasis on species endemic to Mexico, then this should be evident by comparing the assigned species to their distributional categories, and those to the SEMARNAT categories. In order to determine whether this bias is evident, the pertinent data are shown in Table 12. These data indicate that the majority of the non-endemic species (41 of 60, 68.3%) have not been evaluated in the SEMARNAT system. The comparable values for the country endemics are

Table 11. SEMARNAT categorizations for herpetofaunal species in Querétaro, Mexico, summarized by family. Non-native species are excluded.

| Family | Number of species | SEMARNAT category | | | |
|---------------------|-------------------|-------------------|----------------|-------------------------|----------------|
| | | Endangered (P) | Threatened (A) | Special protection (Pr) | No status (NS) |
| Bufonidae | 6 | — | — | — | 6 |
| Craugastoridae | 2 | — | — | 1 | 1 |
| Eleutherodactylidae | 4 | — | — | 1 | 3 |
| Hylidae | 8 | — | 1 | — | 7 |
| Microhylidae | 1 | — | — | — | 1 |
| Ranidae | 4 | — | 1 | 2 | 1 |
| Scaphiopodidae | 2 | — | — | — | 2 |
| Subtotal | 27 | — | 2 | 4 | 21 |
| Ambystomatidae | 1 | — | — | 1 | — |
| Plethodontidae | 6 | — | 2 | 4 | — |
| Subtotal | 7 | — | 2 | 5 | — |
| Total | 34 | — | 4 | 9 | 21 |
| Anguidae | 4 | — | — | 2 | 2 |
| Corytophanidae | 2 | — | — | 2 | — |
| Dactyloidae | 1 | — | — | — | 1 |
| Dibamidae | 1 | — | 1 | — | — |
| Phrynosomatidae | 12 | — | 2 | 1 | 9 |
| Scincidae | 2 | — | — | 1 | 1 |
| Sphenomorphidae | 3 | — | 1 | 2 | — |
| Teiidae | 2 | — | — | — | 2 |
| Xantusiidae | 3 | — | — | 3 | — |
| Xenosauridae | 1 | — | — | — | 1 |
| Subtotal | 31 | — | 4 | 11 | 16 |
| Boidae | 1 | — | — | — | 1 |
| Colubridae | 22 | — | 4 | 2 | 16 |
| Dipsadidae | 15 | — | — | 6 | 9 |
| Elapidae | 1 | — | — | — | 1 |
| Leptotyphlopidae | 2 | — | — | — | 2 |
| Natricidae | 8 | — | 5 | — | 3 |
| Viperidae | 10 | — | 2 | 5 | 3 |
| Subtotal | 59 | — | 11 | 13 | 35 |
| Kinosternidae | 3 | — | — | 3 | — |
| Subtotal | 3 | — | — | 3 | — |
| Total | 93 | — | 15 | 27 | 51 |
| Sum Total | 127 | — | 19 | 36 | 72 |

29 of 67 (43.3%). Similar values were reported by Ramirez-Bautista et al. (2020), but they do not indicate a clear bias in favor of the Mexican endemic species. Nonetheless, these data demonstrate that the SEMARNAT system is not of much use in assessing the conservation status of the Mexican herpetofauna in general, and especially the herpetofauna of Querétaro, until all the species are incorporated.

The IUCN System. The International Union for Conservation of Nature (IUCN) system for conservation assessment is intended to apply to all organisms, although it is mostly applied to vertebrate animals and flowering plants. For example, of the 78,126 animal species assessed as of 10 December 2020, 53,907 are vertebrates (69.0%). Of the 50,369 plant species evaluated, 48,323

Table 12. Comparison of SEMARNAT and Distributional categories for the Querétaro herpetofauna. Non-native species are excluded.

| Distributional category | SEMARNAT category | | | | |
|------------------------------|-------------------|----------------|-------------------------|----------------|------------|
| | Endangered (P) | Threatened (A) | Special Protection (Pr) | No Status (NS) | Total |
| Non-endemic species (NE) | — | 4 | 15 | 41 | 60 |
| Country-endemic species (CE) | — | 16 | 22 | 29 | 67 |
| Total | — | 20 | 37 | 70 | 127 |

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(95.9%) are flowering plants (IUCN Red List version 2020-3: see Table 1a in that list). That table also shows that the vertebrate assessments include 7,166 species of amphibians and 8,236 species of reptiles. The Reptile Database website (accessed 1 January 2021) provides a total count for reptile species as 11,341 (dated August 2020); thus, as of that date 72.6% of the world's reptile species had been assessed by the IUCN; the similar total for amphibian species is 86.7% of 8,270 species (Amphibian Species of the World website; accessed 1 January 2021). Thus, a significantly greater portion of the amphibian species has been assessed, as compared to the reptile species. For the global herpetofauna, of the 19,611 total species, 15,402 (78.5%) have been assessed.

In previous entries of the Mexican Conservation Series, the IUCN system of conservation evaluation has been criticized for several reasons (e.g., see Johnson et al. 2015b). Nonetheless, the IUCN system is sufficiently broadly applied that we would be negligent by not using it here. Thus, the IUCN categorizations for the members of the Hidalgo herpetofauna are shown in Table 8, and summarized in Table 13.

Of the 127 native members of the Querétaro herpetofauna, 107 (84.3%) species have been assessed using the IUCN system (Table 13). This percentage is similar to that calculated by Ramírez-Bautista et al. (2020) for the herpetofauna of the adjacent state of Hidalgo (82.4%). Of these 107 species, only 15 (14.0%) have

Table 13. IUCN Red List categories for the species in each herpetofaunal family in Querétaro, Mexico. Non-native species are excluded. The shaded columns to the left are the “threat categories,” and those to the right are the categories for which either too little information on the conservation status exists to allow the taxon to be placed in any other IUCN category (DD), or the species was simply not evaluated (NE).

| Family | Number of species | IUCN Red List category | | | | | | | |
|-----------------------|-------------------|------------------------|------------|------------|-----------------|---------------|----------------|---------------|--|
| | | Critically Endangered | Endangered | Vulnerable | Near Threatened | Least Concern | Data Deficient | Not Evaluated | |
| Bufonidae | 6 | — | — | — | — | 5 | — | 1 | |
| Craugastoridae | 2 | — | — | 1 | — | 1 | — | — | |
| Eleutherodactylidae | 4 | — | — | 2 | — | 2 | — | — | |
| Hylidae | 8 | — | — | 1 | 1 | 6 | — | — | |
| Microhylidae | 1 | — | — | — | — | 1 | — | — | |
| Ranidae | 4 | — | — | — | 1 | 3 | — | — | |
| Scaphiopodidae | 2 | — | — | — | — | 2 | — | — | |
| Subtotal | 27 | — | — | 4 | 2 | 20 | — | 1 | |
| Ambystomatidae | 1 | — | — | — | — | 1 | — | — | |
| Plethodontidae | 6 | 1 | 2 | 2 | 1 | — | — | — | |
| Subtotal | 7 | 1 | 2 | 2 | 1 | 1 | — | — | |
| Total | 34 | 1 | 2 | 6 | 3 | 21 | — | 1 | |
| Anguidae | 4 | — | — | 1 | — | 3 | — | — | |
| Corytophanidae | 2 | — | — | — | — | 2 | — | — | |
| Dactyloidae | 1 | — | — | — | — | — | — | 1 | |
| Dibamidae | 1 | — | — | — | — | 1 | — | — | |
| Phrynosomatidae | 12 | 1 | — | — | — | 11 | — | — | |
| Scincidae | 2 | — | — | — | — | 2 | — | — | |
| Sphenomorphidae | 3 | — | — | — | — | 3 | — | — | |
| Teiidae | 2 | — | — | — | — | 1 | — | 1 | |
| Xantusiidae | 3 | — | — | 1 | — | 2 | — | — | |
| Xenosauridae | 1 | — | — | — | — | — | — | 1 | |
| Subtotal | 31 | 1 | — | 2 | — | 25 | — | 3 | |
| Boidae | 1 | — | — | — | — | — | — | 1 | |
| Colubridae | 22 | — | — | — | 1 | 16 | — | 5 | |
| Dipsadidae | 15 | — | 1 | — | — | 8 | 2 | 4 | |
| Elapidae | 1 | — | — | — | — | 1 | — | — | |
| Leptotyphlopidae | 2 | — | — | — | — | 1 | — | 1 | |
| Natricidae | 8 | — | 1 | 1 | — | 6 | — | — | |
| Viperidae | 10 | — | — | — | — | 7 | — | 3 | |
| Subtotal | 59 | — | 2 | 1 | 1 | 39 | 2 | 14 | |
| Kinosternidae | 3 | — | — | — | — | 2 | — | 1 | |
| Subtotal | 3 | — | — | — | — | 2 | — | 1 | |
| Total | 93 | 1 | 2 | 3 | 1 | 67 | 2 | 18 | |
| Sum total | 127 | 2 | 4 | 9 | 4 | 87 | 2 | 19 | |
| Category total | 127 | 15 | | | 91 | | | 21 | |

been allocated to one of the three “threat categories,” including two as CR, four as EN, and nine as VU (Table 13). The two CR species are a salamander (*Chiropterotriton magnipes*) and a lizard (*Sceloporus exsul*), both country endemics. The four EN species are two salamanders (*Chiropterotriton chondrostega* and *C. multidentatus*) and two snakes (*Chersodromus rubriventris* and *Thamnophis melanogaster*), all country endemics. The nine VU species are four anurans (*Craugastor decoratus*, *Eleutherodactylus longipes*, *E. verrucipes*, and *Tlalocohyla godmani*), two salamanders (*Aquiloerycea scandens* and *Isthmura bellii*), two lizards (*Abronia taeniata* and *Lepidophyma gaigeae*), and a snake (*Storeria hidalgoensis*), all country endemics.

Of the 92 species allocated in the “lower risk categories” (NT and LC), only four are in the NT category and the remaining 88 are in the LC category (Table 13). The four NT species are two anurans (*Rheohyla miotympanum* and *Lithobates neovolcanicus*), a salamander (*Aquiloerycea cephalica*), and a snake (*Lampropeltis ruthveni*), all country endemics. The 88 LC species constitute 69.3% of

the 127 native species in Querétaro (Table 13). Whether such a large proportion of these native species are actually of “least concern” is open to question, and we examine these assignments below.

Twenty members of the Querétaro herpetofauna have not been assessed using the IUCN system, of which two species are placed in the Data Deficient (DD) category and the remaining 18 in the Not Evaluated (NE) category. These 20 species comprise 15.7% of the native herpetofauna, and we examine them in more detail below.

The EVS System. Originally, the EVS (Environmental Vulnerability Score) system was created for evaluating the conservation status of the Honduran herpetofauna, but since then it has been employed in assessing other components of the Mexican and Central American herpetofaunas (Wilson et al. 2013a,b; Johnson et al. 2015b; and all entries in the Mexican Conservation Series [see above]). In this study, we list the assessed EVS values for the 127 native species in Table 8, and summarize them in Table 14.

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

| Family | Number of species | Environmental Vulnerability Scores | | | | | | | | | | | | | | | |
|-----------------------|-------------------|------------------------------------|----------|----------|-----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|--|
| | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | |
| Bufonidae | 6 | 1 | — | 1 | 1 | — | — | — | — | 1 | 1 | — | 1 | — | — | — | |
| Craugastoridae | 2 | — | — | — | — | — | 1 | — | — | — | — | — | — | 1 | — | — | |
| Eleutherodactylidae | 4 | — | — | — | — | — | — | — | — | 1 | 1 | — | — | 1 | 1 | — | |
| Hylidae | 8 | 1 | 2 | — | — | 1 | 1 | 1 | 1 | — | — | 1 | — | — | — | — | |
| Microhylidae | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | |
| Ranidae | 4 | — | — | — | — | 1 | — | — | — | — | 1 | 2 | — | — | — | — | |
| Scaphiopodidae | 2 | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | |
| Subtotal | 27 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 2 | 1 | — | |
| Ambystomatidae | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | |
| Plethodontidae | 6 | — | — | — | — | — | — | — | — | — | 1 | — | 1 | 1 | 1 | 2 | |
| Subtotal | 7 | — | — | — | — | — | — | — | 1 | — | 1 | — | 1 | 1 | 1 | 2 | |
| Total | 34 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 4 | 3 | 2 | 3 | 2 | 2 | |
| Anguidae | 4 | — | — | — | — | — | — | — | — | — | 1 | 1 | 1 | 1 | — | — | |
| Corytophanidae | 2 | — | — | — | — | — | 1 | — | — | — | — | 1 | — | — | — | — | |
| Dactyloidae | 1 | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | |
| Dibamidae | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | |
| Phrynosomatidae | 12 | — | — | 1 | 1 | — | — | 1 | — | 1 | 3 | 2 | 1 | 1 | — | 1 | |
| Scincidae | 2 | — | — | — | — | — | — | — | 1 | — | 1 | — | — | — | — | — | |
| Sphenomorphidae | 3 | — | — | — | — | — | — | — | — | 1 | 1 | 1 | — | — | — | — | |
| Teiidae | 2 | — | — | — | — | — | — | 1 | — | 1 | — | — | — | — | — | — | |
| Xantusiidae | 3 | — | — | — | — | — | — | — | — | 1 | — | 1 | 1 | — | — | — | |
| Xenosauridae | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | |
| Subtotal | 31 | — | — | 1 | 1 | — | 2 | 2 | 2 | 4 | 6 | 6 | 3 | 2 | 1 | 1 | |
| Boidae | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | |
| Colubridae | 22 | — | — | 2 | 7 | — | — | 3 | 2 | 2 | — | 3 | 1 | 1 | 1 | — | |
| Dipsadidae | 15 | — | 1 | — | 2 | 2 | 1 | 3 | 2 | — | 1 | 1 | 2 | — | — | — | |
| Elapidae | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | |
| Leptotyphlopidae | 2 | — | — | — | — | — | — | — | — | — | — | 2 | — | — | — | — | |
| Natricidae | 8 | — | — | — | — | 1 | 1 | — | — | 1 | — | 1 | 1 | 3 | — | — | |
| Viperidae | 10 | — | — | — | — | — | 1 | 1 | — | 1 | 1 | 1 | — | — | 3 | 2 | |
| Subtotal | 59 | — | 1 | 2 | 9 | 3 | 3 | 7 | 5 | 5 | 2 | 8 | 4 | 4 | 4 | 2 | |
| Kinosternidae | 3 | — | — | — | — | — | — | — | 2 | 1 | — | — | — | — | — | — | |
| Subtotal | 3 | — | — | — | — | — | — | — | 2 | 1 | — | — | — | — | — | — | |
| Total | 93 | — | 1 | 3 | 10 | 3 | 5 | 9 | 9 | 10 | 8 | 14 | 7 | 6 | 5 | 3 | |
| Sum total | 127 | 3 | 4 | 4 | 12 | 5 | 7 | 10 | 11 | 12 | 12 | 17 | 9 | 9 | 7 | 5 | |
| Category total | 127 | 45 | | | | | | 52 | | | | | 30 | | | | |

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

| EVS | IUCN category | | | | | | | Total |
|--------------|-----------------------|------------|------------|-----------------|---------------|----------------|---------------|------------|
| | Critically Endangered | Endangered | Vulnerable | Near Threatened | Least Concern | Data Deficient | Not Evaluated | |
| 3 | — | — | — | — | 2 | — | 1 | 3 |
| 4 | — | — | — | — | 4 | — | — | 4 |
| 5 | — | — | — | — | 3 | — | 1 | 4 |
| 6 | — | — | — | — | 8 | — | 4 | 12 |
| 7 | — | — | — | — | 4 | — | 1 | 5 |
| 8 | — | — | — | — | 5 | — | 2 | 7 |
| 9 | — | — | — | 1 | 8 | — | 1 | 10 |
| 10 | — | — | — | — | 9 | — | 2 | 11 |
| 11 | — | — | — | — | 10 | — | 2 | 12 |
| 12 | — | — | 1 | — | 9 | 1 | 1 | 12 |
| 13 | — | — | 3 | 1 | 11 | — | 2 | 17 |
| 14 | — | 1 | — | 1 | 6 | 1 | — | 9 |
| 15 | — | 2 | 3 | — | 4 | — | — | 9 |
| 16 | 1 | — | 1 | 1 | 3 | — | 1 | 7 |
| 17 | 1 | 1 | 1 | — | 1 | — | 1 | 5 |
| Total | 2 | 4 | 9 | 4 | 87 | 2 | 19 | 127 |

The EVS values range from 3 to 17, three fewer than the entire theoretical range of 3–20. The most frequent values (applied to 10 or more species) are 6 (12 species), 9 (10), 10 (11), 11 (12), 12 (12), and 13 (17). Collectively, these six values are applied to 74 of the 127 native species (58.3%). We determined the lowest score of 3 for three anuran species (*Rhinella horribilis*, *Smilisca baudinii*, and *Scaphiopus couchii*) and the highest score of 17 for five species, including two salamanders (*Aquiloerycea scandens* and *Chiropterotriton chondrostega*), one lizard (*Sceloporus exsul*), and two snakes (*Agkistrodon taylori* and *Crotalus totonacus*); and all five of these species are country endemics.

As in previous MCS studies, we allocated the EVS scores into three categories of low, medium, and high vulnerability. Accordingly, the summary values (Table 14) increase from low vulnerability (45 species) to medium vulnerability (52), and then decrease to high vulnerability (30). In general, this pattern is typical of state herpetofaunas that contain more non-endemic species than country and state endemics, as was found in Chiapas (Johnson et al. 2015a), Tamaulipas (Terán-Juárez et al. 2016), Nuevo León (Nevárez-de los Reyes et al. 2016), Coahuila (Lazcano et al. 2019), and Hidalgo (Ramírez-Bautista et al. 2020). In the case of the Querétaro herpetofauna, however, the number of country endemics (67) is seven more than the number of non-endemics (60).

The numbers of species in the Querétaro herpetofauna for each IUCN category / EVS score combination are shown in Table 15. This comparison indicates that 15 of the 30 high vulnerability species (50.0%) were allocated to one of the three IUCN “threat categories.” This relatively moderate proportion is due primarily to the number of amphibians evaluated as CR, EN, or VU; nine of 34 amphibian species (26.5%) are anurans (four species) and

salamanders (five), compared to six of 92 reptiles (6.5%). Only one salamander (*Chiropterotriton magnipes*) and one lizard (*Sceloporus exsul*) are assessed as CR; only two salamanders (*Chiropterotriton chondrostega* and *C. multidentatus*) and two snakes (*Chersodromus rubriventris* and *Thamnophis melanogaster*) as EN; and four anurans (*Craugastor decoratus*, *Eleutherodactylus longipes*, *E. verrucipes*, and *Tlalocohyla godmani*), two salamanders (*Aquiloerycea scandens* and *Isthmura bellii*), two lizards (*Abronia taeniata* and *Lepidophyma gaigeae*), and one snake (*Storeria hidalgoensis*) as VU. At the other extreme, the 45 low vulnerability species comprise 51.7% of the 87 LC species (Table 15). As demonstrated in other MCS entries, the results of



No. 21. *Crotalus triseriatus* Wagler, 1830. The Central Plateau Dusky Rattlesnake occurs in the states of Veracruz, Michoacán, Morelos, Hidalgo, Querétaro, and Puebla. This individual was found in Huimilpan, Querétaro. Wilson et al. (2013a) determined its EVS as 16, placing it in the high vulnerability category. Its conservation status has been assessed as Least Concern by IUCN, but this species is not listed by SEMARNAT. Photo by Raciél Cruz-Elizalde.

Table 16. Environmental Vulnerability Scores (EVS) for the two members of the herpetofauna of Querétaro, 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 |
| <i>Geophis latifrontalis</i> * | 5 | 7 | 2 | 14 |
| <i>Rhadinaea gaigeae</i> * | 5 | 5 | 2 | 12 |

applying the IUCN and EVS systems do not correspond well to one another.

Two of the 127 native members of the Querétaro herpetofauna were assigned to the DD category (Table 16; *Geophis latifrontalis* and *Rhadinaea gaigeae*). Based on the argument applied in prior MCS studies, we suggest the allocation of *G. latifrontalis* to the VU category and *R. gaigeae* to the NT category.

Nineteen species remain unevaluated using the IUCN system (allocated to the NE category in Tables 8 and 17). Seven of these species are country endemics (*Holcosus amphigrammus*, *Xenosaurus mendozai*, *Ficimia olivacea*, *Lampropeltis polyzona*, *Epictia wynti*, *Crotalus totonacus*, and *Metlapilcoatlus borealis*), and the rest are non-endemics. The EVS values for these 19 species range from 3–17, which places some in all three summary categories (Table 8). Ten have low EVS scores, seven have medium scores, and two have high scores. Until the IUCN evaluations become available for these species, we suggest that the two high EVS species should be placed in one of the three threat categories, perhaps as follows: CR—*Crotalus totonacus*; EN—*Xenosaurus*

mendozai. We also suggest that the species with an EVS of 12 or 13 should be placed in the NT category. The remainder of the species with an EVS of 6–11 can be allocated to the LC category (Table 17).

As in other studies in the Mexican Conservation Series, a sizeable number of members of the herpetofauna of Querétaro have been allocated to the Least Concern category by IUCN (Table 18); this number amounts to 87, or 68.5% of the total of 127 native species. Given this indication that slightly fewer than seven of every 10 herpetofaunal species in Querétaro has been classified as Least Concern, it would appear that the conservation status of state's herpetofauna is in relatively good shape. To determine if this is the case, we further considered the 87 species in Table 18, along with their respective EVS values. Although one might expect that the LC species would most likely be non-endemic to Mexico, 39 (44.8%) are actually country endemics, including six anurans, one salamander, 16 lizards, 15 snakes, and one turtle (Table 18). The range of EVS values of these 39 species covers 9–17, which lies mostly outside of the low vulnerability range of values. The allocation of the

Table 17. Environmental Vulnerability Scores (EVS) for those members of the herpetofauna of Querétaro, 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 |
| <i>Rhinella horribilis</i> | 1 | 1 | 1 | 3 |
| <i>Norops sericeus</i> | 2 | 3 | 3 | 8 |
| <i>Holcosus amphigrammus</i> * | 5 | 3 | 3 | 11 |
| <i>Xenosaurus mendozai</i> * | 5 | 8 | 3 | 16 |
| <i>Boa imperator</i> | 3 | 1 | 6 | 10 |
| <i>Drymobius margaritiferus</i> | 1 | 1 | 4 | 6 |
| <i>Ficimia olivacea</i> * | 5 | 2 | 2 | 9 |
| <i>Lampropeltis polyzona</i> * | 1 | 3 | 5 | 9 |
| <i>Oxybelis potosiensis</i> | 1 | 1 | 3 | 5 |
| <i>Spilotes pullatus</i> | 1 | 1 | 4 | 6 |
| <i>Coniophanes fissidens</i> | 1 | 3 | 3 | 7 |
| <i>Hypsiglena jani</i> | 1 | 3 | 2 | 6 |
| <i>Imantodes gemmistratus</i> | 1 | 3 | 2 | 6 |
| <i>Leptodeira septentrionalis</i> | 2 | 2 | 4 | 8 |
| <i>Epictia wynti</i> * | 5 | 7 | 1 | 13 |
| <i>Bothrops asper</i> | 3 | 4 | 5 | 12 |
| <i>Crotalus totonacus</i> | 5 | 7 | 5 | 17 |
| <i>Kinosternon scorpioides</i> | 3 | 4 | 3 | 10 |

The herpetofauna of Querétaro, Mexico

Table 18. Environmental Vulnerability Scores (EVS) for those members of the herpetofauna of Querétaro, Mexico, that are assigned to the IUCN Least Concern (LC) category. Non-native taxa are not included. * = country endemic.

| Taxon | Environmental Vulnerability Score (EVS) | | | |
|--------------------------------------|---|-------------------------|---|-------------|
| | Geographic distribution | Ecological distribution | Reproductive mode/Degree of persecution | Total score |
| <i>Anaxyrus compactilis</i> * | 5 | 8 | 1 | 14 |
| <i>Anaxyrus punctatus</i> | 1 | 3 | 1 | 5 |
| <i>Anaxyrus speciosus</i> | 4 | 7 | 1 | 12 |
| <i>Incilius nebulifer</i> | 1 | 4 | 1 | 6 |
| <i>Incilius occidentalis</i> * | 5 | 5 | 1 | 11 |
| <i>Craugastor augusti</i> | 2 | 2 | 4 | 8 |
| <i>Eleutherodactylus guttillatus</i> | 2 | 5 | 4 | 11 |
| <i>Eleutherodactylus nitidus</i> * | 5 | 3 | 4 | 12 |
| <i>Dryophytes arenicolor</i> | 2 | 4 | 1 | 7 |
| <i>Dryophytes eximius</i> * | 5 | 4 | 1 | 10 |
| <i>Scinax staufferi</i> | 2 | 1 | 1 | 4 |
| <i>Smilisca baudinii</i> | 1 | 1 | 1 | 3 |
| <i>Tlalocohyla picta</i> | 2 | 5 | 1 | 8 |
| <i>Trachycephalus vermiculatus</i> | 1 | 2 | 1 | 4 |
| <i>Hypopachus variolosus</i> | 2 | 1 | 1 | 4 |
| <i>Lithobates berlandieri</i> | 4 | 2 | 1 | 7 |
| <i>Lithobates montezumae</i> * | 5 | 7 | 1 | 13 |
| <i>Lithobates spectabilis</i> * | 5 | 6 | 1 | 13 |
| <i>Scaphiopus couchii</i> | 1 | 1 | 1 | 3 |
| <i>Spea multiplicata</i> | 1 | 4 | 1 | 6 |
| <i>Ambystoma velasci</i> * | 5 | 4 | 1 | 10 |
| <i>Barisia ciliaris</i> * | 5 | 7 | 3 | 15 |
| <i>Gerrhonotus infernalis</i> | 5 | 5 | 3 | 13 |
| <i>Gerrhonotus ophiurus</i> * | 5 | 4 | 3 | 12 |
| <i>Corytophanes hernandezii</i> | 4 | 6 | 3 | 13 |
| <i>Laemactus serratus</i> | 2 | 3 | 3 | 8 |
| <i>Anelytropsis papillosus</i> * | 5 | 4 | 1 | 10 |
| <i>Phrynosoma orbiculare</i> * | 5 | 4 | 3 | 12 |
| <i>Sceloporus aeneus</i> * | 5 | 5 | 3 | 13 |
| <i>Sceloporus dugesii</i> * | 5 | 5 | 3 | 13 |
| <i>Sceloporus grammicus</i> | 2 | 4 | 3 | 9 |
| <i>Sceloporus minor</i> * | 5 | 6 | 3 | 14 |
| <i>Sceloporus parvus</i> * | 5 | 7 | 3 | 15 |
| <i>Sceloporus scalaris</i> * | 5 | 4 | 3 | 12 |
| <i>Sceloporus serrifer</i> | 2 | 1 | 3 | 6 |
| <i>Sceloporus spinosus</i> * | 5 | 4 | 3 | 12 |
| <i>Sceloporus torquatus</i> * | 5 | 3 | 3 | 11 |
| <i>Sceloporus variabilis</i> | 1 | 1 | 3 | 5 |
| <i>Plestiodon lynxe</i> * | 5 | 2 | 3 | 10 |
| <i>Plestiodon tetragrammus</i> | 4 | 5 | 3 | 12 |
| <i>Scincella gemmingeri</i> * | 5 | 3 | 3 | 11 |
| <i>Scincella lateralis</i> | 3 | 7 | 3 | 13 |
| <i>Scincella silvicola</i> * | 5 | 4 | 3 | 12 |
| <i>Aspidoscelis gularis</i> | 2 | 4 | 3 | 9 |
| <i>Lepidophyma occulor</i> * | 5 | 7 | 2 | 14 |
| <i>Lepidophyma sylvaticum</i> * | 5 | 4 | 2 | 11 |
| <i>Conopsis lineata</i> * | 5 | 6 | 2 | 13 |
| <i>Conopsis nasus</i> * | 5 | 4 | 2 | 11 |
| <i>Drymarchon melanurus</i> | 1 | 1 | 4 | 6 |
| <i>Gyalopion canum</i> | 4 | 3 | 2 | 9 |

Table 18 (continued). Environmental Vulnerability Scores (EVS) for those members of the herpetofauna of Querétaro, Mexico, that are assigned to the IUCN Least Concern (LC) category. Non-native taxa are not included. * = country endemic.

| Taxon | Environmental Vulnerability Score (EVS) | | | |
|----------------------------------|---|-------------------------|---|-------------|
| | Geographic distribution | Ecological distribution | Reproductive mode/Degree of persecution | Total score |
| <i>Leptophis mexicanus</i> | 1 | 1 | 4 | 6 |
| <i>Masticophis mentovarius</i> | 1 | 1 | 4 | 6 |
| <i>Masticophis schotti</i> | 4 | 5 | 4 | 13 |
| <i>Mastigodryas melanolomus</i> | 1 | 1 | 4 | 6 |
| <i>Pituophis deppei</i> * | 5 | 5 | 4 | 14 |
| <i>Pseudelaphe flavirufa</i> | 2 | 4 | 4 | 10 |
| <i>Salvadora bairdi</i> * | 5 | 6 | 4 | 15 |
| <i>Salvadora grahamiae</i> | 4 | 2 | 4 | 10 |
| <i>Senticolis triaspis</i> | 2 | 1 | 3 | 6 |
| <i>Tantilla bocourti</i> * | 5 | 2 | 2 | 9 |
| <i>Tantilla rubra</i> | 2 | 1 | 2 | 5 |
| <i>Trimorphodon tau</i> * | 5 | 4 | 4 | 13 |
| <i>Adelphicos quadrivirgatum</i> | 4 | 4 | 2 | 10 |
| <i>Amastridium sapperi</i> | 4 | 4 | 2 | 10 |
| <i>Coniophanes piceivittis</i> | 1 | 3 | 3 | 7 |
| <i>Conophis lineatus</i> | 2 | 3 | 4 | 9 |
| <i>Diadophis punctatus</i> | 1 | 1 | 2 | 4 |
| <i>Geophis mutitorques</i> * | 5 | 6 | 2 | 13 |
| <i>Ninia diademata</i> | 4 | 3 | 2 | 9 |
| <i>Tropidodipsas sartorii</i> | 2 | 2 | 5 | 9 |
| <i>Micrurus tener</i> | 1 | 5 | 5 | 11 |
| <i>Rena dulcis</i> | 4 | 8 | 1 | 13 |
| <i>Storeria storerioides</i> * | 5 | 4 | 2 | 11 |
| <i>Thamnophis cyrtopsis</i> | 2 | 1 | 4 | 7 |
| <i>Thamnophis eques</i> | 2 | 2 | 4 | 8 |
| <i>Thamnophis pulchrilatus</i> * | 5 | 6 | 4 | 15 |
| <i>Thamnophis scalaris</i> * | 5 | 5 | 4 | 14 |
| <i>Thamnophis sumichrasti</i> * | 5 | 6 | 4 | 15 |
| <i>Agkistrodon taylori</i> * | 5 | 7 | 5 | 17 |
| <i>Crotalus aquilus</i> * | 5 | 6 | 5 | 16 |
| <i>Crotalus atrox</i> | 1 | 3 | 5 | 9 |
| <i>Crotalus molossus</i> | 2 | 1 | 5 | 8 |
| <i>Crotalus polystictus</i> * | 5 | 6 | 5 | 16 |
| <i>Crotalus scutulatus</i> | 2 | 4 | 5 | 11 |
| <i>Crotalus triseriatus</i> * | 5 | 6 | 5 | 16 |
| <i>Kinosternon hirtipes</i> | 2 | 5 | 3 | 10 |
| <i>Kinosternon integrum</i> * | 5 | 3 | 3 | 11 |

EVS values for the 87 species into the three summary categories demonstrates one species is low (3–9), 24 are medium (10–13), and 14 are high (14–20). Accordingly, we suggest that a more realistic assessment would be to place the 14 high vulnerability species into one of the three threat categories, as follows: CR (*Agkistrodon taylori*); EN (*Crotalus aquilus*, *C. polystictus*, and *C. triseriatus*), and VU (*Anaxyrus compactilis*, *Barisia ciliaris*, *Sceloporus minor*, *S. parvus*, *Lepidophyma occulor*, *Pituophis deppei*, *Salvadora bairdi*, *Thamnophis pulchrilatus*, *T. scalaris*, and *T. sumichrasti*). All of the 24 medium vulnerability species probably should be placed in the NT category, and the single low vulnerability

species could remain in the LC category, at least until more targeted surveys can be undertaken.

Relative Herpetofaunal Priority

Johnson et al. (2015a) originated the concept of Relative Herpetofaunal Priority (RHP), a simple device used to measure the relative importance of the herpetofaunal species found in any geographic entity (e.g., a state or physiographic region). Determining the RHP involves the use of two methods: (1) calculating the proportion of state and country endemics as they relate to the entire physiographic regional herpetofauna, and (2) calculating

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Table 19. Number of herpetofaunal species in each distributional status category among the three physiographic regions of Querétaro, Mexico. The rank is based on the number of country endemics.

| Physiographic region | Distributional category | | | Total | Rank order |
|----------------------------|-------------------------|------------------|-------------|-------|------------|
| | Non-endemics | Country endemics | Non-natives | | |
| Central Plateau | 27 | 36 | 1 | 64 | 2 |
| Transmexican Volcanic Belt | 19 | 24 | — | 43 | 3 |
| Sierra Madre Oriental | 44 | 57 | 1 | 102 | 1 |

the absolute number of high category species in each physiographic regional herpetofauna. The pertinent data for these two methods are shown in Tables 19 and 20.

Based on the relative number of country endemics (Table 19), the first rank is held by the SMO with 57 country endemics of a total of 102 species (55.9%). The remaining ranks are second for the CP (36 of 64 species; 56.3%) and third for the TVB (24 of 43 species; 55.8%). Interestingly, the three proportions (55.9, 56.3, and 55.8) only differ from one another by 0.5 or less.

Based on the relative number of high vulnerability species (Table 20), the ranks are the same as above: first is SMO (23 of 101 species; 22.8%); second is CP (14 of 63 species; 22.2%); and third is TVB (six of 43 species; 14.0%).

Based on the results of the RHP analysis, the physiographic region with the highest priority is the SMO, inasmuch as it contains the highest numbers of both country endemics and high vulnerability species (Tables 19–20). This region also has the highest priority in Puebla (Woolrich-Piña et al. 2017) and Hidalgo (Ramírez-Bautista et al. 2020). The country endemics include 12 anurans, seven salamanders, 19 lizards, 18 snakes, and one turtle. We indicate these species with an asterisk in Table 4. The SMO also harbors 23 high vulnerability species, which are identified in Table 8 and listed here for emphasis (with EVS score shown in parentheses):

- Anaxyrus compactilis** (14)
- Craugastor decoratus** (15)
- Eleutherodactylus longipes** (15)
- Eleutherodactylus verrucipes** (16)
- Aquiloerycea cephalica** (14)
- Aquiloerycea scandens** (17)
- Chiropterotriton chondrostega** (17)
- Chiropterotriton magnipes** (16)
- Chiropterotriton multidentatus** (15)
- Abronia taeniata** (15)
- Barisia ciliaris** (14)

- Sceloporus minor** (14)
- Sceloporus parvus** (15)
- Lepidophyma occulor** (14)
- Xenosaurus mendozai** (16)
- Pituophis deppei** (14)
- Salvadora bairdi** (15)
- Chersodromus rubriventris** (14)
- Geophis latifrontalis** (14)
- Thamnophis sumichrasti** (15)
- Agkistrodon taylori** (17)
- Crotalus aquilus** (16)
- Crotalus totonacus** (17)

Of these 24 species, all are country endemics and note that their EVS values range from 14 to 17.

The CP contains 36 country endemics, including seven anurans, two salamanders, 12 lizards, 12 snakes, and one turtle, all of which are indicated with an asterisk in Table 4. The CP also contains 14 high vulnerability species, which are identified in Table 8 and listed here for emphasis:

- Anaxyrus compactilis** (14)
- Aquiloerycea cephalica** (14)
- Chiropterotriton chondrostega** (17)
- Barisia ciliaris** (14)
- Sceloporus exsul** (17)
- Sceloporus minor** (14)
- Sceloporus parvus** (15)
- Pituophis deppei** (14)
- Salvadora bairdi** (15)
- Thamnophis pulchrilatus** (15)
- Thamnophis scalaris** (14)
- Crotalus aquilus** (16)
- Crotalus polystictus** (16)
- Crotalus triseriatus** (16)

All of these 14 species are country endemics and note that their EVS values range from 14 to 17.

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

| Physiographic region | Low | Medium | High | Total | Rank order |
|----------------------------|-----|--------|------|-------|------------|
| Central Plateau | 22 | 27 | 14 | 63 | 2 |
| Transmexican Volcanic Belt | 14 | 23 | 6 | 43 | 3 |
| Sierra Madre Oriental | 37 | 42 | 23 | 101 | 1 |

The TVB is home to 24 country endemic species, including seven anurans, one salamander, six lizards, nine snakes, and one turtle, all of which are indicated with an asterisk in Table 4. The TVB also harbors six high vulnerability species, as indicated in Table 8 and listed here for emphasis:

*Anaxyrus compactilis** (14)
*Eleutherodactylus verrucipes** (16)
*Lampropeltis ruthveni** (16)
*Pituophis deppei** (14)
*Thamnophis melanogaster** (15)
*Crotalus aquilus** (16)

All six of these species are country endemics and note that their EVS values range from 14 to 16.

In each of the three physiographic regions in Querétaro, the largest distributional grouping consists of country endemic species. In addition, the high vulnerability species in each region also are country endemics. Thus, both RHP measures indicate that the species of greatest conservation significance are all country endemic species. These results are important to recognize in any efforts to protect these creatures (as discussed in detail below).

Protected Areas in Querétaro

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. In the case of Querétaro, three such areas have been proposed (Table 21). As noted by Woolrich-Piña et al. (2017), “*in the case of the Mexican herpetofauna, as with all other organismal groups in this country, the compendium of available information on which to base these actions increases with time. As a short-term example, Wilson and Johnson (2010) reported 373 amphibians and 830 crocodylians, squamates, and turtles for a total Mexican herpetofauna of 1,203 species. Three years later, Wilson et al. (2013a,b) indicated the comparable numbers as 378 and 849 (a total of 1,227) and [four years later]... the numbers [stood] at 394 and 898 (a total of 1,292; Johnson et al. 2017).*” At this juncture, the numbers are 416 and 956 (total of 1,372; JD Johnson, unpub. data; 31 March 2022). Thus, over the last 12 years, the number of amphibian species has increased by 43 (11.5%), and those for the crocodylians, squamates, and turtles by 126 (15.2%), so the total has increased by 169 (14.1%). On average, the total number of Mexican herpetofaunal species has increased by 14.1 per year (169/12).

Only three protected areas are currently designated in Querétaro, all of which are federal areas, including two

Table 21 Characteristics of the Natural Protected Areas in Querétaro, Mexico. Abbreviations in the Facilities available column are as follows: A = administrative services; R = park guards; S = systems of pathways; and V = facilities for visitors.

| Name | Category | Date of decree (dd/mm/yyyy) | Area (ha) | Municipalities | Jurisdiction | Physiographic region | Facilities available | Occupied by landowners | Management plan available | Herpetofaunal survey completed |
|-----------------------|------------------------|-----------------------------|-------------|--|----------------------------|----------------------------|----------------------|------------------------|---------------------------|--------------------------------|
| Cerro de Las Campanas | National Park | 07/07/1937 | 58.49 | Santiago de Querétaro | Mexican Federal Government | Transmexican Volcanic Belt | A, R, S, V | Yes | Yes | No |
| El Cimatario | National Park | 21/07/1982 | 2,447.87 | Santiago de Querétaro | Mexican Federal Government | Transmexican Volcanic Belt | A, R, S, V | Yes | Yes | No |
| Sierra Gorda | Reserva de la Biosfera | 09/05/1997 | 383, 567.45 | Arroyo Seco, Jalpan de Serra, Landa de Matamoros, Pinal de Amoles, San Joaquín | Mexican Federal Government | Sierra Madre Oriental | A, R, S, V | Yes | Yes | No |

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Table 22. Distribution of herpetofaunal species in each of the Natural Protected Areas of Querétaro, Mexico, based on herpetofaunal surveys. Abbreviations are as follows: * = species endemic to Mexico, and ** = non-native species.

| Taxon | Natural Protected Area | | |
|---|------------------------|--------------|--------------|
| | Cerro de Las Campanas | El Cimatorio | Sierra Gorda |
| Anura (18 species) | | | |
| Bufonidae (4 species) | | | |
| <i>Anaxyrus compactilis</i> * | + | + | |
| <i>Anaxyrus punctatus</i> | | | + |
| <i>Incilius occidentalis</i> * | | | + |
| <i>Rhinella horribilis</i> | | | + |
| Craugastoridae (2 species) | | | |
| <i>Craugastor augusti</i> | | + | + |
| <i>Craugastor decoratus</i> * | | | + |
| Eleutherodactylidae (2 species) | | | |
| <i>Eleutherodactylus longipes</i> * | | | + |
| <i>Eleutherodactylus verrucipes</i> * | | | + |
| Hylidae (5 species) | | | |
| <i>Dryophytes eximius</i> * | | | + |
| <i>Rheohyla miotympanum</i> * | | | + |
| <i>Smilisca baudinii</i> | | | + |
| <i>Tlalocohyla godmani</i> * | | | + |
| <i>Trachycephalus vermiculatus</i> | | | + |
| Ranidae (3 species) | | | |
| <i>Lithobates berlandieri</i> | | | + |
| <i>Lithobates montezumae</i> * | | + | + |
| <i>Lithobates spectabilis</i> * | | | + |
| Scaphiopodidae (2 species) | | | |
| <i>Scaphiopus couchii</i> | | | + |
| <i>Spea multiplicata</i> | + | + | |
| Caudata (6 species) | | | |
| Plethodontidae (6 species) | | | |
| <i>Aquiloerycea cephalica</i> * | | | + |
| <i>Aquiloerycea scandens</i> * | | | + |
| <i>Chiropterotriton chondrostega</i> * | | | + |
| <i>Chiropterotriton magnipes</i> * | | | + |
| <i>Chiropterotriton multidentatus</i> * | | | + |
| <i>Isthmura bellii</i> * | | | + |
| Squamata (54 species) | | | |
| Anguidae (2 species) | | | |
| <i>Abronia taeniata</i> * | | | + |
| <i>Gerrhonotus ophiurus</i> * | | | + |
| Dibamidae (1 species) | | | |
| <i>Anelytropsis papillosus</i> * | | | + |
| Gekkonidae (1 species) | | | |
| <i>Hemidactylus frenatus</i> ** | | | + |
| Phrynosomatidae (7 species) | | | |
| <i>Sceloporus aeneus</i> * | | | + |
| <i>Sceloporus grammicus</i> | | | + |
| <i>Sceloporus parvus</i> * | | | + |
| <i>Sceloporus scalaris</i> * | | + | + |
| <i>Sceloporus spinosus</i> * | + | + | + |
| <i>Sceloporus torquatus</i> * | | | + |
| <i>Sceloporus variabilis</i> | | | + |
| Scincidae (2 species) | | | |
| <i>Plestiodon lynxe</i> * | | | + |
| <i>Plestiodon tetragrammus</i> | | | + |
| Sphenomorphidae (2 species) | | | |

Table 22 (continued). Distribution of herpetofaunal species in each of the Natural Protected Areas of Querétaro, Mexico, based on herpetofaunal surveys. Abbreviations are as follows: * = species endemic to Mexico, and ** = non-native species.

| Taxon | Natural Protected Area | | |
|------------------------------------|------------------------|--------------|--------------|
| | Cerro de Las Campanas | El Cimatorio | Sierra Gorda |
| <i>Scincella gemmingeri</i> * | | | + |
| <i>Scincella silvicola</i> * | | | + |
| Teiidae (2 species) | | | |
| <i>Aspidoscelis gularis</i> | + | + | + |
| <i>Holcosus amphigrammus</i> * | | | + |
| Xantusiidae (3 species) | | | |
| <i>Lepidophyma gaigeae</i> * | | | + |
| <i>Lepidophyma occulor</i> * | | | + |
| <i>Lepidophyma sylvaticum</i> * | | | + |
| Boidae (1 species) | | | |
| <i>Boa imperator</i> | | | + |
| Colubridae (14 species) | | | |
| <i>Conopsis lineata</i> * | | | + |
| <i>Conopsis nasus</i> * | + | + | + |
| <i>Dryobius margaritiferus</i> | | | + |
| <i>Ficimia olivacea</i> * | | | + |
| <i>Gyalopion canum</i> | | | + |
| <i>Lampropeltis polyzona</i> * | | | + |
| <i>Masticophis schotti</i> | | | + |
| <i>Oxybelis potosiensis</i> | | | + |
| <i>Pituophis deppei</i> * | | | + |
| <i>Pseudelaphe flavirufa</i> | | | + |
| <i>Salvadora bairdi</i> * | | | + |
| <i>Salvadora grahamiae</i> | | | + |
| <i>Senticolis triaspis</i> | | | + |
| <i>Tantilla rubra</i> | | | + |
| Dipsadidae (8 species) | | | |
| <i>Adelphicos quadrivirgatum</i> | | | + |
| <i>Chersodromus rubriventris</i> * | | | + |
| <i>Geophis latifrontalis</i> * | | | + |
| <i>Geophis mutitorques</i> * | | | + |
| <i>Hypsiglena jani</i> | | | + |
| <i>Leptodeira septentrionalis</i> | | | + |
| <i>Rhadinaea gaigeae</i> * | | | + |
| <i>Tropidodipsas sartorii</i> | | | + |
| Elapidae (1 species) | | | |
| <i>Micrurus tener</i> | + | + | + |
| Natricidae (6 species) | | | |
| <i>Storeria hidalgoensis</i> * | | | + |
| <i>Thamnophis cyrtopsis</i> | | | + |
| <i>Thamnophis eques</i> | | | + |
| <i>Thamnophis melanogaster</i> * | + | + | + |
| <i>Thamnophis scalaris</i> * | | | + |
| <i>Thamnophis sumichrasti</i> * | | | + |
| Viperidae (4 species) | | | |
| <i>Crotalus aquilus</i> * | | | + |
| <i>Crotalus atrox</i> | | | + |
| <i>Crotalus molossus</i> | | | + |
| <i>Crotalus triseriatus</i> * | | | + |
| Testudines (1 species) | | | |
| Kinosternidae (1 species) | | | |
| <i>Kinosternon integrum</i> * | + | | + |
| Total (95 species) | 8 | 10 | 77 |

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Table 23. Summary of the distributional status of herpetofaunal species in each natural protected area in Querétaro, 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) |
| NP Cerro de Las Campanas | 8 | 3 | 5 | — |
| NP El Cimatorio | 10 | 4 | 6 | — |
| BR Sierra Gorda | 77 | 29 | 47 | 1 |
| Total | 79 | 30 | 48 | 1 |

national parks and one biosphere reserve (Table 21). These three parks were established between 1937 and 1997, and range in size from about 59 to 383,567 ha. Fortunately, the largest of these areas is located within the Sierra Madre Oriental, the physiographic region of greatest herpetofaunal importance in the state. A full range of facilities is available in each area. Unfortunately, landowners occupy all three areas to some degree, and no herpetofaunal surveys are available. Conversely, management plans are available for all three areas.

Although official herpetofaunal surveys have not been completed for any of the protected areas in Querétaro, the available information on the herpetofaunal species known from the three protected areas has been collated here and is presented in Table 22, and summarized in Table 23.

Of the 129 species known from Querétaro, 79 (60.8%) are known to inhabit at least one of the three protected areas (Tables 22–23). Only a few species are known from the two national parks: Cerro de Las Campanas National Park (eight species, including three non-endemic species and five country endemics) and the El Cimatorio National Park (10, including four non-endemic species and six country endemics). By far, the largest number of species is known from the Sierra Gorda Biosphere Reserve (77, including 29 non-endemic species, 47 country endemics, and one non-native species). Of all 79 species, only two, the country endemic *Anaxyrus compactilis* and the non-endemic *Spea multiplicata*, are not known from the Sierra Gorda Biosphere Reserve. One non-native species (*Hemidactylus frenatus*) is known from this reserve. Unfortunately, these data indicate that completing the herpetofaunal surveys in these three protected areas will constitute a major critical step in assessing the conservation needs of the herpetofauna of Querétaro.

Of the 50 species of amphibians and reptiles which are not known from any of the three protected areas, 19 are country endemics, 30 are non-endemics, and two are non-natives. The 19 country endemics not found in any of the three protected areas are:

Eleutherodactylus nitidus
Lithobates neovolcanicus
Ambystoma velasci
Barisia ciliaris
Phrynosoma orbiculare
Sceloporus dugesii

Sceloporus exsul
Sceloporus minor
Xenosaurus mendozai
Tantilla bocourti
Trimorphodon tau
Epictia wynni
Storeria storerioides
Thamnophis pulchrilatus
Agkistrodon taylori
Crotalus polystictus
Crotalus totonacus
Metlapilcoatlus borealis

The 30 non-endemics not found in any of the three protected areas are:

Anaxyrus speciosus
Incilius nebulifer
Eleutherodactylus guttilatus
Dryophytes arenicolor
Scinax staufferi
Tlalocohyla picta
Hypopachus variolosus
Gerrhonotus infernalis
Corytophanes hernandezii
Laemanctus serratus
Norops sericeus
Sceloporus serrifer
Scincella lateralis
Drymarchon melanurus
Leptophis mexicanus
Masticophis mentovarius
Mastigodryas melanolomus
Spilotes pullatus
Amastridium sapperi
Coniophanes fissidens
Coniophanes piceivittis
Conopsis lineatus
Diadophis punctatus
Imantodes gemmistratus
Ninia diademata
Rena dulcis
Bothrops asper
Crotalus scutulatus
Kinosternon hirtipes
Kinosternon scorpioides

The single non-native species not found in any of the three protected areas is:

Virgotyphlops braminus

Obviously, a principal conservation goal with respect to the herpetofauna of Querétaro is to document the presence of the 19 country endemics and 30 non-endemics, which collectively constitute 38.6% of the native herpetofauna of the state, in one or more of the existing protected areas. Additional protected areas should be established to accommodate the remaining unprotected species, most likely in the Sierra Madre Oriental portion of the state.

Conclusions and Recommendations

Conclusions

A. Presently, the herpetofauna of Querétaro is comprised of 129 species, including 27 anurans, seven salamanders, 92 squamates (32 lizards and 60 snakes), and three turtles.

B. The numbers of species known from the three physiographic regions we recognize in Querétaro range from 43 species in the Transmexican Volcanic Belt to 102 in the Sierra Madre Oriental, with an intermediate number of 64 in the Central Plateau.

C. The numbers of species shared among physiographic regions range from 31 between the Transmexican Volcanic Belt and the Sierra Madre Oriental to 45 between the Central Plateau and the Sierra Madre Oriental. The Coefficient of Biogeographic Resemblance values range from 0.43 between the Transmexican Volcanic Belt and the Sierra Madre Oriental to 0.60 between the Central Plateau and the Transmexican Volcanic Belt. The UPGMA dendrogram indicates that the herpetofaunas of the Central Plateau and the Transmexican Volcanic Belt resemble one another more closely than either of them resembles the herpetofauna of the Sierra Madre Oriental.

D. The level of herpetofaunal endemism in Querétaro is relatively high. Of the 127 species that constitute the native herpetofauna, 67 are endemic to the country of Mexico (52.8%).

E. The distributional status of the species that comprise the Querétaro herpetofauna is as follows (in order of category size): country endemics (67, 51.9%); non-endemics (60, 46.5%); and non-natives (two, 1.6%).

F. Regarding the distribution categories developed by Wilson et al. (2017), of the 60 non-endemic species, 26 (43.3%) are in the MXUS category, with 17 (28.3%) in MXCA, nine (15.0%) in MXSA, five (8.3%) in USCA, and three (5.0%) in USSA.

G. The principal environmental threats are deforestation, livestock rearing, roads, polluted bodies of water, and myths and other cultural factors.

H. To assess the conservation status of the Querétaro herpetofauna, we employed the SEMARNAT, IUCN, and EVS systems. As in prior MCS papers, we ascertained the SEMARNAT system to be of minimal value, since only 55 (43.3%) of the native species have been assessed using this system, including 19 classified as threatened (A) and 36 as special protection (Pr). A comparison of the SEMARNAT and distributional categorizations indicates that of the 20 threatened species, four are non-endemics and 16 are country endemics. Of the 37 special protection species, 15 are non-endemics and 22 are country endemics.

I. Application of the IUCN conservation status evaluation system to the Querétaro herpetofauna demonstrates the following distribution (by category and proportion): CR (two of 127 native species, 1.6%); EN (four, 3.1%); VU (nine, 7.1%); NT (four, 3.1%); LC (87, 68.5%); DD (two, 1.6%); and NE (19, 15.0%).

J. Using the EVS system to assess the conservation status of the native herpetofauna of Querétaro, and allocating the resulting scores to the low, medium, and high vulnerability categories, the values increased from low (45) to medium (52), and then decreased to high (30).

K. Comparing the IUCN and EVS conservation status categories for each individual species, 50.0% of the EVS high vulnerability species have been allocated to the three IUCN threat categories (CR, EN, or VU), while only 51.7% of the EVS low vulnerability species have been placed in the IUCN's LC category. Thus, the results of these two systems do not correspond well with one another.

L. Our assessment indicates that many of the 108 species in the IUCN's DD, NE, and LC categories have been evaluated inadequately as compared to their respective EVS values; consequently, we recommend a reevaluation of these species to better determine their actual prospects for survival.

M. Application of the Relative Herpetofaunal Priority (RHP) measure indicates that the most significant herpetofauna is that of the Sierra Madre Oriental physiographic region, given that it contains the highest numbers of country endemics and high vulnerability species. The rankings of the three physiographic regions in the state are the same based on either endemic or high vulnerability species, i.e., in the order of SMO, CP, and TVB.

N. Three protected areas are designated in Querétaro, all at the federal level. Two of these areas lie within the Transmexican Volcanic Belt and one is in the Sierra Madre Oriental, of which the latter is the most important herpetofaunal region in the state. Regrettably, landowners occupy all three areas, and no herpetofaunal surveys are available for them, although management plans are available for all three.

O. Of the 129 species comprising the Querétaro herpetofauna, 79 have been recorded from the three protected areas in the state collectively, including 18 anurans, six salamanders, 54 squamates, and one turtle.

P. Of the 50 species not currently known from any of the three protected areas, 19 are country endemics, 30 are non-endemics, and one is a non-native.

Recommendations

A. Given that no herpetofaunal surveys have been conducted in any of the three protected areas established in Querétaro, carrying out such surveys is the most basic concern for dealing with the conservation priorities for the state's herpetofauna. However, the data we assembled indicate that 79 species have been found in the three protected areas, which is a good starting point for carrying out such surveys.

B. Once these surveys have been conducted, we can determine the need and rationale for establishing additional protected areas within the state. At this point, our data indicate that 49 native species (19 country endemics and 30 non-endemics) have not been found in any of the three established protected areas; thus, these species need to be found in the three established protected areas or other areas that have not been designated as protected areas thus far.

C. Once the entire herpetofauna of Querétaro has been documented to occur within the established protected areas (i.e., those established either currently or in the future), then monitoring programs should be developed to allow for the long-term protection of the entire herpetofauna of the state.

D. These steps should be taken as soon as possible, considering that Querétaro is the 22nd most populous state in the country and the 7th most densely populated.

“Even before the age of climate change, the literature of conservation furnished many metaphors to choose from...the Gaia hypothesis...spaceship earth...the Pale Blue Dot...You can choose your metaphor. You can't choose the planet, which is the only one any of us will ever call home.”

David Wallace-Wells (2019)

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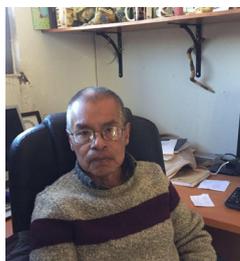
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Aurelio Ramírez-Bautista began his herpetological career as an undergraduate student conducting research at the Los Tuxtlas Biological Field Station in Veracruz, Mexico. He received a Bachelor's in Biology from Universidad Veracruzana in Veracruz, Mexico. He subsequently received a Master's in Science and a Doctorate at the Universidad Nacional Autónoma de México (UNAM), followed by a postdoctoral appointment at the University of Oklahoma in Norman, Oklahoma, USA. His main research involves studies on ecology, demography, reproduction, conservation, and life history evolution, using the amphibians and reptiles of Mexico as models. He served as the president of the Sociedad Herpetológica Mexicana, as an Associate Editor for the journal *Mesoamerican Herpetology*, and as a Professor at UNAM. Currently, Aurelio is a professor at the Universidad Autónoma del Estado de Hidalgo (UAEH), where he teaches population ecology, herpetology, and the natural history of amphibians and reptiles. He has authored or co-authored 295 peer-reviewed papers and books on herpetology, ecology, life history evolution, sexual size dimorphism, reproduction, global climate change, potential distribution, demography, conservation, behavior, and thermal ecology. Over the years he has been responsible for the graduation of 71 students, including 44 undergraduates, 18 Master of Science students, and seven Ph.D. students; and he has participated as an external advisor for Ph.D. students at Brigham Young University, the University of Miami, and Eastern Carolina University, in the United States. He has received national recognition (Helia Bravo Hollis Award by the Technical Council of Scientific Research of UNAM, as a member of the National System of Researchers Level III), and international awards (such as the Donald Tinkle Award by the Southwestern Association of Naturalists), and he has the profile of PRODEP (Programa para el Desarrollo Profesional Docente) at UAEH.



Rubén Pineda-López received B.S. and M.S. degrees from the Universidad Nacional Autónoma de México (UNAM) and a Ph.D. from the University of Alicante in Spain. Rubén is a research professor at the Universidad Autónoma de Querétaro. He has authored or co-authored 47 publications, most of them on the fauna of the state of Querétaro, and is a founding and current member of the Academic Committee of the Thematic Network for Biology, Management, and Conservation of Native Fauna (REFAMA).



Vicente Mata-Silva is a herpetologist originally from Rio Grande, Oaxaca, Mexico. His interests include ecology, conservation, natural history, and biogeography of the herpetofaunas of Mexico, Central America, and the southwestern United States. He received a B.S. degree from the Universidad Nacional Autónoma de México (UNAM), and M.S. and Ph.D. degrees from the University of Texas at El Paso (UTEP). Vicente is an Assistant Professor of Biological Sciences at UTEP, in the Ecology and Evolutionary Biology Program, and Co-Director of UTEP's Indio Mountains Research Station, located in the Chihuahuan Desert of Trans-Pecos, Texas, USA. To date, Vicente has authored or co-authored over 100 peer-reviewed scientific publications. He also was the Distribution Notes Section Editor for the journal *Mesoamerican Herpetology*, and is currently Associate Editor for the journal *Herpetological Review*.



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.

The herpetofauna of Querétaro, Mexico

Elí García-Padilla is a herpetologist who primarily focuses on studying the ecology and natural history of the Mexican herpetofauna. His research efforts have centered on the Mexican states of Baja California, Tamaulipas, Chiapas, and Oaxaca. His first experience in the field was studying the ecology of the insular endemic populations of the rattlesnakes *Crotalus catalinensis*, *C. muertensis* (*C. pyrrhus*) and *C. tortugensis* (*C. atrox*) in the Gulf of California. For his Bachelor's degree, Elí presented a thesis on the ecology of *C. muertensis* (*C. pyrrhus*) on Isla El Muerto, Baja California, Mexico. To date, he has authored or co-authored more than 100 peer-reviewed scientific publications. Currently, he is employed as a formal Curator of Amphibians and Reptiles from Mexico in the electronic platform Naturalista of the Comisión Nacional para el Uso y Conocimiento de la Biodiversidad (CONABIO; www.naturalista.mx). One of his main passions is environmental education, and for several years he has been working on various projects that include the use of audiovisual media as a powerful tool to reach large audiences, while promoting the importance of the knowledge, protection, and conservation of biodiversity in Mexico. Elí's interests include wildlife and conservation photography, and his art has been published in several recognized scientific, artistic, and educational books, magazines, and websites. He is currently collaborating in a research project evaluating the Jaguar (*Panthera onca*) as an umbrella species for the conservation of the herpetofauna of Nuclear Central America.



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 that of southern Mexico. Jerry is the Director of the 40,000-acre Indio Mountains Research Station, was a co-editor of the book *Conservation of Mesoamerican Amphibians and Reptiles* and co-author of four of its chapters. He is 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 100 peer-reviewed papers, including two key articles in 2010, “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. Previously, he was an Associate Editor and Co-chair of the Taxonomic Board for the journal *Mesoamerican Herpetology*.



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 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.



Lydia Allison Fucsko is an amphibian conservationist and environmental activist. She is also a gifted photographer who has taken countless pictures of amphibians, including photo galleries of mostly southeastern Australian frogs. Dr. Fucsko has postgraduate degrees in computer education and in vocational education and training from The University of Melbourne, Parkville, Melbourne, Australia. Lydia also holds a Master's Degree in Counseling from Monash University, Clayton, Melbourne, 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, Melbourne, Australia. In addition, Dr. Fucsko is a sought-after educational consultant. Recently, the species *Tantilla lydia* was named in her honor.



Larry David Wilson is a herpetologist with extensive 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 460 peer-reviewed papers and books on herpetology. Larry is the senior editor of *Conservation of Mesoamerican Amphibians and Reptiles* and the co-author of seven of its chapters. His other books include *The Snakes of Honduras*, *Middle American Herpetology*, *The Amphibians of Honduras*, *Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras*, *The Amphibians and Reptiles of the Honduran Mosquitia*, and *Guide to the Amphibians & Reptiles of Cusuco National Park, Honduras*. To date, he has authored or co-authored the descriptions of 75 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*. In 2005, he was designated a Distinguished Scholar in the Field of Herpetology at the Kendall Campus of Miami-Dade College. Currently, Larry is a Co-chair of the Taxonomic Board for the website *Mesoamerican Herpetology*.

