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Article in *Zootaxa* · July 2019

DOI: 10.11646/zootaxa.4638.2.7

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## An updated checklist of the herpetofauna of Querétaro, Mexico: species richness, diversity, and conservation status

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### Abstract

Mexico contains a large number of amphibian and reptile species, and the states in the southeastern part of the country are the richest and most diverse. Although the study of species richness within Mexico's individual states has been increasing over the last two decades, herpetofaunal species lists for several states in the central region are incomplete. Herein, we provide a list of the herpetofauna of the state of Querétaro, a state that remains relatively unexplored. We also indicate the conservation status of the component species in the state, based on the national and international categorizations, as well as their Environmental Vulnerability Scores (EVS). Based on a review of literature and specimens in scientific collections, our results show that the herpetofauna of Querétaro currently is composed of 138 species, of which 34 are amphibians (27 anurans and seven caudates) and 104 are reptiles (three turtles, 34 lizards, and 67 snakes). The number of Mexican endemic species occurring in the state consists of 19 amphibians and 50 reptiles, representing 55.9% and 48.1%, respectively, of the total numbers in these groups. A total of 61 species (13 species of amphibians and 48 of reptiles) are listed in NOM-059-SEMARNAT-2010, within the categories of Special Protection (Pr) and Threatened (A). According to the International Union for Conservation of Nature (IUCN 2019), 34 species of amphibians (100% of species) and 87 species of reptiles (83.65% of a total of 104) have been placed within a risk category, i.e., except for the DD and NE categories. The EVS results show that nine species of amphibians have high environmental vulnerability, 11 species medium vulnerability, and 14 low vulnerability, whereas among the reptiles, 22 species have high vulnerability, 43 medium vulnerability, and 37 species low vulnerability. The herpetofauna of Querétaro illustrates a high level of species richness, which is typical of central Mexico, as well as diverse groupings associated with the arid, temperate, and tropical environments found in the state. These types of studies are necessary for increasing our knowledge of the herpetofauna in the various states of Mexico, as well as for evaluating the conservation status and implementing management plans for species in both herpetofaunal groups.

**Key words:** Central Mexico, conservation, diversity, Mexican herpetofauna

### Introduction

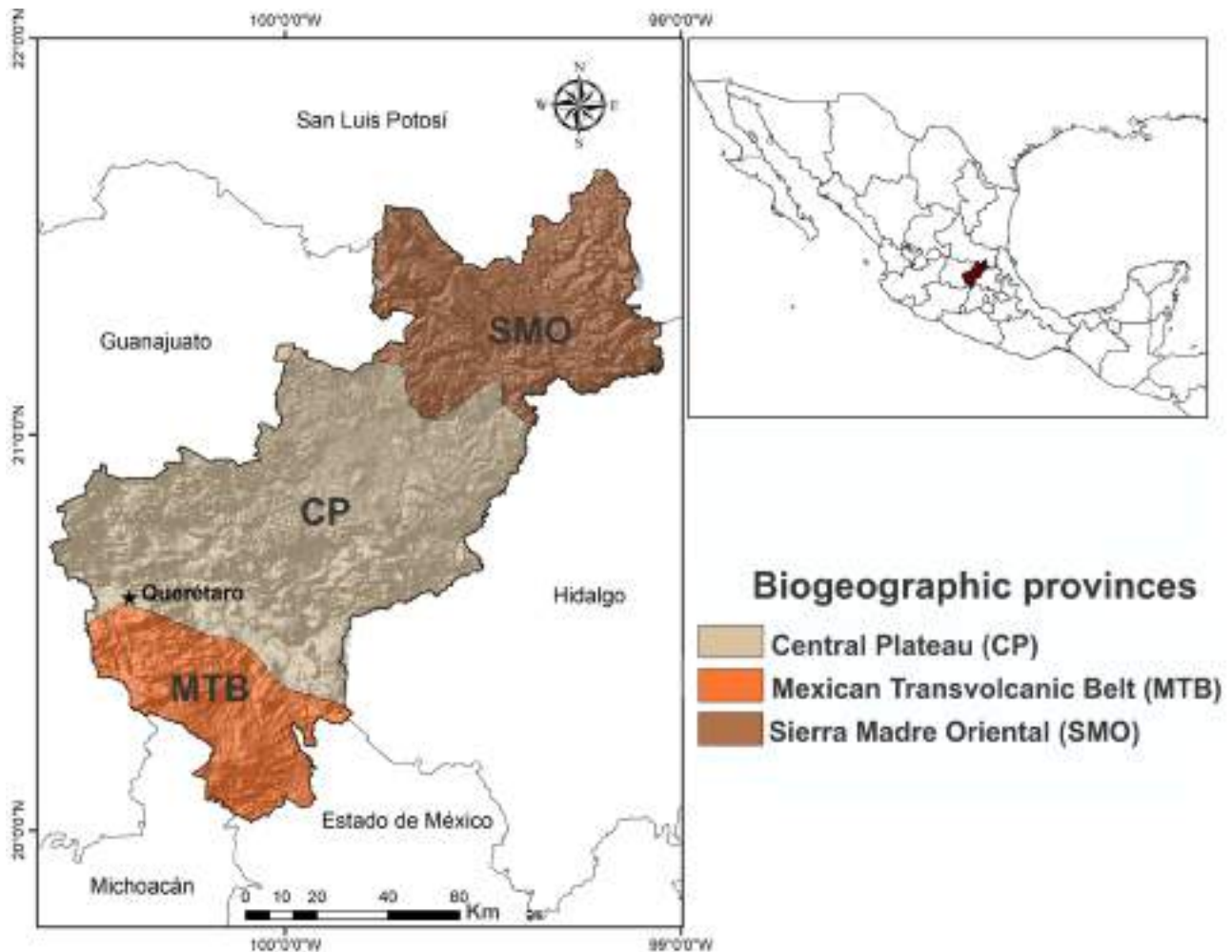
Numerous studies on biological diversity demonstrate that Mexico is one of the world's most diverse countries, ranking fourth after Brazil, Colombia, and Indonesia (Jiménez-Sierra *et al.* 2014), as it contains more than 10% of the species richness in the world (Ramírez-Bautista *et al.* 2017). The amount of richness and species diversity has been explained by factors related to the complex orography of the country, inasmuch as Mexico abuts two large biogeographic provinces, the Neartic and the Neotropical (Morrone 2005). In addition, a large number of biogeographic provinces or ecoregions are present in the country (Morrone 2005), which support a remarkable variety of life forms among the different biological groups (Canseco-Márquez *et al.* 2004; Ramírez-Bautista *et al.* 2017).

The herpetofauna of Mexico is characterized by a high diversity of species, of which our knowledge has increased significantly during the last two decades. An early study by Flores-Villela (1993) documented the presence of 997 species (291 amphibians and 706 reptiles) in the country. More recent studies, however, including those of Flores-Villela & Canseco-Márquez (2004), documented a total of 1,165 herpetofaunal species (361 amphibians and 804 reptiles), and followed by that of Flores-Villela & Canseco-Márquez (2007), who recorded 1,212 species (373 amphibians and 839 reptiles). Subsequently, Wilson *et al.* (2013a, b) indicated a total of 1,227 species (378 amphibians and 849 reptiles), whereas Parra-Olea *et al.* (2014) recorded 376 species of amphibians, and Flores-Villela & García-Vázquez (2014) 864 species of reptiles, for a total of 1,240 species. These results demonstrate a remarkable increase in our knowledge of the Mexican herpetofauna in recent years, especially at the state level (Ramírez-Bautista *et al.* 2014; Mata-Silva *et al.* 2015; Johnson *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; Woolrich-Piña *et al.* 2017; Lemos-Espinal *et al.* 2018a). Johnson *et al.* (2017), in the most recent list for the entire country, documented a total of 1,292 species (394 amphibians and 898 reptiles). This richness, however, continues to be enhanced on account of the descriptions of new species, such as *Gerrhonotus mccoysi* (García-Vázquez *et al.* 2018a), *Rhadinaea nuchalis* (García-Vázquez *et al.* 2018b), *Xenosaurus fractus* (Nieto-Montes de Oca *et al.* 2018) and *Rhadinaea eduardoi* (Mata-Silva *et al.* 2019), as well as new snake genera, such as *Cenaspis* (Campbell *et al.* 2018). These taxonomic innovations are documented on a running basis in a taxonomic list maintained at the Mesoamerican Herpetology website ([www.mesoamerican-herpetology.com](http://www.mesoamerican-herpetology.com)).

The foregoing discussion demonstrates the importance of undertaking faunal studies throughout the country, and updating the state lists of amphibians and reptiles. For example, although the states of southeastern Mexico, such as Oaxaca (Mata-Silva *et al.* 2015) and Chiapas (Johnson *et al.* 2015), contain the greatest richness of amphibian and reptile taxa, the species composition varies markedly among some states in the central region, such as Aguascalientes (Carbajal-Márquez & Quintero-Díaz 2016), Hidalgo (Ramírez-Bautista *et al.* 2014), and Puebla (Woolrich-Piña *et al.* 2017), and in the northern portion of the country, in states such as San Luis Potosí (Lemos-Espinal *et al.* 2018a), Nuevo León (Nevárez-de los Reyes *et al.* 2016), and Durango (Lemos-Espinal *et al.* 2018b). These studies illustrate that orographic complexity and the diversity of vegetation types are important drivers for evolution within diverse taxonomic groups (i.e., genera and families) of both amphibians and reptiles in Mexico (Canseco-Márquez *et al.* 2004; Wilson *et al.* 2013a, b), as well as for providing geographical barriers that promote speciation events (Bryson *et al.* 2014; Nieto-Montes de Oca *et al.* 2017).

The herpetofauna of the state of Querétaro, which is located in the central portion of Mexico (Figs. 1 and 2), has not been studied completely. Historically, the first studies that recorded species of reptiles, such as *Crotalus triseriatus* and *C. polystictus*, were those of Martín del Campo (1935) and Smith (1936, 1939), of which the latter discussed records of species of *Sceloporus*. Smith & Taylor (1966) provided the first lists of amphibians and reptiles for the state, which was complemented by the work of Dixon *et al.* (1972), who produced the first herpetofaunal list for Querétaro, which amounted to 93 species. This number increased with new records of species such as *Holcosus amphigrammus* (Padilla-García & Mendoza-Quijano 1996a; listed as *Ameiva undulata*), *Imantodes gemmistratus* (Padilla-García & Mendoza-Quijano 1996b), *Leptophis mexicanus septentrionalis* (Padilla-García & Mendoza-Quijano 1996c), and *Laemanctus serratus* (Padilla-García *et al.* 1996). The most recent works are those of Nieto Montes de Oca & Pérez Ramos (1999), who reported a total of 133 species, and Dixon & Lemos-Espinal (2010), who corrected and updated this number to 117 species for the state. Parra-Olea *et al.* (2014) reported 22 species of amphibians, and Flores-Villela & García-Vázquez (2014) documented 75 species of reptiles, for a total of 97 species. This number has increased over time, with Cruz-Elizalde *et al.* (2016) documenting a total of 138 species.

The state of Querétaro is located within the metropolitan area of Mexico, a region with high population growth and extensive areas of cultivation (Jones & Serrano Cardenas 2016). A diversity of undisturbed environments still are found in the state, such as cloud forest, pine forest, oak, and tropical deciduous forest (Zamudio *et al.* 1992). Although herpetofaunal inventories have been carried out in several states of the country, to date no complete list of Querétaro's herpetofauna is available, nor an assessment of the conservation status of its species (Mata-Silva *et al.* 2015; Wilson *et al.* 2017; Lemos-Espinal *et al.* 2017, 2018a, b). The goal of this study is to provide an updated list of the herpetofauna of Querétaro, as well as an analysis of the conservation status for each species at both the national and international levels. Thus, we expect that this work will serve as a point of reference for later studies on the conservation, ecology, and distribution of amphibians and reptiles for the central region of Mexico (Johnson *et al.* 2017).



**FIGURE 1.** Biogeographic provinces of the state of Querétaro, Mexico. **CP:** Central Plateau; **SMO:** Sierra Madre Oriental; **MTB:** Mexican Transvolcanic Belt (INEGI 2009). Map modified from Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO 2008).

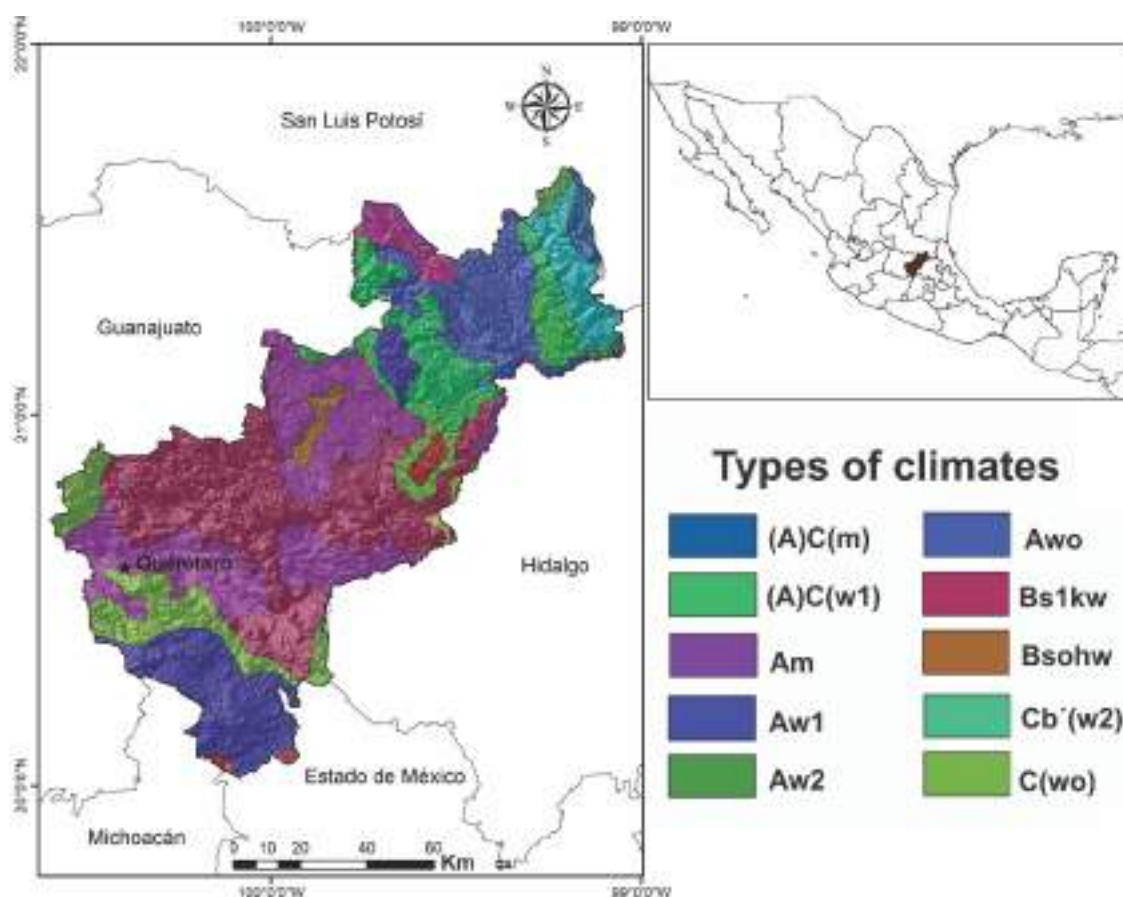
## Materials and methods

**Data collection.** We consulted several sources of information to obtain data on the occurrence of amphibians and reptiles in Querétaro. Initially, we conducted a literature review on the herpetofauna of Querétaro by examining the published works of Nieto Montes de Oca & Pérez Ramos (1999), and Dixon & Lemos-Espinal (2010). Subsequently, we reviewed specialized literature on the distribution of amphibians and reptiles in Mexico from 2010 to December 2018, in the electronic journals *Mesoamerican Herpetology* (<http://www.mesoamericanherpetology.com/index.html>) and *Herpetological Review* (<https://ssarherps.org/herpetological-review-pdfs/>), among others. In addition, we consulted recent herpetofaunal lists for neighboring states, such as those for San Luis Potosí (Lemos-Espinal & Dixon 2013; Lemos-Espinal *et al.* 2018a), Hidalgo (Ramírez-Bautista *et al.* 2014), and Tamaulipas (Terán-Juárez *et al.* 2016), to corroborate the occurrence of species in Querétaro. Another source of information included occurrence records of amphibians and reptiles in the state, obtained from projects conducted by the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO). These projects contain field information and records of species from national and foreign scientific collections. Among the collections we consulted were the Herpetological Collections Center for Biological Research (CIB-UAEH), the National Amphibian and Reptile Collection (CNAR), and the Herpetological Collection of the Museum of Zoology “Alfonso L. Herrera” (MZFC-UNAM) of the Faculty of Sciences of the National Autonomous University of Mexico, in addition to the Collection of Vertebrates, University of Texas at Arlington (UTA), the Collection of Herpetology, University of California at Berkeley Museum

of Vertebrate Zoology MVZ, Collection of Herpetology, Texas Cooperative Wildlife Collection, Texas A & M University TCWC, Collection of Herpetology, Oklahoma Museum of Natural History, University of Oklahoma OMNH, Collection of Herpetology, Zoology Section of Los Angeles, Country Museum of Natural History LACM, Collection of Herpetology, University of Illinois Museum of Natural History UIMNH, Collection of Herpetology, Museum of Comparative Zoology, Harvard University MCZ, and The University of Michigan Museum of Zoology UMMZ.

We based the taxonomic classification of the species in both groups on the works of Wilson *et al.* (2013a, b), and updated the scientific names of the species until January of 2019, based on Frost (2019) for amphibians and Uetz & Hošek (2019) for reptiles. In addition, we assessed recent taxonomic changes in both groups in order to update the identification of species as much as possible (Wilson *et al.* 2013a, b; Ruane *et al.* 2014; Meza-Lázaro & Nieto-Montes de Oca 2015; Rovito *et al.* 2015; Duellman *et al.* 2016; Nieto-Montes de Oca *et al.* 2017). In the final species list, we did not include species with erroneous locality data, or those that represent synonyms of currently recognized taxa.

**Conservation status.** We assigned conservation risk categories for each species based on the Mexican redlist (NOM-059-SEMARNAT-2010; DOF 2010) and the global redlist (IUCN Red List; IUCN 2019). We also evaluated the population trend for each species based on the IUCN Red List (2019). Additionally, we used the Environmental Vulnerability Score (EVS; Wilson *et al.* 2013a, b), which considers three categories of environmental vulnerability: low (3 to 9 points), medium (10–13 points), and high (14–20 points). Species assessments in this system are based on (i) the extent of geographic distribution, (ii) the extent of ecological distribution (vegetation types occupied), and (iii) the type of reproductive mode for amphibians, and the degree of human persecution for reptiles (see Wilson *et al.* 2013a, b for details).



**FIGURE 2.** Types of climates of the state of Querétaro, México. **(A)C(m)**: Semi-warm wet; **(A)C(w1)**: Semi-low subhumid; **Am**: Warm wet; **Aw1, Aw2, Awo**: Warm subhumid; **Bs1kw**: Temperate semiarid; **Bs0hw**: Dry rain; **Cb'(w2)**: Semi-sub humid; **C(wo)**: Subhumid tempered. Map modified from Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO 2008).

## Results

The herpetofauna of Querétaro is composed of 138 species, of which 34 are amphibians (27 anurans and seven caudates; Table 1), and 104 are reptiles (three turtles, 34 lizards, and 67 snakes; Table 1). The herpetofauna of the state represents 10.7% of the 1,292 species recorded for Mexico (Johnson *et al.* 2017), and for amphibians and reptiles in the country, 8.6% of 394 species and 11.6% of 898 species, respectively. Of the 138 species in Querétaro, 19 amphibians and 50 reptiles are endemic to Mexico (Table 1), representing 55.9% and 48.1%, respectively, of the amphibian and reptile species in the state and 7.1% and 9.6% of the amphibian and reptiles endemic to Mexico, respectively (Johnson *et al.* 2017). Two species (*Hemidactylus frenatus* and *Indotyphlops braminus*) are introduced in Querétaro (Table 1).

**Conservation status.** In the state, 61 species occupy some category within the Official Mexican Standard (NOM-059-SEMARNAT-2010; DOF 2010), which represent 44.9% of the 136 native species recorded in the state. Thirteen species of amphibians are protected by NOM-059-SEMARNAT-2010, nine under the category of Special Protection (Pr) and four as Threatened (A; Table 1), and represent 38.2% of the amphibians reported for the state. The remaining 21 amphibian species (61.8%) are not considered under this conservation law. Among the reptiles, 48 species (46.1%) are in some risk category, with 29 species under the category of Pr, and 19 as A (Table 1). The remaining 54 native species (52.4% of a total of 102 species) are not considered under this assessment system.

The International Union for Conservation of Nature (IUCN 2019) includes all the 34 amphibian species (Table 1). For the reptiles, 84 species (80.8% of the total of 104 species) are listed in the IUCN system, whereas 20 species are not considered (19.2%; Table 1; IUCN 2019).

Considering the population status of the species dealt with by the IUCN, 16 species of amphibians are judged to have stable populations (47.1%), nine decreasing populations (26.5%), two increasing populations (5.9%; those of *Rhinella horribilis* and *Tlalocohyla picta*), and seven species an unknown status (20.6%; Table 1). Among the 102 native species of reptiles, 61 species are assessed as having stable populations (59.8%), 13 declining populations (12.7%; e.g., *Abronia taeniata*, *Sceloporus exsul*, and *Chersodromus rubriventris*), none increasing populations, 12 species an unknown status (11.8%), and 16 have populations that not been evaluated (15.7%; Table 1, IUCN 2019).

A high number of amphibian and reptile species are listed in the Least Concern category (22 amphibians or 64.7% of the total of 34; 75 reptiles or 73.5% of the total of 102 native species) by the IUCN (2019). However, threatened species (in the CR, EN, or VU categories) are found among some amphibians (one CR, four EN, and nine VU; Table 1; IUCN 2019).

Finally, considering the environmental vulnerability index employed by Wilson *et al.* (2013a, b), nine amphibian species are considered to have high environmental vulnerability (26.5%), 11 species medium vulnerability (32.4%), and 14 low vulnerability (41.2%; Table 1). Among the reptiles, 22 species are judged to have high vulnerability (21.6% of a total of 102 native species), 43 with medium vulnerability (42.2%), and 37 species low vulnerability (36.3%; Table 1). Two species of exotic reptiles (the gecko *Hemidactylus frenatus* and the blind snake *Indotyphlops braminus*) are not considered in this list.

## Discussion

Mexico houses a remarkable richness and diversity of species, of many biological groups (Ramírez-Bautista *et al.* 2017). With regard to its amphibians and reptiles, a high percentage of species (61.1%) are endemic to the country (Johnson *et al.* 2017). In recent years, the herpetofauna of several states in Mexico has been studied (see above) to better understand the number of amphibian and reptile species that each one contains (Ramírez-Bautista *et al.* 2014; Mata-Silva *et al.* 2015; Lemos-Espinal *et al.* 2017, 2018a, b), including Oaxaca (Mata-Silva *et al.* 2015) and Chiapas (Johnson *et al.* 2015), the richest and most diverse states, with 442 and 330 species reported, respectively.

In this context, the herpetofauna of the state of Querétaro is moderately rich, as it contains 34 amphibian and 104 reptile species. Of these, a moderate percentage of species of each group is endemic to Mexico (55.9% and 48.1%, respectively); both of these figures, however, are less than those for the country as a whole (67.8% for amphibians and 58.1% for reptiles; Johnson *et al.* 2017). Although the species richness of Querétaro is lower than that recorded for states such as Puebla (267 species, Woolrich-Piña *et al.* 2017), Hidalgo (183 species, Ramírez-Bautista *et al.* 2014), and San Luis Potosí (181 species; Lemos-Espinal *et al.* 2018a), the herpetofauna of Querétaro still is larger than that of Coahuila (133 species, Lemos-Espinal & Smith 2016), Aguascalientes (90 species, Carbajal-Márquez & Quintero-Díaz 2016), and Tlaxcala (51 species, Fernández *et al.* 2006).

The state of Querétaro contains 10 vegetational formations (Rzedowski 2006), including temperate environments such as mesophilic mountain forest and oak forest, tropical forests such as tropical deciduous forest and tropical sub-deciduous forest, and arid and semi-arid environments such as xerophilous or pasture scrub (Zamudio *et al.* 1992). Arid and semi-arid environments dominate the largest territorial extension of the state (Martínez & García Mendoza 2001); in addition, a notable amount of area is devoted to agriculture and urbanization (Zamudio *et al.* 1992). The presence of different biogeographic provinces in the state, however, favors the occurrence of different environments, and also contains geographical barriers, which promote the maintenance of different groups of species of amphibians and reptiles (Canseco-Márquez *et al.* 2004).

The arid and semiarid environments of the state are inhabited by species of the bufonid genera *Anaxyrus* and *Incilius*, owing to their high tolerance of variable environmental conditions (temperature, seasonality), as well as to their reproductive behavior (clutch size, mating sites; Wells 2007). For example, in the state of Querétaro and generally in the central region of Mexico, the toad species *Anaxyrus compactilis*, *A. punctatus*, *Scaphiopus couchii*, and *Spea multiplicata* exhibit a high level of abundance, favored by a high tolerance to high temperatures and low humidity, since their skin is more impermeable when compared to other species of anurans or salamanders living in temperate environments (Vitt & Caldwell 2009). This situation allows the better represented in the Mexican Plateau and the Mexican Transvolcanic Belt to require a lesser amount of water or short periods of rain for reproduction (Dayton & Fitzgerald 2005).

In addition to the remarkable number of species in Querétaro occurring in arid and semi-arid environments, those from temperate and tropical environments are found in the northern part of the state (Dixon & Lemos-Espinal 2010). These species include members of the genera *Craugastor*, *Eleutherodactylus*, *Dryophytes*, *Aquiloerycea*, and *Chiropterotriton*, and are distributed in areas of pine, oak, and cloud forest (Canseco-Márquez *et al.* 2004; Flores-Villela *et al.* 2010). The northern region of the state also contains tropical elements (*Hypopachus variolosus* and *Trachycephalus vermiculatus*), which are associated with such neighboring states as San Luis Potosí (Lemos-Espinal & Dixon 2013) and Hidalgo (Ramírez-Bautista *et al.* 2014).

The distributional patterns of reptiles in Querétaro are similar to those of amphibians, in that the arid and semi-arid environments contain a richness and diversity that is unique in the state (Lavin-Murcio & Lazcano 2010; Cruz-Elizalde *et al.* 2016). For example, a large number of species of lizards of the genus *Sceloporus* are distributed in the central and southern regions, as well as snake genera such as *Crotalus* and *Thamnophis* (Rossman *et al.* 1996; Campbell & Lamar 2004). The provinces of the Mexican Plateau and the Mexican Transvolcanic Belt are located in the central region of Mexico (Morrone 2001). This region contains the states of Hidalgo (Ramírez-Bautista *et al.* 2014) and México (Aguilar-Miguel *et al.* 2009), areas where lizard species of the families Anguidae and Phrynosomatidae are distributed, as well as snakes in the families Colubridae, Dipsadidae, and Viperidae (Campbell & Lamar 2004; Flores-Villela *et al.* 2010). In addition, an important number of species endemic to Mexico, such as *Xenosaurus mendozai* and *Geophis mutitorques* (Canseco-Márquez *et al.* 2004; Ramírez-Bautista *et al.* 2014), inhabit the mountainous regions of the Sierra Madre Oriental, in the northern portion of the state; these species only are distributed in the central region of Mexico, and in the case of *X. mendozai*, it occurs only in restricted localities in Querétaro and Hidalgo (Nieto-Montes de Oca *et al.* 2013).

The herpetofauna of Querétaro, despite containing a lower amount of species richness than that of either Chiapas or Oaxaca, or that of neighboring states such as Hidalgo and San Luis Potosí (Ramírez-Bautista *et al.* 2014; Mata-Silva *et al.* 2015; Johnson *et al.* 2015; Lemos-Espinal *et al.* 2018a), contains a moderately high level of diversity of genera and families in both herpetofaunal groups. Within this composition of species, a high percentage has been assessed as threatened or under some category of risk within the national (NOM-059-SEMARNAT-2010) and international regulations (IUCN 2019), or are considered as vulnerable to anthropic factors (Wilson *et al.* 2013a, b). The most vulnerable groups are the salamanders, such as *Aquiloerycea scandens*, *C. chondrostega*, *C. magnipes*, and *C. multidentatus*. These species, due to their low mobility and low tolerance to disturbance, are placed in a high-risk category, which highlights the importance of maintaining protected areas within their distribution, both within the state and in other areas of Mexico (Wilson *et al.* 2013a).

**TABLE 1.** Herpetofaunal species of Querétaro, Mexico and their distribution and conservation status, based on the SEMARNAT, IUCN, and EVS assessment systems. \*: endemic to Mexico; \*\*: non-native. SEMARNAT Status, **P**: Endangered; **A**: Threatened; **Pr**: Special protection; **NS**: No Status. IUCN Categorization, **CR**: Critically Endangered; **EN**: Endangered; **VU**: Vulnerable; **NT**: Near Threatened; **LC**: Least Concern; **DD**: Data Deficient; **NE**: Not Evaluated. IUCN Population Trend, **U**: Unknown; **S**: Stable; **D**: Decreasing; **I**: Increasing; **N**: Not Evaluated. Environmental Vulnerability Score (as developed by Wilson & McCranie 2004, and applied by Wilson *et al.* 2013a, b), **L**: low vulnerability species (EVS of 3–9); **M**: medium vulnerability species (EVS of 10–13); **H**: high vulnerability species (EVS of 14–20). Non-native species not evaluated.

Taxon	SEMARNAT-2010 Category	IUCN Category	IUCN Population Trend	EVS Value	EVS Category
<b>(34 species)</b>					
<b>Anura (27 species)</b>					
<b>Bufonidae (6 species)</b>					
<i>Anaxyrus compactilis</i> (Wiegmann, 1833)*	NS	LC	U	14	H
<i>Anaxyrus punctatus</i> (Baird & Girard, 1852)	NS	LC	S	5	L
<i>Anaxyrus speciosus</i> (Girard, 1854)	NS	LC	S	12	M
<i>Incilius nebulifer</i> (Girard, 1854)	NS	LC	S	6	L
<i>Incilius occidentalis</i> (Camerano, 1879)*	NS	LC	S	11	M
<i>Rhinella horribilis</i> (Linnaeus, 1758)	NS	LC	I	3	L
<b>Craugastoridae (2 species)</b>					
<i>Craugastor augusti</i> (Dugès, 1879)	NS	LC	S	8	L
<i>Craugastor decoratus</i> (Taylor, 1942)*	Pr	VU	U	15	H
<b>Eleutherodactylidae (4 species)</b>					
<i>Eleutherodactylus guttilatus</i> (Cope, 1879)	NS	LC	U	11	M
<i>Eleutherodactylus longipes</i> (Baird, 1859)*	NS	VU	U	15	H
<i>Eleutherodactylus nitidus</i> (Peters, 1870)*	NS	LC	S	12	M
<i>Eleutherodactylus verrucipes</i> (Cope, 1885)*	Pr	VU	S	16	H
<b>Hylidae (8 species)</b>					
<i>Dryophytes arenicolor</i> (Cope, 1866)	NS	LC	S	7	L
<i>Dryophytes eximius</i> (Baird, 1854)*	NS	LC	S	10	M
<i>Rheohyla miotypanum</i> (Cope, 1863)*	NS	NT	D	9	L
<i>Scinax staufferi</i> (Cope, 1865)	NS	LC	S	4	L

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**TABLE 1.** (Continued)

<b>Taxon</b>	<b>SEMARNAT- 2010 Category</b>	<b>IUCN Category</b>	<b>IUCN Population Trend</b>	<b>EVS Value</b>	<b>EVS Category</b>
<i>Smilisca baudinii</i> (Duméril & Bibron, 1841)	NS	LC	S	3	L
<i>Tlalocohyla godmani</i> (Günther, 1901)*	A	VU	U	13	M
<i>Tlalocohyla picta</i> (Günther, 1901)	NS	LC	I	8	L
<i>Trachycephalus vermiculatus</i> (Linnaeus, 1758)	NS	LC	S	4	L
<b>Microhylidae (1 species)</b>					
<i>Hypopachus variolosus</i> (Cope, 1866)	NS	LC	S	4	L
<b>Ranidae (4 species)</b>					
<i>Lithobates berlandieri</i> (Baird, 1859)	Pr	LC	S	7	L
<i>Lithobates montezumae</i> (Baird, 1854)*	Pr	LC	D	13	M
<i>Lithobates neovolcanicus</i> (Hillis & Frost, 1985)*	A	NT	D	13	M
<i>Lithobates spectabilis</i> (Hillis & Frost, 1985)*	NS	LC	D	12	M
<b>Scaphiopodidae (2 species)</b>					
<i>Scaphiopus couchii</i> Baird, 1854	NS	LC	S	3	L
<i>Spea multiplicata</i> (Cope, 1863)	NS	LC	S	6	L
<b>Caudata (7 species)</b>					
<b>Ambystomatidae (1 species)</b>					
<i>Ambystoma velasci</i> (Dugés, 1888)*	Pr	LC	U	10	M
<b>Plethodontidae (6 species)</b>					
<i>Aquiloerycea cephalica</i> (Cope, 1865)*	A	NT	D	14	H
<i>Aquiloerycea scandens</i> (Walker, 1955)*	Pr	VU	U	17	H
<i>Chiropterotriton chondrostega</i> (Taylor, 1941)*	Pr	EN	D	17	H
<i>Chiropterotriton magnipes</i> Raab, 1965*	Pr	CR	D	16	H
<i>Chiropterotriton multidentatus</i> (Taylor, 1939)*	Pr	EN	D	15	H

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**TABLE 1.** (Continued)

Taxon	SEMARNAT- 2010 Category	IUCN Category	IUCN Population Trend	EVS Value	EVS Category
<i>Isthmura bellii</i> (Gray, 1850)*	A	VU	D	12	M
<b>Reptilia (104 species)</b>					
<b>Testudines (3 species)</b>					
<b>Kinosternidae (3 species)</b>					
<i>Kinosternon hirtipes</i> (Wagler, 1830)	Pr	LC	D	10	M
<i>Kinosternon integrum</i> LeConte, 1854*	Pr	LC	S	11	M
<i>Kinosternon scorpioides</i> (Linnaeus, 1766)	Pr	NE	N	10	M
<b>Squamata (101 species)</b>					
<b>Anguidae (5 species)</b>					
<i>Abronia taeniata</i> (Wiegmann, 1828)*	Pr	VU	D	15	H
<i>Barisia ciliaris</i> (Wiegmann, 1828)*	NS	NE	N	15	H
<i>Gerrhonotus infernalis</i> Baird, 1859*	NS	LC	S	13	M
<i>Gerrhonotus liocephalus</i> (Wiegmann, 1828)	Pr	LC	S	6	L
<i>Gerrhonotus ophiurus</i> Cope, 1867*	NS	LC	S	12	M
<b>Corytophanidae (2 species)</b>					
<i>Corytophanes hernandesii</i> (Wiegmann, 1831)	Pr	LC	S	13	M
<i>Laemanctus serratus</i> Cope, 1864	Pr	LC	S	8	L
<b>Dactyloidae (1 species)</b>					
<i>Norops sericeus</i> Hallowell, 1856	NS	NE	N	8	L
<b>Dibamidae (1 species)</b>					
<i>Anelytropsis papillosus</i> Cope, 1885*	A	LC	D	10	M
<b>Gekkonidae (1 species)</b>					
<i>Hemidactylus frenatus</i> Schlegel, 1836**	—	—	—	—	—
<b>Phrynosomatidae (12 species)</b>					
<i>Phrynosoma orbiculare</i> (Linnaeus, 1758)*	A	LC	S	12	M

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**TABLE 1.** (Continued)

<b>Taxon</b>	<b>SEMARNAT- 2010 Category</b>	<b>IUCN Category</b>	<b>IUCN Population Trend</b>	<b>EVS Value</b>	<b>EVS Category</b>
<i>Sceloporus aeneus</i> Wiegmann, 1828*	NS	LC	S	13	M
<i>Sceloporus dugesii</i> Bocourt, 1873*	NS	LC	S	13	M
<i>Sceloporus exsul</i> Dixon, Ketchersid & Lieb, 1972*	A	CR	D	17	H
<i>Sceloporus grammicus</i> Wiegmann, 1828	Pr	LC	S	9	L
<i>Sceloporus minor</i> Cope, 1885*	NS	LC	S	14	H
<i>Sceloporus parvus</i> Smith, 1934*	NS	LC	S	15	H
<i>Sceloporus scalaris</i> Wiegmann, 1828*	NS	LC	S	12	M
<i>Sceloporus serrifer</i> Cope, 1866	NS	LC	S	6	L
<i>Sceloporus spinosus</i> Wiegmann, 1828*	NS	LC	S	12	M
<i>Sceloporus torquatus</i> Wiegmann, 1828*	NS	LC	S	11	M
<i>Sceloporus variabilis</i> Wiegmann, 1834	NS	LC	S	5	L
<b>Scincidae (2 species)</b>					
<i>Plestiodon lynxe</i> (Wiegmann, 1834)*	Pr	LC	S	10	M
<i>Plestiodon tetragrammus</i> (Baird, 1859)	NS	LC	S	12	M
<b>Sphenomorphidae (3 species)</b>					
<i>Scincella gemmingeri</i> (Cope, 1864)*	Pr	LC	S	11	M
<i>Scincella lateralis</i> (Say, 1823)	Pr	LC	S	13	M
<i>Scincella silvicola</i> (Taylor, 1937)*	A	LC	S	12	M
<b>Teiidae (2 species)</b>					
<i>Aspidoscelis gularis</i> (Baird & Girard, 1852)	NS	LC	S	9	L
<i>Holcosus amphigrammus</i> (Smith & Laufe, 1945)*	NS	NE	S	7	L
<b>Xantusiidae (4 species)</b>					
<i>Lepidophyma flavimaculatum</i> Duméril, 1851	Pr	LC	U	8	L
<i>Lepidophyma gaigeae</i> Mosauer, 1936*	Pr	VU	D	13	M

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**TABLE 1.** (Continued)

<b>Taxon</b>	<b>SEMARNAT-2010 Category</b>	<b>IUCN Category</b>	<b>IUCN Population Trend</b>	<b>EVS Value</b>	<b>EVS Category</b>
<i>Lepidophyma occulor</i> Smith, 1942*	Pr	LC	S	14	H
<i>Lepidophyma sylvaticum</i> Taylor, 1939*	Pr	LC	D	11	M
<b>Xenosauridae (1 species)</b>					
<i>Xenosaurus mendozai</i> Nieto-Montes de Oca, García-Vázquez, Zuñiga-Vega, & Schmidt-Ballardo, 2013*	NS	NE	N	17	H
<b>Boidae (1 species)</b>					
<i>Boa imperator</i> (Linnaeus, 1758)	NS	NE	N	10	M
<b>Colubridae (26 species)</b>					
<i>Coluber constrictor</i> Linnaeus, 1758	A	LC	S	10	M
<i>Conopsis biserialis</i> Taylor & Smith, 1942*	A	LC	S	13	M
<i>Conopsis lineata</i> (Kennicott, 1859)*	NS	LC	S	13	M
<i>Conopsis nasus</i> (Günther, 1858)*	NS	LC	S	11	M
<i>Drymarchon melanurus</i> (Duméril, Bibron, & Duméril, 1854)	NS	LC	S	6	L
<i>Drymobius margaritiferus</i> (Schlegel, 1837)	NS	NE	N	6	L
<i>Ficimia olivacea</i> Gray, 1849*	NS	NE	N	9	L
<i>Ficimia streckeri</i> Taylor, 1931	NS	LC	S	12	M
<i>Gyalopion canum</i> (Cope, 1860)	NS	LC	S	9	L
<i>Lampropeltis polyzona</i> (Kennicott, 1861)*	NS	NE	S	7	L
<i>Lampropeltis ruthveni</i> Blanchard, 1920*	A	NT	D	16	H
<i>Leptophis mexicanus</i> Duméril, Bibron & Duméril, 1854	A	LC	S	6	L
<i>Masticophis mentovarius</i> (Duméril, Bibron & Duméril, 1854)	A	LC	U	6	L
<i>Masticophis schotti</i> (Baird & Girard, 1853)	NS	LC	S	13	M
<i>Masticophis taeniatus</i> (Hallowel, 1852)	NS	LC	S	10	M
<i>Mastigodryas melanolomus</i> (Cope, 1868)	NS	LC	S	6	L
<i>Oxybelis aeneus</i> (Wagler, 1824)	NS	NE	N	5	L
<i>Pituophis deppei</i> (Dumeril, 1853)*	A	LC	S	14	H

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**TABLE 1.** (Continued)

Taxon	SEMARNAT-2010 Category	IUCN Category	IUCN Population Trend	EVS Value	EVS Category
<i>Pseudoelaphe flavirufa</i> (Cope, 1867)	NS	LC	D	10	M
<i>Salvadora bairdi</i> Jan, 1860*	Pr	LC	S	15	H
<i>Salvadora grahamiae</i> Baird & Girard, 1853	NS	LC	S	10	M
<i>Senticolis triaspis</i> (Cope, 1866)	NS	LC	S	6	L
<i>Spilotes pullatus</i> (Linnaeus, 1758)	NS	NE	N	6	L
<i>Tantilla bocourti</i> (Günther, 1895)*	NS	LC	U	9	L
<i>Tantilla rubra</i> Cope, 1876	Pr	LC	U	5	L
<i>Trimorphodon tau</i> Cope, 1870*	NS	LC	S	13	M
<b>Dipsadidae (16 species)</b>					
<i>Adelphicos quadrivirgatum</i> Jan, 1862	Pr	LC	U	10	M
<i>Amastridium sapperi</i> Werner, 1903	NS	LC	S	10	M
<i>Chersodromus rubriventris</i> (Taylor, 1949)*	Pr	EN	D	14	H
<i>Coniophanes fissidens</i> (Günther, 1858)	NS	NE	N	7	L
<i>Coniophanes piceivittis</i> Cope, 1869	NS	LC	S	7	L
<i>Conophis lineatus</i> (Duméril, Bibron, & Duméril, 1854)	NS	LC	S	9	L
<i>Diadophis punctatus</i> (Linnaeus, 1776)	NS	LC	S	4	L
<i>Geophis latifrontalis</i> Garman, 1883*	Pr	DD	U	14	H
<i>Geophis mutitorques</i> (Cope, 1885)*	Pr	LC	S	13	M
<i>Hypsiglena jani</i> (Dugès, 1865)	NS	NE	N	6	L
<i>Imantodes gemmistratus</i> (Cope, 1861)	Pr	NE	N	6	L
<i>Leptodeira maculata</i> (Duellman, 1958)	Pr	LC	S	7	L
<i>Leptodeira septentrionalis</i> (Kennicott, 1859)	NS	NE	N	8	L
<i>Ninia diademata</i> Baird & Girard, 1853	NS	LC	S	9	L
<i>Rhadinaea gaigeae</i> Bailey, 1937*	NS	DD	U	12	M
<i>Tropidodipsas sartorii</i> (Cope, 1863)	Pr	LC	S	9	L
<b>Elapidae (1 species)</b>					
<i>Micrurus tener</i> (Baird & Girard, 1953)	NS	LC	S	11	M

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**TABLE 1.** (Continued)

<b>Taxon</b>	<b>SEMARNAT-2010 Category</b>	<b>IUCN Category</b>	<b>IUCN Population Trend</b>	<b>EVS Value</b>	<b>EVS Category</b>
<b>Leptotyphlopidae (2 species)</b>					
<i>Epictia goudotii</i> (Duméril & Bibron, 1844)	NS	NE	N	3	L
<i>Rena dulcis</i> (Baird & Girard, 1853)	NS	LC	U	13	M
<b>Natricidae (9 species)</b>					
<i>Storeria hidalgoensis</i> Taylor, 1942*	NS	VU	D	13	M
<i>Storeria storerioides</i> (Cope, 1865)*	NS	LC	S	11	M
<i>Thamnophis cyrtopsis</i> (Kennicott, 1860)	A	LC	S	7	L
<i>Thamnophis eques</i> (Reuss, 1834)	A	LC	S	8	L
<i>Thamnophis marcianus</i> (Baird & Girard, 1853)	A	LC	U	10	M
<i>Thamnophis melanogaster</i> (Peters, 1864)*	A	EN	D	15	H
<i>Thamnophis pulchrilatus</i> (Cope, 1885)*	NS	LC	U	15	H
<i>Thamnophis scalaris</i> Cope, 1861*	A	LC	S	14	H
<i>Thamnophis sumichrasti</i> (Cope, 1866)*	A	LC	U	15	H
<b>Typhlopidae (1 species)</b>					
<i>Indotyphlops braminus</i> (Daudin, 1803)**	—	—	—	—	—
<b>Viperidae (11 species)</b>					
<i>Agkistrodon taylori</i> Buger & Robertson, 1951*	A	LC	U	17	H
<i>Atropoides nummifer</i> (Rüppell, 1845)*	A	LC	S	13	M
<i>Bothrops asper</i> (Garman, 1883)	NS	NE	N	12	M
<i>Crotalus aquilus</i> Klauber, 1952*	Pr	LC	D	16	H
<i>Crotalus atrox</i> Baird & Girard, 1853	Pr	LC	S	9	L
<i>Crotalus molossus</i> Baird & Girard, 1853	Pr	LC	S	8	L
<i>Crotalus polystictus</i> (Cope, 1865)*	Pr	LC	D	16	H
<i>Crotalus ravus</i> (Cope, 1865)*	A	LC	S	14	H
<i>Crotalus scutulatus</i> (Kennicott, 1861)	Pr	LC	S	11	M
<i>Crotalus totonacus</i> Gloyd & Kauffeld, 1940*	NS	NE	N	17	H
<i>Crotalus triseriatus</i> (Wagler, 1830)*	NS	LC	S	16	H

Conversely, among the main factors that affect the natural populations of amphibians and reptiles, and biodiversity in general, are changes in land use, fragmentation, pollution, and the illegal trafficking of species (Sodhi *et al.* 2008). Some of these factors affect organisms to a greater degree in the central region of Mexico (Flores-Villela *et al.* 2010). The population density of many species is low, and thus these species are in danger of disappearing. For example, the populations of species such as *Crotalus aquilus* and *C. polystictus* are declining, and they exhibit high environmental vulnerability due to the loss of the native vegetation and excessive collection and illegal trafficking for medicinal use, but to date the impact of these factors has not been determined (Fitzgerald *et al.* 2004). In addition, at the national level, different groups of species of the genera *Lithobates*, *Ambystoma*, and various reptiles such as lizards of the genera *Phrynosoma* and *Abronia*, are being collected to be trafficked as pets (Lavín-Murcio & Lazcano 2010), and thus are generating a high risk of extinction for the natural populations.

Different measures and strategies have been carried out at the national level in an effort to protect and conserve the herpetofaunal biodiversity of Mexico (Flores-Villela *et al.* 2010). Among these measures, the creation of Natural Protected Areas (NPAs) has met with the best results (Luja *et al.* 2017; CONANP 2018); however, long-term studies have indicated that global accumulation of carbon dioxide in the environment has led to the disappearance of various populations of lizards in Mexico, in spite of their occurrence in protected areas (Sinervo *et al.* 2010). In the state of Querétaro, there are 17 NPAs with state and/or municipal jurisdiction (CONANP 2018), of which the Sierra Gorda Biosphere Reserve (SGBR), El Cimatario National Park, and the Cerro de Las Campanas are those with the greatest regional coverage and floral and faunal protection (CONANP 2018). Although the SGBR is one of the most important reserves and has the greatest coverage of temperate and tropical vegetation types, compared to other areas near the SGBR it has been relatively ineffective in conserving many species of amphibians and reptiles, and representatives of other vertebrate groups. For example, the NPA Los Mármoles National Park in Hidalgo lies near the southern portion of the SGBR. In addition to harboring a high number of species, this NPA contains a high diversity of supra-specific taxa, such as genera and families (Cruz-Elizalde *et al.* 2015). This feature highlights the importance of evaluating the composition of the herpetofauna occurring in the NPAs of Querétaro, as well as their effectiveness in conserving the species endemic to Mexico that have been placed in high risk categories (Ochoa-Ochoa *et al.* 2009; Wilson *et al.* 2013a, b).

Although in some cases the richness of the herpetofauna of Querétaro is lower than that of other Mexican states, because of the diversity of the different taxonomic groups that are characteristic of arid and semi-arid environments and the temperate and tropical areas of the Mexican Plateau, we demonstrated it to be one of the most important state-level herpetofaunas in the country (Cruz-Elizalde *et al.* 2016). This richness and diversity of species has been affected significantly by the anthropogenic effects impacting the central region of the country, as well as by the low representation of NPAs in the state, principally in the arid and semi-arid regions (Flores-Villela *et al.* 2010). The number of species documented in this study provides a basis for future work that addresses herpetofaunal conservation issues, particularly for species that have been judged as vulnerable based on several conservation assessment systems. Given the level of species richness documented in this study, our knowledge of the herpetofauna of the central region of the country has increased, and Querétaro has been shown to be one of the most important areas in Mexico on account of the consistent description of new species of amphibians and reptiles from the state (Nieto-Montes de Oca *et al.* 2013; Rovito & Parra-Olea 2015; García-Castillo *et al.* 2017).

## Acknowledgements

We thank Ruben Pineda López and Ferdinand Torres Ángeles for their logistic help. We thank the two anonymous referees; your observations and suggestions substantially improved our work. Our work was supported by the project CONABIO JM001.

## Literature cited

- Aguilar-Miguel, x., Casas-Andreu, G., Cárdenas-Ramos, P.J. & Cantellano de Rosas, E. (2009) Análisis espacial y conservación de los anfibios y reptiles del Estado de México. *CIENCIA ergo sum*, 16, 171–180.
- Bryson, Jr., R.W., Linkem, C.W., Dorcas, M.E., Lathrop, A., Jones, J.M., Alvarado-Díaz, J., Grünwald, C.I. & Murphy, R.W. (2014) Multilocus species delimitation in the *Crotalus triseriatus* species group (Serpentes: Viperidae: Crotalinae), with the

- description of two new species. *Zootaxa*, 3826 (3), 475–496.  
<https://doi.org/10.11646/zootaxa.3826.3.3>
- Campbell, J.A. & Lamar, W.W. (2004) *The Venomous Reptiles of the Western Hemisphere. Vol. II*. Comstock Publishing Associates & Cornell University Press, Ithaca, New York, 870 pp.
- Campbell, J.A., Smith, E.N. & Hall, A.S. (2018) Caudals and calyces: the curious case of a consumed chiapan colubroid. *Journal of Herpetology*, 52, 459–472.  
<https://doi.org/10.1670/18-042>
- Canseco-Márquez, L., Mendoza-Quijano, F. & Gutiérrez-Mayén, M.G. (2004) Análisis de la distribución de la herpetofauna. In: Luna-Vega, I., Morrone, J.J. & Esparza, D. (Eds.), *Biodiversidad de la Sierra Madre Oriental*. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Universidad Nacional Autónoma de México, Mexico City, pp. 417–438.
- Carbajal-Márquez, R.A. & Quintero-Díaz, G.E. (2016) The herpetofauna of Aguascalientes, México. *Revista Mexicana de Herpetología*, 2, 1–30.
- CONABIO (2008) *Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, División Política Estatal. Version 2. Scale 1:250,000. Modified from the vectorial data set and toponymy of the topographic chart. Series III*. Instituto Nacional de Estadística, Geografía e Informática (2003–2004). Marco Geoestadístico Municipal, Instituto Nacional de Estadística, Geografía e Informática (2005), México City. Available from: <http://www.conabio.gob.mx/informacion/metadatos/gis/> (accessed 24 June 2019)
- CONANP (2018) *Comisión Nacional de Áreas Naturales Protegidas, ¿Qué hacemos?* Available from: [http://www.conanp.gob.mx/que\\_hacemos](http://www.conanp.gob.mx/que_hacemos) (accessed 9 November 2018)
- Cruz-Elizalde, R., Ramírez-Bautista, A., Wilson, L.D. & Hernández-Salinas, U. (2015) Effectiveness of protected areas in herpetofaunal conservation in Hidalgo, Mexico. *Herpetological Journal*, 25, 41–48.
- Cruz-Elizalde, R., Padilla García, U., Cruz Pérez, M.C. & Tinoco Navarro, C. (2016) Herpetofauna del estado de Querétaro. In: Jones, R.W. & Serrano Cárdenas, V. (Eds.), *Historia Natural de Querétaro*. Universidad Autónoma de Querétaro, Santiago de Querétaro, Querétaro, pp. 300–319.
- Cruz-Sáenz, D., Muñoz-Nolasco, F.J., Mata-Silva, V., Johnson, J.D., García-Padilla, E. & Wilson, L.D. (2017) The herpetofauna of Jalisco, Mexico: composition, distribution, and conservation status. *Mesoamerican Herpetology*, 4, 22–118.
- Dayton, G.H. & Fitzgerald, L.A. (2005) Priority effects and desert anuran communities. *Canadian Journal of Zoology*, 83, 1112–1116.  
<https://doi.org/10.1139/z05-105>
- Dixon, J.R., Ketchersid, C.A. & Lieb, C.S. (1972) The herpetofauna of Querétaro, México, with remarks on taxonomic status. *Southwestern Naturalist*, 16, 225–237. Available from: <https://www.jstor.org/stable/3670059> (Accessed 15 Jul 2019)
- Dixon, J.R. & Lemos-Espinal, J.A. (2010) *Anfibios y Reptiles del Estado de Querétaro*. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. México D.F., 428 pp.
- DOF (2010) Diario Oficial de la Federación, Norma Oficial Mexicana NOM-059-SEMARNAT-2010. *Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-lista de especies en riesgo*, 30 de diciembre de 2010, Segunda Sección, 77 pp.
- Duellman, W.E., Marion, A.B. & Hedges, S.B. (2016) Phylogenetics, classification, and biogeography of the treefrogs (Amphibia: Anura: Arboranae). *Zootaxa*, 4104 (1), 1–109.  
<https://doi.org/10.11646/zootaxa.4104.1.1>
- Fernández, J.A., Sánchez, O. & Flores-Villela, O. (2006) New records of amphibians and reptiles from Tlaxcala, México. *Acta Zoológica Mexicana*, Neue Serie, 22, 159–162.
- Fitzgerald, L.E., Painter, C.W., Reuter, A. & Hoover, C. (2004) *Collection, Trade & Regulation of Reptiles and Amphibians of the Chihuahuan Desert Ecoregion*. TRAFFIC North America, World Wildlife Fund, Washington, D.C., 75 pp.
- Flores-Villela, O. (1993) Herpetofauna Mexicana. *Carnegie Museum of Natural History Special Publication*, 17, 1–73.
- Flores-Villela, O. & Canseco-Márquez, L. (2004) Nuevas especies y cambios taxonómicos para la Herpetofauna de México. *Acta Zoológica Mexicana*, New Series, 20, 115–144.
- Flores-Villela, O. & Canseco-Márquez, L. (2007) Riqueza de la herpetofauna. In: Luna-Vega, I., Morrone, J.J. & Espinosa, D. (Eds.), *Biodiversidad de la Faja Volcánica Transmexicana*. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Universidad Nacional Autónoma de México, México D.F., pp. 407–420.
- Flores-Villela, O., Canseco-Márquez, L. & Ochoa-Ochoa, L.M. (2010) Geographic distribution and conservation of the Mexican central highlands herpetofauna. In: Wilson, L.D., Townsend, J.H. & Johnson, J.D. (Eds.), *Conservation of the Mesoamerican Amphibians and Reptiles*. Eagle Mountain Publishing, L.C., Eagle Mountain, Utah, pp. 303–321.
- Flores-Villela, O. & García-Vázquez, U.O. (2014) Biodiversidad de reptiles en México. *Revista Mexicana de Biodiversidad*, Supplement 85, S467–S475.  
<https://doi.org/10.7550/rmb.43236>
- Frost, D.R. (2019) *Amphibian Species of the World: An Online Reference. Versions 6.0*. Available from: <http://www.research.amnh.org/herpetology/amphibia/index.html> (accessed 7 April 2019)
- García-Castillo, M.G., Rovito, S.M., Wake, D.B. & Parra-Olea, G. (2017) A new terrestrial species of *Chiropterotriton* (Caudata: Plethodontidae) from central Mexico. *Zootaxa*, 4363 (4), 489–505.  
<https://doi.org/10.11646/zootaxa.4363.4.2>
- García-Vázquez, U.O., Contreras-Arquieta, A., Trujano-Ortega, M. & Nieto-Montes de Oca, A. (2018a) A new species of *Ger-*



- rhonotus* (Squamata: Anguillidae) from the Cuatro Ciénegas Basin, Coahuila, Mexico. *Herpetologica*, 74, 269–278.  
<https://doi.org/10.1655/HERPETOLOGICA-D-17-00013>
- García-Vázquez, U.O., Pavón-Vázquez, C.J., Blancas-Hernández, J.C., Blancas-Calva, E. & Centenero-Alcalá, E. (2018b) A new rare species of the *Rhadinaea decorata* group from the Sierra Madre del Sur of Guerrero, Mexico (Squamata, Colubridae). *ZooKeys*, 780, 137–154.  
<https://doi.org/10.3897/zookeys.780.25593>
- IUCN (2019) *The IUCN Red List of Threatened Species. Version 2016-3*. Available from: <http://www.iucnredlist.org> (accessed 15 January 2019)
- Jiménez-Sierra, C.L., Sosa Ramírez, J., Cortés-Calva, P., Solís Cámara, A.B., Íñiguez Dávalos, L.I. & Ortega-Rubio, A. (2014) México país megadiverso y la relevancia de las áreas naturales protegidas. *Investigación y Ciencia de la Universidad Autónoma de Aguascalientes*, 60, 16–22.
- Johnson, J.D., Mata-Silva, V., García-Padilla, E. & Wilson, L.D. (2015) The herpetofauna of Chiapas, Mexico: composition, distribution, and conservation. *Mesoamerican Herpetology*, 2, 271–329.
- Johnson, J.D., Wilson, L.D., Mata-Silva, V., García-Padilla, E. & DeSantis, D.L. (2017) The endemic herpetofauna of Mexico: organisms of global significance in severe peril. *Mesoamerican Herpetology*, 4, 544–620.
- Jones, R.W. & Serrano Cárdenas, V. (2016) *Historia Natural de Querétaro*. Universidad Autónoma de Querétaro, Querétaro, 458 pp.
- Lavín-Murcio, P.A. & Lazcano, D. (2010) Geographic distribution and conservation of the herpetofauna of northern Mexico. In: Wilson, L.D., Townsend, J.H. & Johnson, J.D. (Eds.), *Conservation of the Mesoamerican Amphibians and Reptiles*. Eagle Mountain Publishing, L.C., Eagle Mountain, Utah, pp. 274–301.
- Lemos-Espinal, J.A. & Dixon, J.R. (2013) *Amphibians and Reptiles of San Luis Potosí*. Eagle Mountain Publishing, L.C., Eagle Mountain, Utah, 300 pp.
- Lemos-Espinal, J.A. & Smith, G.R. (2016) Amphibians and reptiles of the state of Coahuila, Mexico, with comparison with adjoining states. *ZooKeys*, 593, 117–137.  
<https://doi.org/10.3897/zookeys.593.8484>
- Lemos-Espinal, J.A., Smith, G.R., Woolrich-Piña, G. & Cruz, A. (2017) Amphibians and reptiles of the state of Chihuahua, Mexico, with comparisons with adjoining states. *ZooKeys*, 658, 105–130.  
<https://doi.org/10.3897/zookeys.658.10665>
- Lemos-Espinal, J.A., Smith, G.R. & Woolrich-Piña, G. (2018a) Amphibians and reptiles of the state of San Luis Potosí, Mexico, with comparisons with adjoining states. *ZooKeys*, 753, 83–106.  
<https://doi.org/10.3897/zookeys.753.21094>
- Lemos-Espinal, J.A., Smith, G.R., Gadsden-Esparza, H., Valdez-Lares, R. & Woolrich-Piña, G. (2018b) Amphibians and reptiles of the state of Durango, Mexico, with comparisons with adjoining states. *ZooKeys*, 748, 65–87.  
<https://doi.org/10.3897/zookeys.748.22768>
- Luja, V.H., López, J.A., Cruz-Elizalde, R. & Ramírez-Bautista, A. (2017) Herpetofauna inside and outside from a natural protected area: the case of Reserva Estatal de la Biósfera Sierra San Juan, Nayarit, Mexico. *Nature Conservation*, 21, 15–38.  
<https://doi.org/10.3897/natureconservation.21.12875>
- Martín del Campo, R. (1935) Notas acerca de la distribución geográfica de los reptiles ponzoñosos de México. *Annales del Instituto de Biología UNAM*, 7, 271–286.
- Martínez, M. & García Mendoza, A. (2001) Flora y vegetación acuáticas de localidades selectas del estado de Querétaro. *Acta Botánica Mexicana*, 54, 1–23.  
<https://doi.org/10.21829/abm54.2001.864>
- Mata-Silva, V., Johnson, J.D., Wilson, L.D. & García-Padilla, E. (2015) The herpetofauna of Oaxaca, Mexico: composition, physiographic distribution, and conservation status. *Mesoamerican Herpetology*, 2, 5–62.
- Mata-Silva, V., Rocha, A., Ramírez-Bautista, A., Berriozabal-Islas, C. & Wilson, L.D. (2019) A new species of forest snake of the genus *Rhadinaea* (Squamata: Dipsadidae) from tropical montane rainforest in the Sierra Madre del Sur of Oaxaca, Mexico. *ZooKeys*, 813, 55–65.  
<https://doi.org/10.3897/zookeys.813.29617>
- Meza-Lázaro, R.N. & Nieto-Montes de Oca, A. (2015) Long forsaken species diversity in the Middle American lizard *Holcosus undulatus* (Teiidae). *Zoological Journal of the Linnean Society*, 175, 189–210.  
<https://doi.org/10.1111/zoj.12264>
- Morrone, J.J. (2001) Biogeografía de América Latina y el Caribe. *Manuales y Tesis Sociedad Entomológica Aragonesa*, 3, 1–148.
- Morrone, J.J. (2005) Hacia una síntesis biogeográfica de México. *Revista Mexicana de Biodiversidad*, 76, 207–252.
- Nevárez-de los Reyes, M., Lazcano, D., García-Padilla, E., Mata-Silva, V., Johnson, J.D. & Wilson, L.D. (2016) The herpetofauna of Nuevo León, Mexico: composition, distribution, and conservation. *Mesoamerican Herpetology*, 3, 557–638.
- Nieto Montes de Oca, A. & Pérez Ramos, E. (1999) *Anfibios y reptiles del estado de Querétaro*. Universidad Nacional Autónoma de México. Facultad de Ciencias, Informe final SNIB-CONABIO, proyecto No. H250, México, DF, 145 pp.
- Nieto-Montes de Oca, A., García-Vázquez, U.O., Zuñiga-Vega, J. & Schmidt-Ballardo, W. (2013) A new species of *Xenosaurus* (Squamata: xenosauridae) from the Sierra Gorda Biosphere Reserve of Querétaro, Mexico. *Revista Mexicana de Biodiversidad*, 84, 485–498.

<https://doi.org/10.7550/rmb.35733>

- Nieto-Montes de Oca, A., Barley, A.J., Meza-Lázaro, R.N., García-Vázquez, U.O., Zamora-Abrego, J.G., Thomson, R.C. & Leaché, A.D. (2017) Phylogenomics and species delimitation in the knob-scaled lizards of the genus *Xenosaurus* (Squamata: xenosauridae) using ddRADseq data reveal a substantial underestimation of diversity. *Molecular Phylogenetics and Evolution*, 106, 241–253.  
<https://doi.org/10.1016/j.ympev.2016.09.001>
- Nieto-Montes de Oca, A., Sánchez-Vega, H. & Durán-Fuentes, I. (2018) A new species of knob-scaled lizard (Xenosauridae, *Xenosaurus*) from the Sierra Madre Oriental of Puebla, Mexico. *ZooKeys*, 737, 141–160.  
<https://doi.org/10.3897/zookeys.737.15095>
- Ochoa-Ochoa, L., Urbina-Cardona, J.N., Vázquez, L.B., Flores-Villela, O. & Bezaury-Creel, J. (2009) The effects of governmental protected areas and social initiatives for land protection on the conservation of Mexican amphibians. *PLoS ONE*, 4 (9), e6878.  
<https://doi.org/10.1371/journal.pone.0006878>
- Padilla-García, U. & Mendoza-Quijano, F. (1996a) Geographic Distribution, *Ameiva undulata*. *Herpetological Review*, 27, 210.
- Padilla-García, U. & Mendoza-Quijano, F. (1996b) Geographic Distribution, *Imantodes gemmistratus*. *Herpetological Review*, 27, 213.
- Padilla-García, U. & Mendoza-Quijano, F. (1996c) Geographic Distribution, *Leptophis mexicanus septentrionalis*. *Herpetological Review*, 27, 213–214.
- Padilla-García, U., Schmidt-Ballardo, W. & Mendoza-Quijano, F. (1996) Geographic Distribution, *Laemanctus serratus serratus*. *Herpetological Review*, 27, 21.
- Parra-Olea, G., Flores-Villela, O. & Mendoza-Almeralla, C. (2014) Biodiversidad de anfibios en México. *Revista Mexicana de Biodiversidad*, Supplement 85, S460–S466.  
<https://doi.org/10.7550/rmb.32027>
- Ramírez-Bautista, A., Hernández-Salinas, U., Cruz-Elizalde, R., Berriozabal-Islas, C., Lara-Tufiño, D., Goyenechea Mayer-Goyenechea, I. & Castillo-Cerón, J.M. (2014) *Los Anfibios y Reptiles de Hidalgo, México: Diversidad, Biogeografía y Conservación*. Sociedad Herpetológica Mexicana, A.C., México, D.F., 387 pp.
- Ramírez-Bautista, A., Sánchez-González, A., Sánchez-Rojas, G. & Cuevas-Cardona, C. (2017) *Biodiversidad del Estado de Hidalgo*. Universidad Autónoma del Estado de Hidalgo, Consejo Nacional de Ciencia y Tecnología, Pachuca, Hidalgo, 652 pp.
- Rossman, D.A., Ford, N.B. & Seigel, R.A. (1996) *The Garter Snakes, Evolution and Ecology*. University of Oklahoma Press, Norman, Oklahoma, 332 pp.
- Rovito, S.M. & Parra-Olea, G. (2015) Two new species of *Chiropterotriton* (Caudata: Plethodontidae) from northern Mexico. *Zootaxa*, 4048 (1), 57–74.  
<https://doi.org/10.11646/zootaxa.4048.1.3>
- Rovito, S.M., Parra-Olea, G., Recuero, E. & Wake, D.B. (2015) Diversification and biogeographical history of Neotropical plethodontid salamanders. *Zoological Journal of the Linnean Society*, 175, 167–188.  
<https://doi.org/10.1111/zoj.12271>
- Ruane, S., Bryson, Jr. R.W., Pyron, R.A. & Burbrink, F.T. (2014) Coalescent species delimitation in milksnakes (genus *Lampropeltis*) and impacts on phylogenetic comparative analyses. *Systematic Biology*, 63, 231–250.  
<https://doi.org/10.1093/sysbio/syt099>
- Rzedowski, J. (2006) *Vegetación de México*. Editorial Limusa, Mexico City, 505 pp.
- Sinervo, B., Méndez-de la Cruz, F.R., Miles, D.B., Heulin, B., Bastiaans, E., Villagran-Santa Cruz, M., Lara-Resendiz, R., Martínez-Méndez, N., Calderón-Espinosa, M.L., Meza-Lázaro, R.N., Gadsden, H., Avila, L.J., Morando, M., De la Riva, I.J., Victoriano-Sepulveda, P., Duarte-Rocha, C.F., Ibarguengoytía, N., Puntriano, C.A., Massot, M., Lepetz, V., Oksanen, T.A., Chapple, D.G., Bauer, A.M., Branch, W.R., Clobert, J. & Sites, Jr. J.W. (2010) Erosion of lizard diversity by climate change and altered thermal niches. *Science*, 324, 894–899.  
<https://doi.org/10.1126/science.1184695>
- Smith, H.M. (1936) Description of new lizards of the genus *Sceloporus* from Mexico and Southern United States. *Transactions of the Kansas Academy of Science*, 37, 263–285.  
<https://doi.org/10.2307/3625310>
- Smith, H.M. (1939) The Mexican and Central American lizards of the genus *Sceloporus*. *Field Museum of Natural History*, Zoological Series, 26, 1–397.  
<https://doi.org/10.5962/bhl.title.2894>
- Smith, H.M. & Taylor, E.H. (1966) *An annotated checklist and keys to the amphibians and reptiles. A reprint of bulletins 187, 194 and 199*. Eric Lundberg, Ashton, Maryland, 429 pp.
- Sodhi, N., Bickford, D., Diesmos, A., Lee, T., Koh, L., Brook, B.W., Sekercioglu, C. & Bradshaw, C.J.A. (2008) Measuring the meltdown: drivers of global amphibian extinction and decline. *PLoS ONE*, 3, e1636.  
<https://doi.org/10.1371/journal.pone.0001636>
- Terán-Juárez, S.A., García-Padilla, E., Mata-Silva, V., Johnson, J.D. & Wilson, L.D. (2016) The herpetofauna of Tamaulipas, Mexico: composition, distribution, and conservation status. *Mesoamerican Herpetology*, 3, 43–113.

- Uetz, P. & Hošek, J. (2019) The Reptile Database. Available from: <http://www.reptile-database.org> (accessed 20 January 2019)
- Vitt, L.J. & Caldwell, J.P. (2009) *Herpetology: An Introductory Biology of Amphibians and Reptiles. 3rd Edition*. Burlington, Academic Press, Massachusetts, 720 pp.
- Wells, K.D. (2007) *The Ecology and Behavior of Amphibians*. The University of Chicago, Press, Chicago, Illinois, 1400 pp.
- Wilson, L.D. & McCranie, J.R. (2004) The conservation status of the herpetofauna of Honduras. *Amphibian & Reptile Conservation*, 3, 6–33.
- Wilson, L.D., Mata-Silva, V. & Johnson, J.D. (2013a) A conservation reassessment of the reptiles of Mexico based on the EVS measure. *Amphibian & Reptile Conservation*, 7, 1–47.
- Wilson, L.D., Johnson, J.D. & Mata-Silva, V. (2013b) A conservation reassessment of the amphibians of Mexico based on the EVS measure. *Amphibian & Reptile Conservation*, 7, 97–127.
- Wilson, L.D., Johnson, J.D., Porras, L.W., Mata-Silva, V. & García-Padilla, E. (2017) A system for categorizing the distribution of the Mesoamerican herpetofauna. *Mesoamerican Herpetology*, 4, 901–913.
- Woolrich-Piña, G.A., Ramírez-Silva, J.P., Loc-Barragán, J., Ponce Campos, P., Mata-Silva, V., Johnson, J.D., García-Padilla, E. & Wilson, L.D. (2016) The herpetofauna of Nayarit, Mexico: composition, distribution, and conservation status. *Mesoamerican Herpetology*, 3, 375–448.
- Woolrich-Piña, G.A., García-Padilla, E., DeSantis, D.L., Johnson, J.D., Mata-Silva, V. & Wilson, L.D. (2017) The herpetofauna of Puebla, Mexico: composition, distribution, and conservation status. *Mesoamerican Herpetology*, 4, 790–884.
- Zamudio, S.R., Rzedowski, J., Carranza, E. & Calderón de Rzedowski, G. (1992) *La vegetación en el estado de Querétaro*. Instituto de Ecología, A.C., Consejo de Ciencia y Tecnología del Estado de Querétaro, Querétaro, 92 pp.