



Chiropterotriton chico García-Castillo, Rovito, Wake, and Parra-Olea 2017. El Chico Salamander is a state endemic species known only from Parque Nacional El Chico, at elevations from 2,400 to 3,050 m in pine-oak forest (Frost 2019). In the original description the authors noted that “it is unlikely to occur more widely, because surrounding areas have been extensively surveyed” (García-Castillo et al. 2017: 502). Also noted in the original description is that “this species was previously considered as conspecific with *C. multidentatus* and occurs in sympatry with *C. dimidiatus* and *Aquiloerycea cephalica*. Likewise, *Isthmura bellii* has been collected very near sites where *C. chico* was once common... , but it is unknown if the two species occur in syntopy” (García-Castillo et al. 2017: 502). García-Castillo et al. (2017: 502–503) noted that this salamander was “incredibly abundant” when one of the authors of this paper (David B. Wake) visited the park in August of 1971, but that by the mid-1970s it had become “uncommon and then rare.” These authors also indicated (p. 503) that the decline of *C. chico* apparently is not related to habitat loss or disturbance. They concluded that this salamander should be judged to be Critically Endangered, based on the IUCN criteria B1 ab(v). Finally, García-Castillo et al. (2017: 503) noted that “Hidalgo includes an unusual region where two of the main mountain complexes of Mexico meet: the Trans-Mexican Volcanic Belt (TMVB) and Sierra Madre Oriental (SMO). These ranges are known to have a high degree of topographic, geologic and climatic variability [that] has promoted a high biodiversity... This is especially true for the herpetofauna from Hidalgo... which is the state with the highest number of species of *Chiropterotriton* (6), representing 37.5% of the described species of this genus.” Photo by Sean Rovito, courtesy of Mirna G. García-Castillo.



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

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Abstract.—The herpetofauna of Hidalgo, Mexico, is comprised of 203 species, including 42 anurans, 17 caudates, one crocodylian, 137 squamates, and six turtles. Here, the distribution of the herpetofaunal species are catalogued among the four recognized physiographic regions. The total number of species varies from 77 in the Mexican Plateau to 166 in the Sierra Madre Oriental. The individual species occupy from one to four regions (mean = 2.1). About 69% of the Hidalgo herpetofauna is found in only one or two of the four regions, which is of considerable conservation significance. The greatest number of single-region species occupies the Sierra Madre Oriental (25), followed by the Gulf Coastal Lowlands (15), the Trans-Mexican Volcanic Belt (6), and the Mexican Plateau (2). The Coefficient of Biogeographic Resemblance (CBR) indicates that the Sierra Madre Oriental and the Gulf Coastal lowlands share the most species (72), because of their adjacent geographic position and they contain a significant number of generalist species that occur in the Gulf lowlands of Mexico, southern USA, Central America, and/or South America. The two largest geographic regions in Hidalgo by area, Sierra Madre Oriental and Mexican Plateau, reflect opposite patterns in species richness (166 and 77 species, respectively) due to overall differences in the ecological characteristics between them. A similarity dendrogram based on the Unweighted Pair Group Method with Arithmetic Averages (UPGMA) depicts two distinct clusters, one between the Sierra Madre Oriental and Gulf Coastal Lowlands and the other between the Mexican Plateau and Trans-Mexican Volcanic Belt. The former cluster reflects the two regions sharing a substantial number of herpetofaunal species that occur on the Gulf lowlands of North America and Central America, as well as a few that enter South America. The second cluster is due to the two montane regions being adjacent to one another and their ecological similarities. With respect to the distributional categories, the largest number of species is that of the country endemics (104 of 203), followed by non-endemics (92), state endemics (four), and non-natives (three). The principal environmental threats to the Hidalgo herpetofauna are deforestation, livestock, roads, pollution of water sources, cultural factors, and diseases. The conservation status of each native species was assessed by means of the SEMARNAT (NOM-059), IUCN, and EVS systems, of which the EVS system was the most useful. The Relative Herpetofaunal Priority (RHP) method was also used to designate the rank order significance of the physiographic regions and the highest values were found for the Sierra Madre Oriental. Most of the five protected areas in Hidalgo are located in the Trans-Mexican Volcanic Belt, which is only the second most important region from a conservation perspective. In addition, only 78 of the 200 native species found in Hidalgo are recorded in total from the five protected areas. Finally, a set of conclusions and recommendations are offered for the future protection of the Hidalgo herpetofauna.

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

Resumen.—La herpetofauna de Hidalgo, México, consiste de 203 especies, incluyendo 42 anuros, 17 caudados, un cocodrilo, 137 escamosos, y seis tortugas. Catalogamos la distribución de las especies entre cuatro regiones fisiográficas aquí reconocidas. El número total de especies varía de 77 en la Altiplanicie Mexicana, a 166 en la Sierra Madre Oriental. Las especies individualmente ocupan de una a cuatro regiones ($x = 2.1$). Aproximadamente 69% de la herpetofauna de Hidalgo se encuentra en una o dos de las cuatro regiones, lo

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cual es de importancia considerable para su conservación. El mayor número de especies que ocupan una sola región, se encuentra en la Sierra Madre Oriental (25), seguida por las Tierras Costeras del Golfo (15), la Faja Volcánica Transmexicana (6), y la Altiplanicie Mexicana (2). Una matriz de coeficiente de similitud biogeográfica (CSB), indica que la Sierra Madre Oriental y las Tierras Costeras del Golfo comparten la mayoría de las especies (72) debido a su proximidad geográfica y al número significativo de especies generalistas presentes en las Tierras Costeras del Golfo de México, sur de Estados Unidos, Centroamérica, y/o Suramérica. Con respecto a la superficie, las dos regiones más grandes de Hidalgo, la Sierra Madre Oriental y la Faja Volcánica Transmexicana reflejan relaciones opuestas sobre la riqueza específica (166 vs 77 especies, respectivamente) debido a las características ecológicas entre estas. Un dendrograma de similitud basado en el Método por Agrupamiento de Pares no Ponderado con Media Aritmética (MAPMA) revela dos agrupamientos; uno entre la Sierra Madre Oriental y la Tierras Costeras del Golfo, y el otro entre las dos regiones que comparten la Faja Volcánica Transmexicana. El primer grupo se debe a que las dos regiones comparten un número significativo de especies que ocurren en las tierras costeras del golfo de Norteamérica y Centroamérica, así como algunas especies que llegan a Sudamérica. El segundo grupo se debe al contacto de estas dos regiones y sus similitudes ecológicas. Con respecto a las categorías de distribución, el mayor número de especies está representado por las especies endémicas a México (104 de 203), seguido por las especies no endémicas (92), endémicas para el estado (cuatro), y las no nativas (tres). Las principales amenazas ambientales para la herpetofauna de Hidalgo son la deforestación, ganadería, carreteras, contaminación de fuentes de agua, factores culturales, y enfermedades. Calculamos el estatus de conservación de las especies nativas por medio de los sistemas de SEMARNAT (NOM-059), IUCN, y el EVS, de los cuales el EVS resultó ser el más útil. También utilizamos el método de Prioridad Herpetofaunística Relativa (PHR) para designar el rango de orden de importancia de las regiones fisiográficas y determinamos que los valores más altos pertenecen a la Sierra Madre Oriental. Examinamos las características de las cinco áreas protegidas en Hidalgo y determinamos que la mayoría de estas se encuentran en la Faja Volcánica Transmexicana, que es la segunda región más importante desde la perspectiva de conservación. También determinamos que solamente 78 de las 200 especies nativas registradas en Hidalgo, se encuentran en estas cinco áreas protegidas. Finalmente, establecemos un conjunto de conclusiones y recomendaciones para la futura protección de la herpetofauna de Hidalgo.

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

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“One reason we’ve failed to recognize the damage we’re doing we’ve assumed it’s fine to use our atmosphere as an open sewer.”

—Al Gore (2017)

Introduction

Hidalgo is an eastern Mexican state located at the confluence of four major physiographic regions in the country, i.e., the Gulf Coastal Plain, occupying a small eastern portion of the state; the Sierra Madre Oriental, extending across the majority of the eastern sector of the state; the Trans-Mexican Volcanic Belt, traversing the southern portion of the state; and the Mexican Plateau, occupying the central and northwestern regions of the state (Fig. 1). Hidalgo is bounded to the north by San Luis Potosí and Querétaro, to the east by Veracruz and Puebla, to the south by Tlaxcala, and to the west by México.

With a surface area of 20,813 km², Hidalgo is the 26th largest state in Mexico among the 31 that are recognized (<http://cuentame.inegi.org.mx/monografias/>

[informacion/hgo/](http://cuentame.inegi.org.mx/monografias/informacion/hgo/)). The 2015 population figure was 2,858,359, ranking the state as the 17th most populous (<http://cuentame.inegi.org.mx/monografias/informacion/hgo/>). The population density of Hidalgo is 140 people/km², ranking 8th in the country (<http://cuentame.inegi.org.mx/monografias/informacion/hgo/>).

The highest elevation in the state of 3,380 m is that of Cerro la Peñuela, located in the southeastern-most corner of Hidalgo in the municipality of Almoloya (<http://cuentame.inegi.org.mx/monografias/informacion/hgo/>). Even though much of the state of Hidalgo is mountainous, the heights of these mountains are much less imposing than those of the neighboring state of Puebla (see Woolrich-Piña et al. 2017). The highest mountain in Puebla, Pico de Orizaba, is 5,747 m in elevation, which is 1.7 times the height of Cerro la Peñuela. Two of the other highest mountains in Mexico also are partially located in Puebla (Woolrich-Piña et al. 2017). Thus, Hidalgo would be expected to have a smaller total herpetofauna than Puebla and also support fewer endemic species, both at the national and state levels. An examination of these hypotheses is undertaken in this paper.

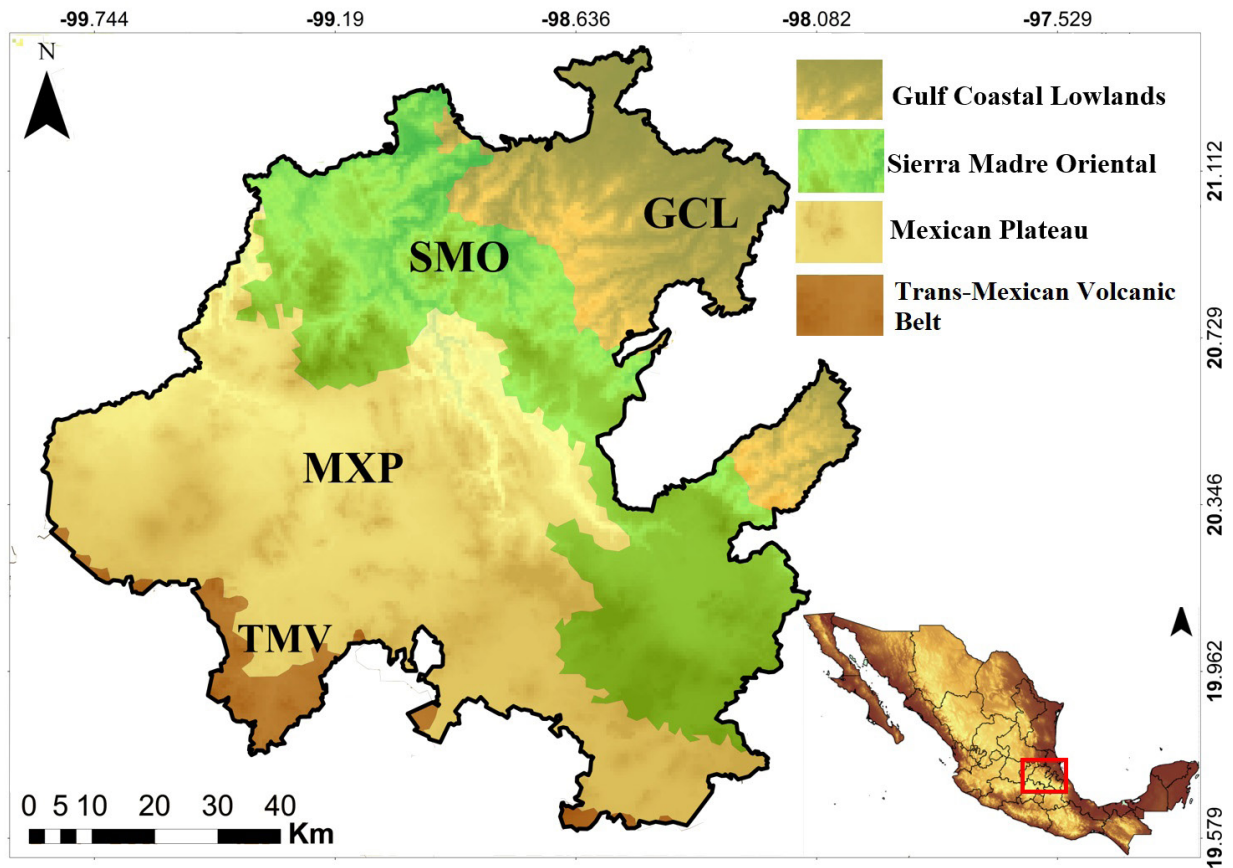


Fig. 1. Physiographic regions of Hidalgo, Mexico. Abbreviations: GCL = Gulf Coastal Lowlands; SMO = Sierra Madre Oriental; MXP = Mexican Plateau; TMV = Trans-Mexican Volcanic Belt.

Materials and Methods

Our Taxonomic Position

We follow the same taxonomic position in this paper as explained in previous works on other portions of Mesoamerica (Johnson et al. 2015a,b; Mata-Silva et al. 2015; Terán-Juárez et al. 2016; Woolrich-Piña et al. 2016, 2017; Nevárez-de los Reyes et al. 2016; Cruz-Sáenz et al. 2016; Gonzalez-Sánchez et al. 2017; Lazcano et al. 2019). Johnson et al. (2015a) can be consulted for a detailed statement of this position, with special reference to the subspecies concept.

System for Determining Distributional Status

The same system developed by Alvarado-Díaz et al. (2013) for the herpetofauna of Michoacán was employed here to ascertain the distributional status of members of the herpetofauna of Hidalgo. Subsequently, Mata-Silva et al. (2015), Johnson et al. (2015a), Terán-Juárez et al. (2016), Woolrich-Piña et al. (2016, 2017), Nevárez-de los Reyes et al. (2016), Cruz-Sánchez et al. (2017), González-Sánchez et al. (2017), and Lazcano et al. (2019) also used this system, which consists of the following four categories: SE = endemic to Hidalgo; 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 Hidalgo, this survey employed the same systems (i.e., SEMARNAT, IUCN, and EVS) as used by Alvarado-Díaz et al. (2013), Mata-Silva et al. (2015), Johnson et al. (2015a), Terán-Juárez et al. (2016), Woolrich-Piña et al. (2016, 2017), Nevárez-de los Reyes et al. (2016), Cruz-Sánchez et al. (2017), González-Sánchez et al. (2017), and Lazcano et al. (2019). Detailed descriptions of these three systems appear in the earlier papers of this series (e.g., Alvarado-Díaz et al. 2013; Johnson et al. 2015a; Mata-Silva et al. 2015) and do not need to be 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), as a part of a set of five papers designated as the Special Mexico Issue published in *Amphibian & Reptile Conservation*. The basic format of the entries in the MCS was established in that paper, i.e., providing 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 continued with papers

on the herpetofauna of Oaxaca (Mata-Silva et al. 2015) and Chiapas (Johnson et al. 2015a). In the ensuing year, three entries in the MCS appeared, those on Tamaulipas (Terán-Juárez et al. 2016), Nayarit (Woolrich-Piña et al. 2016), and Nuevo León (Nevárez-de los Reyes et al. 2016). Finally, three entries on Jalisco (Cruz-Sáenz et al. 2017), the Mexican Yucatan Peninsula (González-Sánchez et al. 2017), and Puebla (Woolrich-Piña et al. 2017) appeared in 2017, and one on Coahuila was published recently (Lazcano et al. 2019). Thus, this paper on the herpetofauna of Hidalgo is the eleventh entry in this series.

Physiography and Climate

Physiographic Regions

The distribution of the herpetofauna of Hidalgo is analyzed using the classification system of physiographic regions (= physiographic provinces) of INEGI (2000) and CONABIO (2008). According to these studies, these consist of four regions, which are briefly described below.

Gulf Coastal Lowlands (GCL). This province belongs to the Neotropical Region (Morrone 2001) and extends from the San Fernando River in the state of Tamaulipas to the Candelaria River located in the Yucatan Peninsula. This region covers the northern portion of the states of Quintana Roo, Campeche, Tabasco, and Veracruz, and small portions of Tamaulipas, eastern San Luis Potosí, northeastern Hidalgo, northern Puebla, northeastern Oaxaca, and Campeche. Specifically, in the state of Hidalgo, this physiographic region is located in the municipalities of San Felipe Orizatlán and Huejutla (Sánchez-Rojas and Bravo-Cadena 2017). This region is located between 25°52'17.02"N, -94°04'11.48"W, and 20°55'36.56"N, -90°18'06.7"W, at elevations spanning 18–1,200 m (Espinosa et al. 2008). Mean annual precipitation varies between 1,000 and 2,000 mm, while the average annual temperature for this physiographic province is 21.2 °C. Dominant vegetation types include tropical evergreen forest, scrub, subdeciduous forest, and tropical dry forest (CONABIO 2008).

Sierra Madre Oriental (SMO). This region is located parallel to the Gulf coastal region of Mexico, which is connected to the Central Plateau and the Trans-Mexican Volcanic Belt. The SMO belongs to the Neotropical Realm and embraces 2.84% of the country (Morrone 2001; CONABIO 2008). This province is composed mostly of sedimentary and metamorphic rocks from the Cretaceous and Jurassic, which makes this province a complex area from a geological perspective (CONABIO 2008). The SMO encompasses part of southern Zacatecas, central and eastern Jalisco, southern Michoacán, Querétaro, and northeastern Hidalgo (CONABIO 2008). In the state of Hidalgo, this province extends into the municipalities

of Huehuetla and Tenango de Doria, Calnali, Molango, Tlanchinol, Lolotla, Chapulhuacán, Pisaflores, Tepehuacán, Xochicoatlán, and Eloxochitlán (CONABIO 2008; Ramírez-Bautista et al. 2014; Sánchez-Rojas and Bravo-Cadena 2017). The northern extent of the SMO lies at 25°36'23.13"N, -100°17'38.99"W, and the southern limit lies at 17°28'45.86"N, -96°04'34.85"W. Elevation within the SMO in Hidalgo ranges from 100–3,300 m (CONABIO 2008; Sánchez-Rojas and Bravo-Cadena 2017). Mean annual precipitation varies considerably, ranging from 400–800 mm in the montane cloud forests of the northern region of the municipality of Tlanchinol (Ramírez-Bautista et al. 2014). The temperature in the montane environments ranges from 4–28 °C, and from 10–40 °C in the temperate valleys during winter and summer, respectively. The average annual temperature is 17.4 °C. On the wet slopes, the dominant vegetation communities are coniferous forest (28%), oak forest (26%), and cloud forest (8%); and the vegetation is represented by xerophilous scrub (16%) in the dry region (CONABIO 2008).

Trans-Mexican Volcanic Belt (TMV). The TMV belongs to the Neotropical Region (Morrone 2001; CONABIO 2008), and is a volcanic arc located in the central part of Mexico. The TMV has an east-west orientation, extending from the state of Veracruz (Gulf of Mexico) to the state of Nayarit (Pacific Ocean; Ferrusquía-Villafranca 2007; CONABIO 2008). This belt is formed by a set of volcanoes of different ages, from Miocene to Plio-Pleistocene, aligned within 19°31'54.81"N, -98°37'42.45"W and 21°53'40.02"N, -105°36'09.80"W. The region occupies 8% of Mexico's surface area, ranging in elevation from 1,000–5,700 m. In Hidalgo the TMV reaches a high point of 2,004 m. Within the TMV lies the Sierra de Pachuca, which includes the municipalities of Mineral del Monte, Mineral El Chico, Huasca de Ocampo, Atotonilco El Grande, and a portion of Tulancingo (Ramírez-Bautista et al. 2014). The mean annual precipitation varies from 581–2,236 mm, and the mean annual temperature is 15.3 °C (Suárez-Mota et al. 2014). Natural vegetation communities are represented primarily by coniferous forest (31%) and oak forest (28%), with the remainder composed of pastures, subalpine scrub, cloud forest, and farmland. Arid portions of the region are dominated by xerophilous scrub, while sub-humid areas contain tropical dry forest.

Mexican Plateau (MXP). This region is within the more inclusive Nearctic Region (Morrone 2001; CONABIO 2008). This plateau extends through the central zone of Mexico between 1,700–4,000 m, and it is located between the Sierra Madre Occidental and Sierra Madre Oriental. Portions of the MXP fall within the boundaries of Chihuahua, Coahuila, Durango, Guanajuato, Hidalgo, Jalisco, Michoacán, Puebla, San Luis Potosí, Tlaxcala, and Zacatecas. This region is confined within



No. 1. *Craugastor decoratus* (Taylor 1942). The Adorned Robber Frog is distributed from southern Tamaulipas, eastern San Luis Potosí, adjacent northern Querétaro, northern Hidalgo, and adjacent central Veracruz and northern Puebla, Mexico (Frost 2019). This individual was found at La Gargantilla, in the municipality of Pisaflores. Wilson et al. (2013b) calculated its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has been considered as Vulnerable by the IUCN, and as Special Protection (Pr) by SEMARNAT. *Photo by Daniel Lara-Tuñiño.*



No. 2. *Charadrahyla taeniopus* (Günther 1901). The Porthole Treefrog occurs “on the Atlantic slopes of the Sierra Madre Oriental from north-eastern Hidalgo southward through northern Puebla to central Veracruz, Mexico” (Frost 2019). This individual was located at San Mateo, in the municipality of Acaxochitlán. Wilson et al. (2013b) assessed its EVS as 13, placing it at the upper limit of the medium vulnerability category. Its conservation status has been judged as Vulnerable by the IUCN, and it is placed in the Threatened (A) category by SEMARNAT. *Photo by Uriel Hernández-Salinas.*



No. 3. *Dryophytes euphorbiaceus* (Günther 1858). The Southern Highland Treefrog ranges from the “highlands of southern Mexico (central Veracruz, eastern Hidalgo, Tlaxcala, and southeastern Puebla to mountains of Oaxaca, including those south of Oaxaca City)” (Frost 2019). This individual was encountered at San Mateo, in the municipality of Acaxochitlán. Wilson et al. (2013b) calculated its EVS as 12, placing it in the upper portion of the medium vulnerability category. Its conservation status has been considered as Near Threatened by the IUCN, but this species is not listed by SEMARNAT. *Photo by Uriel Hernández-Salinas.*



No. 4. *Dryophytes plicatus* (Brocchi 1877). The Ridged Treefrog is distributed in the Sierra Madre Oriental and the Cordillera Volcánica along the southern edge of the Mexican Plateau (Michoacán, Morelos, México, D.F., Tlaxcala, Puebla, Veracruz, and Hidalgo) [Frost 2019]. This individual was found at Agua Zarca, in the municipality of Tenango de Doria. Wilson et al. (2013b) calculated its EVS as 11, placing it in the middle portion of the medium vulnerability category. Its conservation status has been considered as Least Concern by the IUCN, and SEMARNAT lists this treefrog as Threatened (A). *Photo by Uriel Hernández-Salinas.*

Table 1. Monthly minimum, mean (in parentheses), maximum, and annual temperature data (in °C) for the physiographic regions of Hidalgo, Mexico. Localities for each of the regions and their elevations are as follows: Gulf Coastal Plain—Huehuetla (420 m); Sierra Madre Oriental—Tlanchinol (1,700 m); Trans-Mexican Volcanic Belt—Tepeapulco (2,530 m); Mexican Plateau—Zimapan (1,763 m). Data taken from <http://www.worldclim.org/biodlim> (accessed 19 March 2018).

Physiographic Region	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Gulf Coastal Lowlands	11.5 (17.2) 22.9	12.7 (18.5) 24.2	15.6 (21.3) 27.0	18.2 (23.9) 29.6	20.0 (25.7) 31.4	19.8 (25.5) 31.3	19.2 (24.5) 29.8	19.4 (24.7) 30.0	19.7 (24.5) 29.3	17.0 (22.3) 27.6	14.8 (20.1) 25.4	12.7 (18.0) 23.3	16.7 (21.2) 27.7
Sierra Madre Oriental	7.0 (13.8) 20.5	8.2 (15.0) 21.8	10.9 (17.6) 24.4	12.7 (19.4) 26.2	13.8 (20.5) 27.3	13.1 (19.8) 26.6	11.7 (18.8) 26.0	11.7 (18.8) 26.0	11.3 (18.4) 25.6	9.8 (16.9) 24.2	8.4 (15.5) 22.8	7.1 (14.3) 21.5	10.5 (17.4) 24.4
Trans Mexican Volcanic Belt	4.9 (12.2) 19.5	5.9 (13.2) 20.5	8.2 (15.5) 22.8	9.8 (17.1) 24.4	10.6 (17.9) 25.2	10.1 (17.4) 24.7	7.8 (16.5) 25.6	7.8 (16.6) 25.3	7.4 (16.1) 24.9	6.2 (14.9) 23.6	4.9 (13.7) 22.4	3.9 (12.6) 21.3	7.3 (15.3) 23.4
Mexican Plateau	6.0 (13.1) 20.2	7.1 (14.3) 21.4	9.6 (16.8) 23.9	11.3 (18.5) 25.6	12.3 (19.5) 26.6	11.6 (18.8) 25.9	9.5 (17.8) 26.1	9.5 (17.8) 26.1	9.1 (17.4) 25.7	7.8 (16.1) 24.3	6.4 (14.7) 23.0	5.4 (13.7) 21.9	8.8 (18.5) 24.2

24°39'53.31"N, -101°54'04.92"W and 19°31'54.81"N, -98°37'42.45"W, encompassing a total surface area of 601,882 m². The climate is dry, arid, and relatively cold; the mean annual temperature is 18.5 °C, with a nocturnal mean of -5 °C and a diurnal mean of 25 °C. Dominant vegetation communities include thorn scrub and xerophilous scrub. Mean annual precipitation is < 200 mm across all vegetation communities. The MXP is situated in the central and western portions of Hidalgo, in the municipalities of Mineral de la Reforma, Actopan, Ixmiquilpan, Zimapan, and Huichapan (Ramírez-Bautista et al. 2014).

Climate

Temperature. The monthly minimum, mean, and maximum temperatures for a single locality for each of the four recognized physiographic regions in Hidalgo are shown in Table 1. The elevations for these localities vary from 420 m at Huehuetla in the GCL to 2,530 m at Tepeapulco in the TMX.

The mean annual temperature is highest at Huehuetla (elevation 420 m) in the GCL at 21.2 °C, followed by Zimapan (elevation 1,763 m) in the MXP at 18.5 °C, and Tlanchinol (elevation 1,700 m) in the SMO at 17.4 °C, with the lowest mean temperature of 15.3 °C at Tepeapulco (elevation 2,530 m) in the TMV.

In the four physiographic regions in Hidalgo, the minimum annual temperatures range from 11.0–16.1 °C lower than the maximum annual temperatures (Table 1). The mean minimum monthly temperatures peak during May and reach their lowest levels in December or January. The mean maximum monthly temperatures are highest in May or July and are lowest in January (Table 1). The mean monthly temperatures are highest in May and lowest in January (Table 1).

Precipitation. As expected, monthly precipitation is lowest during the dry season in either December or February, and highest during the rainy season in either July or September (Table 2). The data in Table 2 indicate that 79.2–94.3% of the annual precipitation occurs during the rainy season from May to October. Annual rainfall varies from 537.5 mm on the Mexican Plateau to 1,790.7 mm in the Gulf Coastal Lowlands (Table 2).

Recent Literature on the Hidalgo Herpetofauna

Historically, most information on the herpetofauna of the state was derived from regional studies or those from specific localities (see Ramírez-Bautista et al. [2014] and Lemos-Espinal and Dixon [2016] for a detailed list of previous studies in the state). In 2010, a checklist of the state’s herpetofauna (Ramírez-Bautista et al. 2010) included a total of 173 species (54 amphibians and 119 reptiles), and subsequently Ramírez-Bautista et al. (2014) published an updated checklist with 183

Table 2. Monthly and annual precipitation data (in mm) for the physiographic regions of Hidalgo, Mexico. Localities for each of the regions and their elevations are as follows: Gulf Coastal Plain—Huehuetla (420 m); Sierra Madre Oriental—Tlanchinol (1,700 m); Trans Mexican Volcanic Belt—Tepeapulco (2,530 m); Mexican Plateau—Zimapan (1,763 m). Data taken from <http://www.worldclim.org/bioclim> (accessed 19 March 2018). The shaded area indicates the months of the rainy season.

Physiographic Region	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Gulf Coastal Lowlands	51.9	51.8	52.0	73.4	126.6	268.9	261.2	239.8	334.8	186.3	89.8	54.2	1,790.7
Sierra Madre Oriental	21.0	19.6	20.6	36.8	61.0	140.3	135.4	130.7	179.2	92.7	36.2	20.6	894.1
Trans Mexican Volcanic Belt	10.3	8.7	11.6	25.7	58.8	111.5	131.7	110.5	100.3	49.0	14.1	7.8	1,379.3
Mexican Plateau	11.6	9.5	12.2	26.7	51.9	90.3	91.9	80.2	93.6	47.3	14.5	7.8	537.5

species (53 amphibians and 130 reptiles), along with the first comprehensive analysis of the state's species richness, diversity, and distribution, and an evaluation of the conservation status and potential threats to the persistence of Hidalgo's herpetofauna. Lemos-Espinal and Smith (2015) provided an additional checklist of the herpetofauna of Hidalgo with a total of 175 species, eight fewer than the number reported by Ramírez-Bautista et al. (2014). Lemos-Espinal and Dixon (2016) reported the same figure (175 species). Finally, in 2017 two chapters on the herpetofauna of the state were published in a book entitled *Biodiversidad del Estado de Hidalgo*. The chapter on amphibians by Goyenechea Mayer-Goyenechea et al. (2017) listed 53 species, and the chapter on reptiles by Manríquez-Morán et al. (2017) listed 130 species; both were the same numbers given by Ramírez-Bautista et al. (2014). The assessment here provides the most current species composition for the state following the latest taxonomic changes.

Composition of the Herpetofauna

Families

The herpetofauna of Hidalgo is represented by 37 families, including nine anuran, three salamander, one crocodylian, 22 squamate, and two turtle families (Table 3). This total figure is 62.7% of the 59 herpetofaunal families recorded from Mexico (Wilson et al. 2013a,b). No caecilians are registered in the state. Of the amphibian families, 86.4% of the species are placed in the families Bufonidae, Eleutherodactylidae, Hylidae, Ranidae, and Plethodontidae (Tables 4–5). Among the reptile families, 75.7% of the species are allocated to the families

Anguidae, Dactyloidae, Phrynosomatidae, Colubridae, Dipsadidae, Natricidae, and Viperidae (Tables 4–5).

Genera

Ninety-six herpetofaunal genera are represented in Hidalgo, including 20 anuran, seven salamander, one crocodylian, 65 squamate, and three turtle genera (Table 3). These 96 taxa comprise 45.7% of the 210 genera recorded from Mexico (Wilson et al. 2013a,b). Among the amphibians, the most species-rich genera are *Craugastor* (five species), *Eleutherodactylus* (five), *Lithobates* (five), and *Chiropterotriton* (nine). Among the reptile genera, the most speciose are *Sceloporus* (13), *Thamnophis* (nine), *Crotalus* (nine), and *Norops* (five).

Species

The herpetofauna of Hidalgo is composed of 203 species, including 42 anurans, 17 salamanders, one crocodylian, 137 squamates, and six turtles (Table 3). The current numbers of native species in these five groups in Mexico are, respectively, 248, 151, three, 865, and 51 (J. Johnson, unpub.). The 203 species in Hidalgo comprise 15.4% of the 1,318 species in the entire Mexican herpetofauna (J. Johnson, unpub., 26 June 2019).

The one state sharing a common border with Hidalgo examined thus far in the Mexican Conservation Series is Puebla (Woolrich-Piña et al. 2017), the herpetofauna of which consists of 267 species or 1.3 times the richness of Hidalgo (203). This comparative figure somewhat resembles the relative areas of the two states. The surface area of Puebla is 34,306 km² (Woolrich-Piña et al. 2017) and that of Hidalgo, as noted above, is 20,813 km²; thus, Puebla is 1.6

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

Order	Families	Genera	Species
Anura	9	20	42
Caudata	3	7	17
Subtotal	12	27	59
Crocodylia	1	1	1
Squamata	22	65	137
Testudines	2	3	6
Subtotal	25	69	144
Total	37	96	203



No. 5. *Rheohyla miotypanum* (Cope, 1863). The Small-eared Treefrog occupies the “highlands of Nuevo León and Coahuila (Sierra Madre Oriental) to Guanajuato (Sierra Santa Rosa), Hidalgo, and Oaxaca, adjacent Veracruz, and central Chiapas in eastern and central Mexico” (Frost 2019). This individual was located at San Mateo, in the municipality of Acaxochitlán. 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 considered as Near Threatened by the IUCN, but this species is not listed by SEMARNAT. *Photo by Uriel Hernández-Salinas.*



No. 6. *Sarcohyla robertsoni* (Taylor 1940). Roberts’ Treefrog occupies “the Sierra Madre Oriental in eastern Mexico (Puebla and Hidalgo)” (Frost 2019). This individual was encountered in Zoquiacoquiapan, in the municipality of Metztlán. Wilson et al. (2013b) assessed its EVS as 13, placing it at the upper limit of the medium vulnerability category. Its conservation status has been considered as Endangered by the IUCN, and it is placed in the Threatened (A) category by SEMARNAT. *Photo by Raquel Hernández-Austria.*



No. 7. *Lithobates johnei* (Blair, 1965). John’s Frog is distributed from “southeastern San Luis Potosí, eastern Hidalgo, and northern Puebla, Mexico” (Frost 2019). This individual was found at Río Blanco, in the municipality of Huehuetla. Wilson et al. (2013b) calculated its EVS as 14, placing it at the lower limit of the high vulnerability category. Its conservation status has been considered as Endangered by the IUCN, and it is placed in the Endangered (P) category by SEMARNAT. *Photo by Christian Berriozabal-Islas.*



No. 8. *Lithobates montezumae* (Baird 1854). The Montezuma Leopard Frog ranges from San Luis Potosí, Querétaro, Jalisco, and eastern Durango south to the southeastern edge of the Mexican Plateau in Tlaxcala, Puebla, Hidalgo, Ciudad de México, and Veracruz, Mexico (Frost 2019). This individual was discovered at El Huemac, in the municipality of Tezontepec de Aldama. Wilson et al. (2013b) estimated its EVS as 13, placing it at the upper limit of the medium vulnerability category. Its conservation status has been considered as Least Concern by the IUCN, and it is allocated to the Special Protection (Pr) category by SEMARNAT. *Photo by Christian Berriozabal-Islas.*

Table 4. Distribution of the amphibians, crocodylians, squamates, and turtles of Hidalgo, Mexico, by physiographic region. Abbreviations: SMO = Sierra Madre Oriental; MXP = Mexican Plateau; TMV = Trans-Mexican Volcanic Belt; and GCL = Gulf Coastal Lowlands. See text for descriptions of these regions. * = species endemic to Mexico; ** = species endemic to Hidalgo; and *** = non-native species.

Taxa	Physiographic regions of Hidalgo				Number of regions occupied
	SMO	MXP	TMV	GCL	
Anura (42 species)					
Bufonidae (6 species)					
<i>Anaxyrus punctatus</i>	+	+	+		3
<i>Incilius marmoratus</i> *			+	+	2
<i>Incilius nebulifer</i>	+		+		2
<i>Incilius occidentalis</i> *	+	+	+		3
<i>Incilius valliceps</i>	+	+		+	3
<i>Rhinella horribilis</i>	+	+		+	3
Craugastoridae (5 species)					
<i>Craugastor augusti</i>	+		+		2
<i>Craugastor berkenbuschii</i> *				+	1
<i>Craugastor decoratus</i> *	+			+	2
<i>Craugastor mexicanus</i> *	+			+	2
<i>Craugastor rhodopsis</i> *	+			+	2
Eleutherodactylidae (5 species)					
<i>Eleutherodactylus cystignathoides</i>	+			+	2
<i>Eleutherodactylus guttilatus</i>	+	+	+		3
<i>Eleutherodactylus longipes</i> *	+		+		2
<i>Eleutherodactylus nitidus</i> *	+		+		2
<i>Eleutherodactylus verrucipes</i> *	+		+		2
Hylidae (15 species)					
<i>Bromeliohyla dendroscarta</i> *	+			+	2
<i>Charadrahyla taeniopus</i> *	+				1
<i>Dryophytes arenicolor</i>	+	+			2
<i>Dryophytes euphorbiaceus</i> *	+		+	+	3
<i>Dryophytes eximius</i> *	+	+	+		3
<i>Dryophytes plicatus</i> *	+	+	+		3
<i>Rheohyla miotypanum</i> *	+	+		+	3
<i>Sarcohyla arborescandens</i> *	+	+	+		3
<i>Sarcohyla bistrincta</i> *	+	+	+		3
<i>Sarcohyla charadricola</i> *	+	+			2
<i>Sarcohyla robertorum</i> *	+	+			2
<i>Scinax staufferi</i>				+	1
<i>Smilisca baudinii</i>	+			+	2
<i>Tlalocohyla picta</i>	+			+	2
<i>Trachycephalus vermiculatus</i>	+			+	2
Leptodactylidae (2 species)					
<i>Leptodactylus fragilis</i>	+			+	2
<i>Leptodactylus melanonotus</i>	+	+		+	3
Microhylidae (1 species)					
<i>Hypopachus variolosus</i>			+	+	2
Ranidae (5 species)					
<i>Lithobates berlandieri</i>	+	+	+	+	4
<i>Lithobates catesbeianus</i> ***			+	+	2
<i>Lithobates johni</i> *	+			+	2
<i>Lithobates montezumae</i> *	+	+	+		3
<i>Lithobates spectabilis</i> *	+	+	+		3
Rhinophrynidae (1 species)					
<i>Rhinophrynus dorsalis</i>	+			+	2
Scaphiopodidae (2 species)					
<i>Scaphiopus couchii</i>	+				1
<i>Spea multiplicata</i>		+	+		2
Caudata (17 species)					

Herpetofauna of Hidalgo, Mexico

Table 4 (continued). Distribution of the amphibians, crocodylians, squamates, and turtles of Hidalgo, Mexico, by physiographic region. Abbreviations: SMO = Sierra Madre Oriental; MXP = Mexican Plateau; TMV = Trans-Mexican Volcanic Belt; and GCL = Gulf Coastal Lowlands. See text for descriptions of these regions. * = species endemic to Mexico; ** = species endemic to Hidalgo; and *** = non-native species.

Taxa	Physiographic regions of Hidalgo				Number of regions occupied
	SMO	MXP	TMV	GCL	
Ambystomatidae (1 species)					
<i>Ambystoma velasci</i> *	+	+	+		3
Plethodontidae (15 species)					
<i>Aquiloerycea cephalica</i> *	+		+		2
<i>Bolitoglossa platyductyla</i> *				+	1
<i>Chiropetrotriton arboreus</i> *	+		+		2
<i>Chiropetrotriton chico</i> **			+		1
<i>Chiropetrotriton chiropetrus</i> *		+	+		2
<i>Chiropetrotriton chondrostega</i> *	+		+		2
<i>Chiropetrotriton dimidiatus</i> **	+	+	+		3
<i>Chiropetrotriton magnipes</i> *			+		1
<i>Chiropetrotriton mosaueri</i> **	+	+	+		3
<i>Chiropetrotriton multidentatus</i> *	+	+	+		3
<i>Chiropetrotriton terrestris</i> **	+		+		2
<i>Isthmura bellii</i> *	+	+	+		3
<i>Isthmura gigantea</i> *	+				1
<i>Pseudoeurycea altamontana</i> *			+		1
<i>Pseudoeurycea leprosa</i> *	+	+	+		3
Salamandridae (1 species)					
<i>Notophthalmus meridionalis</i>	+			+	2
Crocodylia (1 species)					
Crocodylidae (1 species)					
<i>Crocodylus moreletii</i>				+	1
Squamata (136 species)					
Anguidae (5 species)					
<i>Abronia taeniata</i> *	+	+	+		3
<i>Barisia imbricata</i> *	+	+	+		3
<i>Gerrhonotus infernalis</i>	+	+			2
<i>Gerrhonotus liocephalus</i>	+		+		2
<i>Gerrhonotus ophiurus</i> *	+			+	2
Corytophanidae (3 species)					
<i>Basiliscus vittatus</i>				+	1
<i>Corytophanes hernandezii</i>	+			+	2
<i>Laemactus serratus</i>	+			+	2
Dactyloidae (5 species)					
<i>Norops laeiventris</i>	+				1
<i>Norops lemurinus</i>	+			+	2
<i>Norops naufragus</i> *	+			+	2
<i>Norops petersii</i>	+			+	2
<i>Norops sericeus</i>	+			+	2
Dibamidae (1 species)					
<i>Anelytropsis papillosus</i> *	+			+	2
Eublepharidae (1 species)					
<i>Coleonyx elegans</i>	+				1
Gekkonidae (1 species)					
<i>Hemidactylus frenatus</i> ***				+	1
Iguanidae (1 species)					
<i>Ctenosaura acanthura</i>				+	1
Phrynosomatidae (14 species)					
<i>Phrynosoma orbiculare</i> *	+	+	+		3
<i>Sceloporus aeneus</i> *	+	+	+		3
<i>Sceloporus bicanthalis</i> *			+		1
<i>Sceloporus cyanogenys</i>	+				1
<i>Sceloporus grammicus</i>	+	+	+		3

Table 4 (continued). Distribution of the amphibians, crocodylians, squamates, and turtles of Hidalgo, Mexico, by physiographic region. Abbreviations: SMO = Sierra Madre Oriental; MXP = Mexican Plateau; TMV = Trans-Mexican Volcanic Belt; and GCL = Gulf Coastal Lowlands. See text for descriptions of these regions. * = species endemic to Mexico; ** = species endemic to Hidalgo; and *** = non-native species.

Taxa	Physiographic regions of Hidalgo				Number of regions occupied
	SMO	MXP	TMV	GCL	
<i>Sceloporus megalepidurus</i> *	+	+	+		3
<i>Sceloporus minor</i> *	+	+	+		3
<i>Sceloporus mucronatus</i> *		+	+		2
<i>Sceloporus parvus</i> *	+	+			2
<i>Sceloporus scalaris</i> *	+	+	+		3
<i>Sceloporus serrifer</i>				+	2
<i>Sceloporus spinosus</i> *	+	+	+		3
<i>Sceloporus torquatus</i> *	+	+	+		3
<i>Sceloporus variabilis</i>	+	+		+	3
Scincidae (2 species)					
<i>Plestiodon lynxe</i> *	+	+	+		3
<i>Plestiodon tetragrammus</i>	+				1
Sphenomorphidae (2 species)					
<i>Scincella gemmingeri</i> *	+	+		+	3
<i>Scincella silvicola</i> *	+		+	+	3
Teiidae (2 species)					
<i>Aspidoscelis gularis</i>	+			+	2
<i>Holcosus amphigrammus</i> *	+			+	2
Xantusiidae (4 species)					
<i>Lepidophyma flavimaculatum</i>	+			+	2
<i>Lepidophyma gaigeae</i> *	+		+		2
<i>Lepidophyma occulor</i> *	+			+	2
<i>Lepidophyma sylvaticum</i> *	+			+	2
Xenosauridae (3 species)					
<i>Xenosaurus mendozai</i> *	+				1
<i>Xenosaurus newmanorum</i> *	+				1
<i>Xenosaurus tzacualtipantecus</i> *	+				1
Boidae (1 species)					
<i>Boa imperator</i>	+			+	2
Colubridae (32 species)					
<i>Coluber constrictor</i>				+	1
<i>Conopsis biserialis</i> *	+		+		2
<i>Conopsis lineata</i> *	+	+	+		3
<i>Conopsis nasus</i> *	+	+	+		3
<i>Drymarchon melanurus</i>	+	+		+	3
<i>Drymobius chloroticus</i>	+			+	2
<i>Drymobius margaritiferus</i>	+			+	2
<i>Ficimia hardyi</i> *	+	+			2
<i>Ficimia olivacea</i> *			+	+	2
<i>Ficimia streckeri</i>	+			+	2
<i>Lampropeltis annulata</i>		+			1
<i>Lampropeltis mexicana</i> *	+	+			2
<i>Lampropeltis polyzona</i> *	+			+	2
<i>Lampropeltis ruthveni</i> *		+	+		2
<i>Leptophis diplotropis</i> *				+	1
<i>Leptophis mexicanus</i>	+			+	2
<i>Masticophis flagellum</i>	+				1
<i>Masticophis mentovarius</i>		+	+		2
<i>Masticophis schotti</i>		+	+	+	3
<i>Mastigodryas melanolomus</i>	+			+	2
<i>Oxybelis aeneus</i>	+			+	2
<i>Pantherophis emoryi</i>	+	+		+	3
<i>Pituophis catenifer</i>	+				1
<i>Pituophis deppei</i> *	+	+	+		3
<i>Pseudelaphe flavirufa</i>		+		+	2

Herpetofauna of Hidalgo, Mexico

Table 4 (continued). Distribution of the amphibians, crocodylians, squamates, and turtles of Hidalgo, Mexico, by physiographic region. Abbreviations: SMO = Sierra Madre Oriental; MXP = Mexican Plateau; TMV = Trans-Mexican Volcanic Belt; and GCL = Gulf Coastal Lowlands. See text for descriptions of these regions. * = species endemic to Mexico; ** = species endemic to Hidalgo; and *** = non-native species.

Taxa	Physiographic regions of Hidalgo				Number of regions occupied
	SMO	MXP	TMV	GCL	
<i>Salvadora bairdi</i> *	+	+			2
<i>Salvadora grahamiae</i>	+		+	+	3
<i>Senticolis triaspis</i>	+		+	+	3
<i>Spilotes pullatus</i>	+			+	2
<i>Tantilla bocourti</i> *	+	+	+	+	4
<i>Tantilla rubra</i>	+				1
<i>Trimorphodon tau</i> *	+		+		2
Dipsadidae (27 species)					
<i>Adelphicos quadrivirgatum</i>	+			+	2
<i>Amastridium sapperi</i>	+			+	2
<i>Chersodromus rubriventris</i> *	+			+	2
<i>Coniophanes fissidens</i>	+			+	2
<i>Coniophanes imperialis</i>				+	1
<i>Coniophanes piceivittis</i>				+	1
<i>Diadophis punctatus</i>	+	+	+		3
<i>Geophis latifrontalis</i> *	+				1
<i>Geophis lorancai</i>	+				1
<i>Geophis mutitorques</i> *	+	+	+		3
<i>Geophis semidoliatus</i> *	+	+	+		3
<i>Geophis turbidus</i> *	+				1
<i>Hypsiglena jani</i>	+	+			2
<i>Hypsiglena tanzeri</i> *	+				1
<i>Imantodes cenchoa</i>	+			+	2
<i>Imantodes gemmistratus</i>	+			+	2
<i>Leptodeira maculata</i> *	+			+	2
<i>Leptodeira septentrionalis</i>	+			+	2
<i>Ninia diademata</i>	+			+	2
<i>Pliocercus elapoides</i>	+			+	2
<i>Rhadinaea decorata</i>	+				1
<i>Rhadinaea gaigeae</i> *			+		1
<i>Rhadinaea hesperia</i> *			+		1
<i>Rhadinaea marcellae</i> *	+				1
<i>Rhadinaea quinquelineata</i> *	+	+	+	+	4
<i>Sibon nebulatus</i>	+			+	2
<i>Tropidodipsas sartorii</i>	+	+		+	3
Elapidae (2 species)					
<i>Micrurus diastema</i>	+				1
<i>Micrurus tener</i>	+	+		+	3
Leptotyphlopidae (3 species)					
<i>Epictia wyzni</i> *				+	1
<i>Rena dulcis</i>		+			1
<i>Rena myopica</i> *	+			+	2
Natricidae (13 species)					
<i>Nerodia rhombifer</i>	+			+	2
<i>Storeria dekayi</i>	+				1
<i>Storeria hidalgoensis</i> *	+				1
<i>Storeria storerioides</i> *		+	+		2
<i>Thamnophis cyrtopsis</i>	+	+	+		3
<i>Thamnophis eques</i>	+	+	+		3
<i>Thamnophis marcianus</i>	+		+	+	3
<i>Thamnophis melanogaster</i> *	+	+			2
<i>Thamnophis proximus</i>	+			+	2
<i>Thamnophis pulchrilatus</i> *			+	+	2
<i>Thamnophis scalaris</i> *	+		+		2

Table 4 (continued). Distribution of the amphibians, crocodylians, squamates, and turtles of Hidalgo, Mexico, by physiographic region. Abbreviations: SMO = Sierra Madre Oriental; MXP = Mexican Plateau; TMV = Trans-Mexican Volcanic Belt; and GCL = Gulf Coastal Lowlands. See text for descriptions of these regions. * = species endemic to Mexico; ** = species endemic to Hidalgo; and *** = non-native species.

Taxa	Physiographic regions of Hidalgo				Number of regions occupied
	SMO	MXP	TMV	GCL	
<i>Thamnophis scaliger</i> *		+	+		2
<i>Thamnophis sumichrasti</i> *	+	+			2
Sibynophiidae (1 species)					
<i>Scaphiodontophis annulatus</i>				+	1
Typhlopidae (1 species)					
<i>Indotyphlops braminus</i> ***	+	+	+		3
Viperidae (13 species)					
<i>Agkistrodon taylori</i> *	+			+	2
<i>Bothrops asper</i>	+			+	2
<i>Crotalus aquilus</i> *	+	+	+		3
<i>Crotalus atrox</i>	+	+		+	3
<i>Crotalus intermedius</i> *	+		+		2
<i>Crotalus molossus</i>	+	+	+		3
<i>Crotalus polystictus</i> *	+	+	+		3
<i>Crotalus ravus</i> *	+	+	+		3
<i>Crotalus scutulatus</i>	+	+	+		3
<i>Crotalus totonacus</i> *	+			+	2
<i>Crotalus triseriatus</i> *	+	+	+		3
<i>Metlapilcoatlus nummifer</i> *	+				1
<i>Ophryacus smaragdinus</i> *	+				1
Testudines (6 species)					
Emydidae (2 species)					
<i>Terrapene mexicana</i> *	+				1
<i>Trachemys venusta</i>				+	1
Kinosternidae (4 species)					
<i>Kinosternon herrerai</i> *	+			+	2
<i>Kinosternon hirtipes</i>	+		+		2
<i>Kinosternon integrum</i> *	+	+	+		3
<i>Kinosternon scorpioides</i>				+	1

times the size of Hidalgo. Therefore, the state area/species richness ratio for Hidalgo is 102.5 compared to 128.5 for Puebla.

Patterns of Physiographic Distribution

Here, four physiographic regions in Hidalgo are recognized (Fig. 1), and the occurrence of the members of the herpetofauna among these four regions are documented in Table 4 and summarized in Table 5.

The total numbers of species in each of these four regions vary from a low of 77 in the Mexican Plateau (MXP) to a high of 166 in the Sierra Madre Oriental (SMO). The intermediate figures are 85 for the Trans-Mexican Volcanic Belt and 95 for the Gulf Coastal Lowlands. Interestingly, the number of species recorded from the Sierra Madre Oriental is about 1.7 to 2.2 times those in the three other regions in the state. The herpetofauna of the SMO comprises 81.8% of that of the entire state (203 species).

As expected, the largest proportions of the species by broader herpetofaunal groups are found in the SMO (Table 5), including 36 of 42 anurans (85.7%), 12 of 17

salamanders (70.6%), 114 of 137 squamates (83.2%), and four of six turtles (66.7%).

As noted above, the numbers of species in the other three regions are approximately half of that found in the SMO (Table 5). Of these three regions, the largest number of species (95) is found in the Gulf Coastal Lowlands, including 22 of 42 anurans (52.4%), two of 17 salamanders (11.8%), one of one crocodylian (100%), 67 of 137 squamates (48.9%), and three of six turtles (50.0%). The next largest number of species in these three regions (85) is found in the Trans-Mexican Volcanic Belt, including 20 of 42 anurans (47.6%), 14 of 17 salamanders (82.4%), 49 of 137 squamates (35.8%), and two of six turtles (33.3%). Finally, the smallest number of species (77) is registered on the Mexican Plateau, including 18 of 42 anurans (42.9%), seven of 17 salamanders (41.2%), 51 of 137 squamates (37.2%), and one of six turtles (16.7%).

The members of the Hidalgo herpetofauna inhabit from one to four of the four physiographic regions, as follows: one (48; 23.6%); two (93; 46.0%); three (59; 29.2%); and four (three; 1.5%). The average regional



No. 9. *Ambystoma velasci* (Dugès 1888). The Plateau Tiger Salamander ranges from northwestern Chihuahua south 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 located in Parque Nacional El Chico, in the municipality of Mineral del Chico. Wilson et al. (2013b) determined its EVS as 10, placing it at the lower limit of the medium vulnerability category. Its conservation status has been considered as Least Concern by the IUCN, and it has been placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Christian Berriozabal-Islas.*



No. 10. *Aquiloeurycea cephalica* (Cope 1865). The Chunky False Brook Salamander is distributed in “the Transverse Volcanic Range in Ciudad de México and states of Veracruz, Hidalgo, México, Puebla, and Morelos” (Frost 2019). This individual was found in the municipality of Tlanchinol. Wilson et al. (2013b) assessed its EVS as 14, placing it at the lower limit of the high vulnerability category. Its conservation status has been considered as Near Threatened by the IUCN, and as occupying the Threatened (A) category by SEMARNAT. *Photo by Uriel Hernández-Salinas.*



No. 11. *Bolitoglossa platydactyla* (Gray 1831). The Broad-footed Salamander occurs from “southern Tamaulipas and eastern San Luis Potosí south through Hidalgo to southern Veracruz, Puebla, Oaxaca, and extreme northeastern Chiapas, Mexico” (Frost 2019). This individual was found at Cececamel in the municipality of San Felipe Orizatlán. Wilson et al. (2013b) ascertained its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status had been judged as Near Threatened by the IUCN, and SEMARNAT has placed it in the Special Protection (Pr) category. *Photo by Cristian Raúl Olvera-Olvera.*



No. 12. *Isthmura belli* (Gray 1850). Bell's Salamander is found in “southern Tamaulipas, Tlaxcala, Hidalgo and the Sierra Madre del Sur of Guerrero, Mexico, and west and north to southern Nayarit and southern Zacatecas” (Frost 2019). This individual was encountered at Las Coas, in the municipality of Tlahuiltepa. Wilson et al. (2013b) calculated its EVS as 12, placing it in the upper portion of the medium vulnerability category. Its conservation status has been considered as Vulnerable by the IUCN, and as Threatened (A) by SEMARNAT. *Photo by Christian Berriozabal-Islas.*

Table 5. Summary of distribution occurrence of herpetofaunal families in Hidalgo, Mexico, by physiographic province. See Table 4 for explanation of abbreviations.

Family	Number of species	Distributional occurrence			
		SMO	MXP	TMV	GCL
Bufonidae	6	5	4	4	3
Craugastoridae	5	4	—	1	4
Eleutherodactylidae	5	5	1	4	1
Hylidae	15	14	8	5	7
Leptodactylidae	2	2	1	—	2
Microhylidae	1	—	—	1	1
Ranidae	5	4	3	4	3
Rhinophrynidae	1	1	—	—	1
Scaphiopodidae	2	1	1	1	—
Subtotal	42	36	18	20	22
Ambystomatidae	1	1	1	1	—
Plethodontidae	15	10	6	13	1
Salamandridae	1	1	—	—	1
Subtotal	17	12	7	14	2
Total	59	48	25	34	24
Crocodylidae	1	—	—	—	1
Subtotal	1	—	—	—	1
Anguidae	5	5	3	3	1
Corytophanidae	3	2	—	—	3
Dactyloidae	5	5	—	—	4
Dibamidae	1	1	—	—	1
Eublepharidae	1	1	—	—	—
Gekkonidae	1	—	—	—	1
Iguanidae	1	—	—	—	1
Phrynosomatidae	14	12	10	10	2
Scincidae	2	2	1	1	—
Sphenomorphidae	2	2	1	1	2
Teiidae	2	2	—	—	2
Xantusiidae	4	4	—	1	3
Xenosauridae	3	3	—	—	1
Subtotal	44	39	15	16	21
Boidae	1	1	—	—	1
Colubridae	32	24	14	12	18
Dipsadidae	27	23	6	6	15
Elapidae	2	2	1	—	1
Leptotyphlopidae	3	1	1	—	2
Natricidae	13	10	6	7	4
Sibynophiidae	1	—	—	—	1
Typhlopidae	1	1	1	1	—
Viperidae	13	13	7	7	4
Subtotal	93	75	36	33	46
Emydidae	2	1	—	—	1
Kinosternidae	4	3	1	2	2
Subtotal	6	4	1	2	3
Total	144	118	52	51	71
Sum Total	203	166	77	85	95

occupancy is 2.1, which means that, on average, each individual species occupies only about half of the physiographic regions found in the state.

A sizable proportion of the herpetofauna is distributed in one or two regions (141, or 69.5% of the total). This proportion is very close to that seen for Puebla (68.5%; Woolrich-Piña et al. 2017); in the case of Puebla, however, there are six regions instead of the four found in Hidalgo.

The number of species found in a single region range from three (in the MXP) to 25 (in the SMO). The 25 single-region species in the SMO are:

*Charadrahyla taeniopus**
Scaphiopus couchii
*Isthmura gigantea**
Norops laevis
Coleonyx elegans
Sceloporus cyanogenys
Plestiodon tetragrammus
*Xenosaurus mendozai**
*Xenosaurus newmanorum**
*Xenosaurus tzacualtipantecus**
Masticophis flagellum
Pituophis catenifer
Tantilla rubra

Table 6. Pair-wise comparison matrix of Coefficient of Biogeographic Resemblance (CBR) data of herpetofaunal relationships for the four physiographic regions in Hidalgo, 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. 6 for the UPGMA dendrogram produced from the CBR data.

	Sierra Madre Oriental	Mexican Plateau	Trans-Mexican Volcanic Belt	Gulf Coastal Lowlands
Sierra Madre Oriental	<u>166</u>	67	66	72
Mexican Plateau	0.55	<u>77</u>	53	16
Trans-Mexican Volcanic Belt	0.53	0.65	<u>85</u>	13
Gulf Coastal Lowlands	0.55	0.19	0.14	<u>25</u>

*Geophis latifrontalis**
*Geophis lorancai**
*Geophis turbidus**
*Hypsiglena tanzeri**
Rhadinaea decorata
*Rhadinaea marcellae**
Micrurus diastema
Storeria dekayi
*Storeria hidalgoensis**
*Metlapilcoatlus nummifer**
*Ophryacus smaragdinus**
*Terrapene mexicana**

Fourteen of the 25 SMO single-region species (56.0%) are Mexican endemics (indicated by asterisks); the remainder are non-endemic species.

The 15 single-region species in the GCL are:

*Craugastor berkenbuschii**
Scinax staufferi
*Bolitoglossa platyductyla**
Crocodylus moreletii
Basiliscus vittatus
*Hemidactylus frenatus****
Ctenosaura acanthura
Coluber constrictor
*Leptophis diplotropis**
Coniophanes imperialis
Coniophanes piceivittis
*Epictia wynni**
Scaphiodontophis annulatus
Trachemys venusta
Kinosternon scorpioides

Four of the 15 GCL single-region species are Mexican endemics (single asterisk), one is a non-native (triple asterisk), and the remainder are non-endemic species.

The six single-region species in the TMV are:

*Chiropterotriton chico***
*Chiropterotriton magnipes**
*Pseudoeurycea altamontana**
*Sceloporus bicanthalis**
*Rhadinaea gaigeae**
*Rhadinaea hesperia**

Five of the six TMV single-region species are Mexican endemics and one is a state endemic.

The two single-region species in the MXP are:

Lampropeltis annulata
Rena dulcis

Both of these species are non-endemics.

In summary, of the 48 single-region species in Hidalgo, 23 are Mexican endemics, one is a state endemic, 23 are non-endemics, and one is a non-native. Of the four physiographic regions, the SMO is of the greatest conservation importance given that it houses the greatest overall number of species (166), the greatest number of single-region species (25), and the largest number of country endemics (14).

A Coefficient of Biogeographic Resemblance (CBR) matrix was created for studying the herpetofaunal similarity relationships among the four physiographic regions in Hidalgo (Table 6) and those data were used to construct a UPGMA dendrogram. The SMO contains the greatest species richness (166 species) and the MXP the least (77 species). The mean species richness value for all four areas is 105.5. The number of shared species between each of the regional pairs ranges from a high of 72 between SMO and GCL to a low of 13 between TMV and GCL. The mean value of shared species among all four regions is 47.8. The lowest number of shared species between the TMV and the GCL (13 species) was expected because these two regions are situated on opposite ends of Hidalgo, are not connected geographically (being completely separated by the



No. 13. *Isthmura gigantea* (Taylor 1939). The Giant False Brook Salamander ranges “in the La Joya-Jalapa region of Veracruz and into northeastern Hidalgo, Mexico” (Frost 2019). This individual was encountered at Chilijapa, in the municipality of Tepehuacan de Guerrero. 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 considered as Critically Endangered by the IUCN, but this species is not listed by SEMARNAT. *Photo by Christian Berriozabal-Islas.*



No. 14. *Barisia imbricata* (Wiegmann, 1828). The Transvolcanic Alligator Lizard ranges in the Trans-Mexican Volcanic Belt and the Sierra Madre Oriental, in the states of México, Ciudad de México, Querétaro, Hidalgo, Jalisco, Puebla, Oaxaca, Michoacán, Morelos, and Tlaxcala. This individual was found at Puentecillas in the municipality of Singuilucan. Wilson et al. (2013b) calculated its EVS as 15, placing it in the lower portion of the high 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 Cristian Raúl Olvera-Olvera.*



No. 15. *Gerrhonotus ophiurus* Cope 1867. This alligator lizard occurs in the Mexican states of Hidalgo, Veracruz, San Luis Potosí, Querétaro, Michoacán, and Puebla (Ramírez-Bautista et al. 2014). This individual was encountered at El Demañi, in the municipality of Tlahuiltepa. Wilson et al. (2013a) assessed 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, but this species is not listed by SEMARNAT. *Photo by Christian Berriozabal-Islas.*



No. 16. *Norops naufragus* (Campbell, Hillis, and Lamar 1989). The Hidalgo Anole is found only in the states of Hidalgo and Puebla in Mexico (Ramírez-Bautista et al. 2014). This individual was found at Cuatatlán, in the municipality of Tlanchinol. Wilson et al. (2013a) ascertained its EVS as 13, placing it at the upper limit of the medium vulnerability category. Its conservation status has been considered as Vulnerable by the IUCN, and it is placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Christian Berriozabal-Islas.*

SMO and the MXP), and are environmentally different on an elevational scale. The GCL, with an elevational range from near sea level to 1,200 m, contains tropical evergreen forest and subhumid formations of scrublands to tropical dry forests. On the other hand, the TMV with a limited geographic area within Hidalgo contains humid, semihumid, and subhumid vegetation in montane environments at elevations from 1,000 m in large sloping river valleys to 3,400 m on volcanic peaks. The SMO and the GCL share the most species (72), which also was not unexpected because they are directly adjacent to each other in Hidalgo, and the tropical lowland environments of the GCL ascend into the mountainous habitats of the SMO. The pairwise comparisons of regions aligned in order from highest to lowest species richness (underlined values) and their corresponding numbers of shared species (in parentheses) are:

SMO 166: GCL (72), MXP (67), TMV (66)

GCL 95: SMO (72), MXP (16), TMV (13)

TMV 85: SMO (66), MXP (53), GCL (13)

MXP 77: SMO (67), TMV (53), GCL (16)

In general, the pattern indicates how species richness values within each of the four biogeographic regions of Hidalgo equate to numbers of shared species among the other three regions. There is a higher correlation of species richness values to number of shared species between regions that are in contact with each other, but also observed correlations between regions that share similar ecological parameters. Interestingly, the two regions that share the most species (72) are a highland region (SMO) and a lowland region (GCL), which is probably due to the GCL containing many generalist species that can endure both montane and non-montane environments in low to moderate elevations. The fact that the GCL shares few species with the MXP and the TMV gives credibility to the premise that regions separated by ecological barriers will share fewer species than they will with regions in direct contact.

The following data show ranges and mean numbers of shared species (bold in parentheses) for each of the four regions that are arranged according to increasing species richness (underlined values) in each region:

Sierra Madre Oriental – SMO (166): 66–72 (**68.3**)

Gulf Coastal Lowlands – GCL (95): 13–72 (**33.6**)

Trans-Mexican Volcanic Belt – TMV (85): 13–66 (**44.0**)

Mexican Plateau – MXP (77): 16–67 (**45.3**)

The mean numbers of shared species compared to the species richness values in all four regions indicate that higher species richness in pairwise comparisons does not translate into higher reciprocal numbers when all regional pairs are totaled. The most apparently extreme example of this is the comparison between the SMO

and the GCL—which are 1st and 2nd in species richness, but 1st and last (4th) in mean numbers of shared species, respectively. The SMO also has higher mean numbers of shared species with TMV (44.0) and MXP (45.3), but if GCL (2nd in species richness, last in mean number of shared species) is removed from the tabulation, the three montane regions have even higher mean numbers of shared species. Specifically, the average number of shared species between the SMO, the TMV, and the MXP combined is **62.0** (calculated from Table 6).

Regarding area, the two largest geographic regions, the SMO and the MXP, reflect opposite relationships in species richness (166 vs. 77 species, respectively). The SMO contains more tropical, subtropical humid, and semihumid vegetation formations compared to the mostly subhumid environments in the MXP, in addition to being in direct contact with the second most species-rich region, the GCL, which shares the highest number of species in Hidalgo with the SMO. The GCL, the second most speciose region and third smallest region in the state, contains 10 more species than does the TMV, the smallest area by far that also contains less humid and semi-humid environments than does GCL. Also note that Hidalgo is a relatively small state in area (5th smallest of the 31 in Mexico), which undoubtedly affects species richness. As an example, the adjacent state of Puebla, which is slightly larger and contains two more physiographic regions than does Hidalgo, contains 267 species of amphibians and reptiles (Woolrich-Piña et al. 2017).

Based on the data in Table 6, a UPGMA dendrogram (Fig. 6) was created to depict the herpetofaunal similarity resemblance patterns in a hierarchical fashion among the four physiographic regions of Hidalgo (see map, Fig. 1). The dendrogram is composed of two distinct clusters; one comprising two montane regions (MXP and TMV) at the 0.65 level and the other containing one montane region (SMO) and the lowland region (GCL) at the 0.55 level. The two clusters connect together at the 0.39 level. Regions within both clusters are adjacent to each other and depict patterns of ecological similarity; and in the case of the SMO and the GCL, they share generalist species that primarily occur on the Gulf-facing side that ascends from the lowlands (the GCL) into the higher elevations in the SMO. Fifty-three of the 203 herpetofaunal species (26.2%) presently known from Hidalgo are shared only between the SMO and the GCL (Table 4), and many of them are wide-ranging species along the Gulf versant of Mexico, some of which also enter the USA, and/or Central America and South America (Wilson and Johnson 2010). Those 53 species also represent 73.6% of the 72 species shared among the SMO, the GCL, and other regions in Hidalgo. We also predict that other species now restricted to either the SMO or especially the GCL eventually will be discovered in both regions. In our opinion, the shared generalist species within the SMO and the GCL are the exclusive reason why the SMO clusters with the GCL instead of with the two other montane regions (MXP and TMV).



No. 17. *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 Parque Nacional El Chico, in the municipality of Mineral del Chico. 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 Christian Berriozabal-Islas.*



No. 18. *Sceloporus bicanthalis* Smith 1937. The Transvolcanic Bunchgrass Lizard is distributed in the states of Hidalgo, México, Oaxaca, Puebla, and Veracruz (Ramírez-Bautista et al. 2014). This individual was found in the municipality of Mineral El Chico. Wilson et al. (2013a) calculated its EVS as 13, placing it at the upper limit of the medium vulnerability category. Its conservation status has been considered as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Uriel Hernández-Salinas.*



No. 19. *Sceloporus minor* Cope 1885. The Minor Scaly Lizard ranges into the states of Nuevo León, Zacatecas, San Luis Potosí, Tamaulipas, Querétaro, and Guanajuato (Ramírez-Bautista et al. 2014). This individual was located at La Mesa, in the Municipality of Zacualtipán. Wilson et al. (2013a) calculated its EVS as 14, placing it at the lower limit of the high vulnerability category. Its conservation status has been considered as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Aarón García-Rosales.*



No. 20. *Lepidophyma occulor* Smith 1942. The Jalpan Tropical Night Lizard has a restricted distribution in adjacent areas of Querétaro, San Luis Potosí, and Hidalgo (Ramírez-Bautista et al. 2014). This individual came from Puerto Oscuro, in the municipality of Pisaflores. Wilson et al. (2013a) determined its EVS as 14, placing it at the lower limit of the high vulnerability category. Its conservation status has been considered as Least Concern by the IUCN, and it is placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Daniel Lara-Tuñiño.*

Distribution Status Categorizations

The assessment of the distribution status of the members of the Hidalgo herpetofauna here uses the system developed by Alvarado-Díaz et al. (2013) and employed in all the other entries in the Mexican Conservation Series (see above). The categories in the system are non-endemic, country endemic, state endemic, and non-native, and data are presented in Table 7 and summarized in Table 8.

The numbers of species in each of the four categories, in decreasing order of size, are: country endemics, 104 (51.2%); non-endemics, 92 (45.3%); state endemics, four (2.0%); and non-natives, three (1.5%). As with the states of Michoacán (Alvarado-Díaz et al. 2013), Nayarit (Woolrich-Piña et al. 2016), Jalisco (Cruz-Sáenz et al. 2017), and Puebla (Woolrich-Piña et al. 2017), the greatest number of herpetofaunal species in Hidalgo lies within the country endemic category. The largest number falls within the non-endemic category in the

Table 7. Distributional and conservation status measures for members of the herpetofauna of Hidalgo, Mexico. Distributional Status: SE = endemic to Hidalgo; CE = endemic to country of Mexico; NE = not endemic to state or country; and NN = non-native. Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20). IUCN categorizations: 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 text for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Species	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
<i>Anaxyrus punctatus</i>	NE	L (5)	LC	NS
<i>Incilius marmoreus</i> *	CE	M (11)	LC	NS
<i>Incilius nebulifer</i>	NE	L (6)	LC	NS
<i>Incilius occidentalis</i> *	CE	M (11)	LC	NS
<i>Incilius valliceps</i>	NE	L (6)	LC	NS
<i>Rhinella horribilis</i>	NE	L (3)	NE	NS
<i>Craugastor augusti</i>	NE	L (8)	LC	NS
<i>Craugastor berkenbuschii</i> *	CE	H (14)	NT	Pr
<i>Craugastor decoratus</i> *	CE	H (15)	VU	Pr
<i>Craugastor mexicanus</i> *	CE	M (10)	LC	NS
<i>Craugastor rhodopis</i> *	CE	H (14)	VU	NS
<i>Eleutherodactylus cystignathoides</i>	NE	M (12)	LC	NS
<i>Eleutherodactylus guttillatus</i>	NE	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>Bromeliophyla dendroscarta</i> *	CE	H (17)	CR	Pr
<i>Charadrahyla taeniopus</i> *	CE	M (13)	VU	A
<i>Dryophytes arenicolor</i>	NE	L (7)	LC	NS
<i>Dryophytes euphorbiaceus</i> *	CE	M (13)	NT	NS
<i>Dryophytes eximius</i> *	CE	M (10)	LC	NS
<i>Dryophytes plicatus</i> *	CE	M (11)	LC	A
<i>Rheohyla miotypanum</i> *	CE	L (9)	NT	NS
<i>Sarcohyala arborescandens</i> *	CE	M (11)	EN	Pr
<i>Sarcohyala bistincta</i> *	CE	L (9)	LC	Pr
<i>Sarcohyala charadricola</i> *	CE	H (14)	EN	A
<i>Sarcohyala robertsorum</i> *	CE	M (13)	EN	A
<i>Scinax staufferi</i>	NE	L (4)	LC	NS
<i>Smilisca baudinii</i>	NE	L (3)	LC	NS
<i>Tlalocohyla picta</i>	NE	L (8)	LC	NS
<i>Trachycephalus vermiculatus</i>	NE	L (4)	LC	NS

Table 7 (continued). Distributional and conservation status measures for members of the herpetofauna of Hidalgo, Mexico. Distributional Status: SE = endemic to Hidalgo; CE = endemic to country of Mexico; NE = not endemic to state or country; and NN = non-native. Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20). IUCN categorizations: 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 text for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Species	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
<i>Leptodactylus fragilis</i>	NE	L (5)	LC	NS
<i>Leptodactylus melanonotus</i>	NE	L (6)	LC	NS
<i>Hypopachus variolosus</i>	NE	L (4)	LC	NS
<i>Lithobates berlandieri</i>	NE	L (7)	LC	Pr
<i>Lithobates catesbeianus</i> ***	NN	—	—	—
<i>Lithobates johni</i> *	CE	H (14)	EN	P
<i>Lithobates montezumae</i> *	CE	M (13)	LC	Pr
<i>Lithobates spectabilis</i> *	CE	M (12)	LC	NS
<i>Rhinophrynus dorsalis</i>	NE	L (8)	LC	Pr
<i>Scaphiopus couchii</i>	NE	L (3)	LC	NS
<i>Spea multiplicata</i>	NE	L (6)	LC	NS
<i>Ambystoma velasci</i> *	CE	M (10)	LC	Pr
<i>Aquiloerycea cephalica</i> *	CE	H (14)	NT	A
<i>Bolitoglossa platyductyla</i> *	CE	H (15)	NT	Pr
<i>Chiropterotriton arboreus</i> *	CE	H (18)	CR	Pr
<i>Chiropterotriton chico</i> **	SE	H (18)	NE	NS
<i>Chiropterotriton chiropterus</i> *	CE	H (16)	CR	Pr
<i>Chiropterotriton chondrostega</i> *	CE	H (17)	EN	Pr
<i>Chiropterotriton dimidiatus</i> **	SE	H (17)	EN	Pr
<i>Chiropterotriton magnipes</i> *	CE	H (16)	CR	Pr
<i>Chiropterotriton mosaueri</i> **	SE	H (18)	CR	Pr
<i>Chiropterotriton multidentatus</i> *	CE	H (15)	EN	Pr
<i>Chiropterotriton terrestris</i> **	SE	H (18)	CR	NS
<i>Isthmura bellii</i> *	CE	M (12)	VU	A
<i>Isthmura gigantea</i> *	CE	H (16)	CR	NS
<i>Pseudoerycea altamontana</i> *	CE	H (17)	EN	Pr
<i>Pseudoerycea leprosa</i> *	CE	H (16)	VU	A
<i>Notophthalmus meridionalis</i>	NE	M (12)	EN	P
<i>Crocodylus moreletii</i>	NE	M (13)	LC	Pr
<i>Abronia taeniata</i> *	CE	H (15)	VU	Pr
<i>Barisia imbricata</i> *	CE	H (14)	LC	Pr
<i>Gerrhonotus infernalis</i>	NE	M (13)	LC	NS
<i>Gerrhonotus liocephalus</i>	NE	L (6)	LC	Pr
<i>Gerrhonotus ophiurus</i> *	CE	M (12)	LC	NS
<i>Basiliscus vittatus</i>	NE	L (7)	LC	NS
<i>Corytophanes hernandezii</i>	NE	M (13)	LC	Pr
<i>Laemanctus serratus</i>	NE	L (8)	LC	Pr
<i>Norops laeviventris</i>	NE	L (9)	NE	NS
<i>Norops lemuringus</i>	NE	L (8)	NE	NS
<i>Norops naufragus</i> *	CE	M (13)	VU	Pr

Herpetofauna of Hidalgo, Mexico

Table 7 (continued). Distributional and conservation status measures for members of the herpetofauna of Hidalgo, Mexico. Distributional Status: SE = endemic to Hidalgo; CE = endemic to country of Mexico; NE = not endemic to state or country; and NN = non-native. Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20). IUCN categorizations: 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 text for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Species	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
<i>Norops petersii</i>	NE	L (9)	NE	NS
<i>Norops sericeus</i>	NE	L (8)	NE	NS
<i>Anelytropsis papillosus</i> *	CE	M (10)	LC	A
<i>Coleonyx elegans</i>	NE	L (9)	LC	A
<i>Hemidactylus frenatus</i> ***	NN	—	—	—
<i>Ctenosaura acanthura</i>	NE	M (12)	NE	Pr
<i>Phrynosoma orbiculare</i> *	CE	M (12)	LC	A
<i>Sceloporus aeneus</i> *	CE	M (13)	LC	NS
<i>Sceloporus bicanthalis</i> *	CE	M (13)	LC	NS
<i>Sceloporus cyanogenys</i>	NE	M (13)	NE	NS
<i>Sceloporus grammicus</i>	NE	L (9)	LC	Pr
<i>Sceloporus megalepidurus</i> *	CE	H (14)	VU	Pr
<i>Sceloporus minor</i> *	CE	H (14)	LC	NS
<i>Sceloporus mucronatus</i> *	CE	M (13)	LC	NS
<i>Sceloporus parvus</i> *	CE	H (15)	LC	NS
<i>Sceloporus scalaris</i> *	CE	M (12)	LC	NS
<i>Sceloporus serrifer</i>	NE	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>	NE	L (5)	LC	NS
<i>Plestiodon lynxe</i> *	CE	M (10)	LC	Pr
<i>Plestiodon tetragrammus</i>	NE	M (12)	LC	NS
<i>Scincella gemmingeri</i> *	CE	M (11)	LC	Pr
<i>Scincella silvicola</i> *	CE	M (12)	LC	A
<i>Aspidoscelis gularis</i>	NE	L (9)	LC	NS
<i>Holcosus amphigrammus</i> *	CE	M (11)	NE	NS
<i>Lepidophyma flavimaculatum</i>	NE	L (8)	LC	Pr
<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>Xenosaurus newmanorum</i> *	CE	H (15)	EN	Pr
<i>Xenosaurus tzacualtipantecus</i> *	CE	H (16)	NE	NS
<i>Boa imperator</i>	NE	M (10)	NE	NS
<i>Coluber constrictor</i>	NE	M (10)	LC	A
<i>Conopsis biserialis</i> *	CE	M (13)	LC	A
<i>Conopsis lineata</i> *	CE	M (13)	LC	NS
<i>Conopsis nasus</i> *	CE	M (11)	LC	NS
<i>Drymarchon melanurus</i>	NE	L (6)	LC	NS
<i>Drymobius chloroticus</i>	NE	L (8)	LC	NS

Table 7 (continued). Distributional and conservation status measures for members of the herpetofauna of Hidalgo, Mexico. Distributional Status: SE = endemic to Hidalgo; CE = endemic to country of Mexico; NE = not endemic to state or country; and NN = non-native. Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20). IUCN categorizations: 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 text for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Species	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
<i>Dryobius margaritiferus</i>	NE	L (6)	NE	NS
<i>Ficimia hardyi</i> *	CE	M (13)	EN	NS
<i>Ficimia olivacea</i> *	CE	L (9)	NE	NS
<i>Ficimia streckeri</i>	NE	M (12)	LC	NS
<i>Lampropeltis annulata</i>	NE	M (12)	NE	NS
<i>Lampropeltis mexicana</i> *	CE	H (15)	LC	A
<i>Lampropeltis polyzona</i> *	CE	M (11)	NE	NS
<i>Lampropeltis ruthveni</i> *	CE	H (16)	NT	A
<i>Leptophis diplotropis</i> *	CE	H (14)	LC	A
<i>Leptophis mexicanus</i>	NE	L (6)	LC	A
<i>Masticophis flagellum</i>	NE	L (8)	LC	A
<i>Masticophis mentovarius</i>	NE	L (6)	LC	A
<i>Masticophis schotti</i>	NE	M (13)	LC	NS
<i>Mastigodryas melanolomus</i>	NE	L (6)	LC	NS
<i>Oxybelis aeneus</i>	NE	L (5)	NE	NS
<i>Pantherophis emoryi</i>	NE	M (13)	LC	NS
<i>Pituophis catenifer</i>	NE	L (9)	LC	NS
<i>Pituophis deppei</i> *	CE	H (14)	LC	A
<i>Pseudelaphe flavirufa</i>	NE	M (10)	LC	NS
<i>Salvadora bairdi</i> *	CE	H (15)	LC	Pr
<i>Salvadora grahamiae</i>	NE	M (10)	LC	NS
<i>Senticolis triaspis</i>	NE	L (6)	LC	NS
<i>Spilotes pullatus</i>	NE	L (6)	NE	NS
<i>Tantilla bocourti</i> *	CE	L (9)	LC	NS
<i>Tantilla rubra</i>	NE	L (5)	LC	Pr
<i>Trimorphodon tau</i> *	CE	M (13)	LC	NS
<i>Adelphicos quadrivirgatum</i>	NE	M (10)	LC	Pr
<i>Amastridium sapperi</i>	NE	M (10)	LC	NS
<i>Chersodromus rubriventris</i> *	CE	H (14)	EN	Pr
<i>Coniophanes fissidens</i>	NE	L (7)	NE	NS
<i>Coniophanes imperialis</i>	NE	L (8)	LC	NS
<i>Coniophanes piceivittis</i>	NE	L (7)	LC	NS
<i>Diadophis punctatus</i>	NE	L (4)	LC	NS
<i>Geophis latifrontalis</i> *	CE	H (14)	DD	Pr
<i>Geophis lorancai</i>	CE	H (14)	NE	NS
<i>Geophis mutitorques</i> *	CE	M (13)	LC	Pr
<i>Geophis semidoliatus</i> *	CE	M (13)	LC	NS
<i>Geophis turbidus</i> *	CE	H (15)	NE	NS
<i>Hypsiglena jani</i>	NE	L (6)	NE	NS
<i>Hypsiglena tanzeri</i> *	CE	H (15)	DD	NS

Herpetofauna of Hidalgo, Mexico

Table 7 (continued). Distributional and conservation status measures for members of the herpetofauna of Hidalgo, Mexico. Distributional Status: SE = endemic to Hidalgo; CE = endemic to country of Mexico; NE = not endemic to state or country; and NN = non-native. Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20). IUCN categorizations: 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 text for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Species	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
<i>Imantodes cenchoa</i>	NE	L (6)	NE	Pr
<i>Imantodes gemmistratus</i>	NE	L (6)	NE	Pr
<i>Leptodeira maculata</i>	NE	L (7)	LC	Pr
<i>Leptodeira septentrionalis</i>	NE	L (8)	NE	NS
<i>Ninia diademata</i>	NE	L (9)	LC	NS
<i>Pliocercus elapoides</i>	NE	M (10)	LC	NS
<i>Rhadinaea decorata</i>	NE	L (9)	LC	NS
<i>Rhadinaea gaigeae</i> *	CE	M (12)	DD	NS
<i>Rhadinaea hesperia</i> *	CE	M (10)	LC	Pr
<i>Rhadinaea marcellae</i> *	CE	M (12)	EN	Pr
<i>Rhadinaea quinquelineata</i> *	CE	H (15)	DD	Pr
<i>Sibon nebulatus</i>	NE	L (5)	NE	NS
<i>Tropidodipsas sartorii</i>	NE	L (9)	LC	Pr
<i>Micrurus diastema</i>	NE	L (8)	LC	Pr
<i>Micrurus tener</i>	NE	M (11)	LC	NS
<i>Epictia wynni</i> *	CE	M (13)	NE	NS
<i>Rena dulcis</i>	NE	M (13)	LC	NS
<i>Rena myopica</i> *	CE	M (13)	LC	NS
<i>Nerodia rhombifer</i>	NE	M (10)	LC	NS
<i>Storeria dekayi</i>	NE	L (7)	LC	NS
<i>Storeria hidalgoensis</i> *	CE	M (13)	VU	NS
<i>Storeria storerioides</i> *	CE	M (11)	LC	NS
<i>Thamnophis cyrtopsis</i>	NE	L (7)	LC	A
<i>Thamnophis eques</i>	NE	L (8)	LC	A
<i>Thamnophis marcianus</i>	NE	M (10)	LC	A
<i>Thamnophis melanogaster</i> *	CE	H (15)	EN	A
<i>Thamnophis proximus</i>	NE	L (7)	LC	A
<i>Thamnophis pulchrilatus</i> *	CE	H (15)	LC	NS
<i>Thamnophis scalaris</i> *	CE	H (14)	LC	A
<i>Thamnophis scaliger</i> *	CE	H (15)	VU	A
<i>Thamnophis sumichrasti</i> *	CE	H (15)	LC	A
<i>Scaphiodontophis annulatus</i>	NE	M (11)	LC	NS
<i>Indotyphlops braminus</i> ***	NN	—	—	—
<i>Agkistrodon taylori</i> *	CE	H (17)	LC	A
<i>Bothrops asper</i>	NE	M (12)	NE	NS
<i>Crotalus aquilus</i> *	CE	H (16)	LC	Pr
<i>Crotalus atox</i>	NE	L (9)	LC	Pr
<i>Crotalus intermedius</i> *	CE	H (15)	LC	A
<i>Crotalus molossus</i>	NE	L (8)	LC	Pr
<i>Crotalus polystictus</i> *	CE	H (16)	LC	Pr

Table 7 (continued). Distributional and conservation status measures for members of the herpetofauna of Hidalgo, Mexico. Distributional Status: SE = endemic to Hidalgo; CE = endemic to country of Mexico; NE = not endemic to state or country; and NN = non-native. Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20). IUCN categorizations: 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 text for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Species	Distributional status	Environmental Vulnerability Category (Score)	IUCN categorization	SEMARNAT status
<i>Crotalus ravus</i> *	CE	H (14)	LC	A
<i>Crotalus scutulatus</i>	NE	M (11)	LC	Pr
<i>Crotalus totonacus</i> *	CE	H (17)	NE	NS
<i>Crotalus triseriatus</i> *	CE	H (16)	LC	NS
<i>Metlapilcoatlus nummifer</i> *	CE	M (13)	LC	A
<i>Ophryacus smaragdinus</i> *	CE	H (14)	NE	NS
<i>Terrapene mexicana</i> *	CE	H (19)	NE	NS
<i>Trachemys venusta</i>	NE	H (19)	VU	NS
<i>Kinosternon herrerae</i> *	CE	H (14)	NT	Pr
<i>Kinosternon hirtipes</i>	NE	M (10)	LC	Pr
<i>Kinosternon integrum</i> *	CE	M (11)	LC	Pr
<i>Kinosternon scorpioides</i>	NE	M (10)	NE	Pr

other states surveyed thus far: 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).

In the ten previous individual-state entries in the MCS, the numbers of state endemics varied considerably, from one in Nayarit and Nuevo León (Woolrich-Piña et al. 2016; Nevárez-de los Reyes et al. 2016) to a maximum of 93 in Oaxaca (Mata-Silva et al. 2015). The number of state endemics in Hidalgo is near the lower end of that range at four, and all of them are plethodontid salamanders in the genus *Chiropterotriton*: *C. chico*, *C. dimidiatus*, *C. mosaueri*, and *C. terrestris* (Table 7).

As noted in the introduction, we hypothesized that the number of endemic species should be greater for the state of Puebla than for Hidalgo. Woolrich-Piña et al. (2017) reported the number of country endemics for Puebla as 162 (60.7% of state total). As noted above, this figure for Hidalgo is 104, which is 51.2% of the state total. The number of state endemics, however, is the same for these two states, at four (Woolrich-Piña et al. 2017), which supports our hypothesis since Puebla has the greater total number of endemic species (166) than does Hidalgo (108).

Three non-native species occur in Hidalgo: *Lithobates catesbeianus*, *Hemidactylus frenatus*, and *Indotyphlops braminus*. Two of these three (*H. frenatus* and *I. braminus*) are the most widespread of the non-native species thus far recorded in the 11 entries in the Mexican Conservation Series (Woolrich-Piña et al. 2017), having been recorded, as of this paper, in 10 and 11 states, respectively.

Principal Environmental Threats

In this section we highlight the problems that we view as most significantly affecting the sustainability of Hidalgo's herpetofauna populations. The major threats include the increasing and unregulated clearing of forests for farming and livestock, construction of roads, the constant and increasing pollution of water bodies, emerging diseases, and strongly ingrained cultural factors (Ramírez-Bautista et al. 2014; Cruz-Elizalde et al. 2017).

Deforestation

The state of Hidalgo encompasses 903,502.5 ha used for livestock and agricultural activities (INEGI 2011). The area utilized for these activities, however, continues to increase, consequently eliminating ~1,200–5,102 ha of natural vegetation cover per year (SEMARNAT 2012). Hidalgo ranks from fifth to seventh among the 31 Mexican states in terms of deforestation rates (SEMARNAT 2012). Unfortunately, the loss of natural habitats affects both biological communities and human development in the region, since deforestation accelerates the loss of soils, increases water runoff, and accelerates the evaporation rates of water bodies that serve many local communities.

At the local level, increasing deforestation is driven primarily by agriculture. After farmers clear an area (often on pronounced slopes), they typically only use this land for one or two years. Once the terrain loses most of its top soil layers to erosion (Fig. 1), the site is abandoned in favor of clearing of a new area of native vegetation. For instance, in the SMO large trees are cut down and the lower vegetation is eliminated with



No. 21. *Lepidophyma sylvaticum* Taylor 1939. The Madrean Tropical Night Lizard is distributed in the Mexican states of Puebla, Hidalgo, Nuevo León, Querétaro, San Luis Potosí, Tamaulipas, and Veracruz (Ramírez-Bautista et al. 2014). This individual was located at La Cueva, in the municipality of Pisaflores. Wilson et al. (2013a) calculated its EVS as 11, placing it in the lower portion of the medium vulnerability category. Its conservation status has been considered as Least Concern by the IUCN, and it is placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Daniel Lara-Tufiño.*



No. 22. *Xenosaurus mendozai* Nieto Montes de Oca, García Vázquez, Zúñiga-Vega, and Schmidt-Ballardo 2013. This individual was found at El Pinalito, in the municipality of Jacala de Ledezma. Wilson et al. (2013a) calculated its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has not been determined by the IUCN, and this species is not listed by SEMARNAT. *Photo by Christian Berriozabal-Islas.*



No. 23. *Xenosaurus newmanorum* Taylor 1949. Newman's Knob-scaled Lizard ranges from southeastern San Luis Potosí and extreme northern Hidalgo (Ramírez-Bautista et al. 2014). This individual was found at La Ameca, in the municipality of Pisaflores. Wilson et al. (2013a) assessed its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has been considered as Endangered by the IUCN, and is allocated to the Special Protection (Pr) category by SEMARNAT. *Photo by Christian Berriozabal-Islas.*



No. 24. *Xenosaurus tzacualtipantecus* Woolrich-Piña and Smith 2012. The Zacualtipán Knob-scaled Lizard is limited to the Sierra Madre Oriental in the states of Hidalgo and Veracruz (Ramírez-Bautista et al. 2014). This individual came from La Mojonera, in the municipality of Zacualtipán. Wilson et al. (2013a) calculated its EVS as 17, placing it in the middle portion of the high vulnerability category. Its conservation status has been considered as Near Threatened by the IUCN, but this species is not listed by SEMARNAT. *Photo by Lia Victoria Berriozabal-Varela.*



Fig. 2. Gulf Coastal Lowlands. Riparian vegetation in the vicinity of Achiquihuixtla in the municipality of Atlapexco. *Photo by Cristian Raúl Olvera-Olvera.*



Fig. 4. Mexican Plateau. Vegetation in the vicinity of Santa Monica in the municipality of Metztlán. *Photo by Cristian Raúl Olvera-Olvera.*

controlled fires (Fig. 2). The removal of the arboreal layer affects a diversity of species that are dependent on specific microclimatic parameters. Some examples of herpetofaunal taxa involved are salamanders of the genera *Aquiloerycea*, *Chiropterotriton*, and *Isthmura*, anurans of the genera *Craugastor*, *Eleutherodactylus*, *Charadrahyla*, and *Plectrohyla*, lizards of the genera *Abronia*, *Norops*, *Corytophanes*, *Laemanctus*, *Lepidophyma*, and *Xenosaurus*, and snakes of the genera *Boa*, *Spilotes*, *Metlapilcoatlus*, *Bothrops*, and *Ophryacus* (Cruz-Elizalde et al. 2017).

Livestock

Similar to agricultural deforestation, livestock ranching also involves vegetation removal for short-term exploitation. Livestock activities are associated with the destruction of thousands of ha of pristine forest. The soils in these pastures are prone to erosion and can only support one or two years of cattle grazing. Ranchers are then forced to look for new sites to clear at the expense of the natural ecosystems (Ramírez-Bautista et al. 2014). As a testimony to this crisis, in regions such as SMO and GCL, pasturelands have increased dramatically. Originally, these areas were covered with cloud forests and tropical forests (Fig. 3). The semiarid region in the state is not exempt from deforestation either, and goats are the main concern. Goat herders take their animals



Fig. 3. Sierra Madre Oriental. Panoramic view in the vicinity of Diego Mateo inside the Parque Nacional El Chico in the municipality of Mineral del Chico. *Photo by Cristian Raúl Olvera-Olvera.*

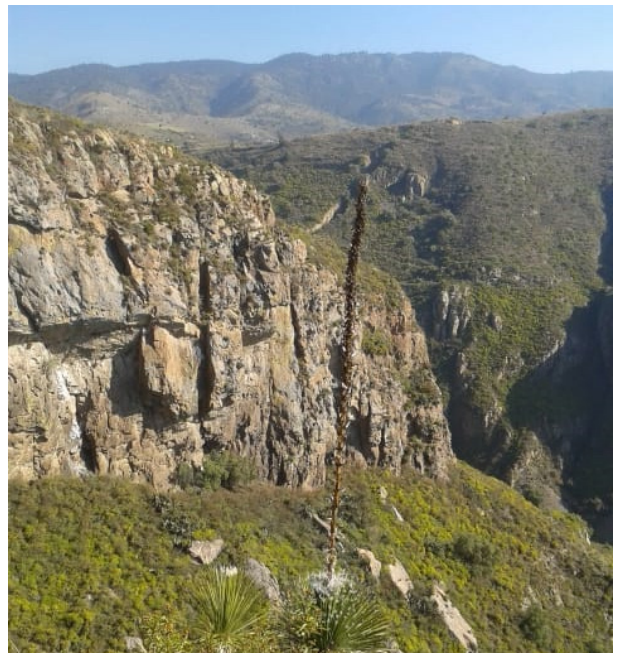


Fig. 5. Trans-Mexican Volcanic Belt. Sierra de Pachuca. Xerophilic scrub in Cerro de San Cristobal in the municipality of Pachuca. *Photo by Paola Lazcano-Juárez.*

to feed in areas covered with shrubs, destroying the slow-growth plants such as cacti and agaves, and in turn leading to erosion of the fragile soil (Ramírez-Bautista et al. 2014; Magno-Benítez et al. 2016).

Roads

Road infrastructure is important for the economic and social growth in the state. However, as is becoming more evident, this development brings adverse consequences to biodiversity (Puc Sánchez et al. 2013). Specifically, roads act as physical barriers for many amphibian and reptile species and reduce connectivity between populations. Vehicle-induced mortality or “roadkill” is one of the most visible effects of roads, as many herpetofauna cross busy roadways due to migration or

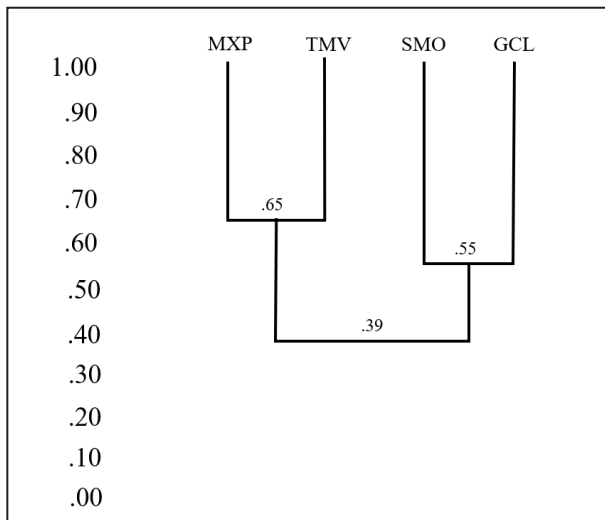


Fig. 6. A UPGMA generated dendrogram illustrating the similarity relationships of species richness among the herpetofauna in the four physiographic regions of Hidalgo (based on the data in Table 6). Similarity values were calculated using Duellman's (1990) Coefficient of Biogeographic Resemblance (CBR).

dispersal, or use paved roads for basking (Figs. 4–5).

Pollution of water bodies

Continuous human population growth in Hidalgo (SEMARNAT 2012) and the lack of urban development plans have exacerbated the improper disposal of waste products and, consequently, have affected water sources such as rivers in the MXP, SMO, and GCL. Additionally, many fields used to produce vegetables in the western region of the state have been irrigated with sewage water, which, unfortunately, contaminates the soils and local water sources. The sewage water that ends up in rivers has also modified the water properties significantly, causing many frog and turtle populations to disappear from those sites (Ramírez-Bautista et al. 2014; Magno-Benítez et al. 2016).

Myths and other cultural factors

Two cultural aspects that contribute to the detriment of Hidalgo's herpetofauna are the lack of understanding regarding the important roles of amphibians and reptiles in ecosystems, and harmful misconceptions that often lead to direct persecution (Cruz-Elizalde et al. 2017). For instance, many people in Hidalgo believe that some species of salamanders (genera *Aquiloerycea* and *Chiropterotriton*) and lizards (genera *Abronía* and *Barisia*) are venomous, while all snakes are indiscriminately regarded as dangerous, and, therefore, killed on sight. Additionally, many people believe that the salamanders *Aquiloerycea cephalica*, *Bolitoglossa platydactyla*, *Chiropterotriton arboreus*, *C. chondrostega*, and the snake *Pituophis deppei* somehow impregnate women; therefore, encounters with these creatures frequently



Fig. 7. Forest fires. A forest fire for land use conversion in the vicinity of El Naranjal, in the municipality of Pisaflores. Photo by Christian Berriozabal-Islas.



Fig. 8. Deforestation for ranching purposes. Cattle pasture in the municipality of Tepehuacan de Guerrero. Photo by Christian Berriozabal-Islas.

end up with them being killed (Ramírez-Bautista et al. 2014; Cruz-Elizalde et al. 2017). Consumption of most herpetofaunal members has not been well-documented in the state. In some rural communities, however, the salamander *Ambystoma velasci* is known to be part of the diet (Fig. 6) and rattlesnakes are used as part of the folk medicine by some inhabitants (Cruz-Elizalde et al. 2017).

Diseases

Globally, many amphibian populations are disappearing due to chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*; Skerrat et al. 2007). Unfortunately, this disease was reported recently in Hidalgo in the anurans *Craugastor rhodopis*, *Lithobates berlandieri*, *L. johni*, and *Rheohyla miotympanum* (Hernández-Austria 2017). Two factors have been identified as the main drivers of the successful spread of this infection in Hidalgo: the exotic American Bullfrog (*L. catesbeianus*) and global climate change (Kriger et al. 2006). Monitoring of this infection is necessary in order to assess its impact on the diverse native frog populations (Hernández-Austria 2017).

Under these circumstances, government authorities



Fig. 9. Deforestation for agricultural purposes. Change in land use for agricultural purposes in the vicinity of San Cristobal in the municipality of Metztlán. *Photo by Cristian Raúl Olvera-Olvera.*



Fig. 10. Invasive species. *Lithobates catesbeianus* in the vicinity of El Naranjal in the municipality of San Felipe Orizatlán. *Photo by Cristian Raúl Olvera-Olvera.*



Fig. 11. Pet trade. A boa constrictor (*Boa imperator*) captured by locals for maintenance in captivity as a pet in El Borbollon in the municipality of Huehuetla. *Photo by Christian Berriozabal-Islas.*



Fig. 12. Urbanization. Urban growth in the vicinity of Molango de Escamilla in the municipality of the same name. *Photo by Cristian Raúl Olvera-Olvera.*

at all levels and conservation groups must invest more effort in the protection of these species and the habitats where they are found. These efforts are particularly critical in regions that harbor species and habitats that are already vulnerable to anthropogenic stressors. Another critical step is that the respective authorities need to invest more resources in the continuous education of the general public on the importance of the herpetofauna of the state. Otherwise, adequate protection of these species will always remain an elusive goal.

Conservation Status

The conservation status of the members of the herpetofauna of Hidalgo is assessed here using the same three systems of conservation assessment as in the previous entries in the Mexican Conservation Series (see above). These systems are those of SEMARNAT (2010), the IUCN Red List (<http://iucnredlist.org>), and the EVS (Wilson et al. 2013a,b), and these three systems have been updated as necessary.

The SEMARNAT System

The SEMARNAT system is a means of conservation

status assessment developed and implemented by the Secretaría del Medio Ambiente y Recursos Naturales of the federal government of Mexico (SEMARNAT 2010). The ratings are available for some of the herpetofaunal species inhabiting Hidalgo as shown in Table 7 and summarized in Table 9. Three categories of assessment exist in the SEMARNAT system: Endangered (P), Threatened (A), and Under Special Protection (Pr); and the species remaining unassessed in this system are assigned a “No Status” (NS) category.

The data in Table 9 indicate that of the 200 native species in Hidalgo, only 93 (45.8%) have been evaluated using this system. This leaves 107 (52.7%) without a conservation assessment based on SEMARNAT.

If one can assume that SEMARNAT personnel have placed a greater emphasis on species endemic to Mexico or some portion thereof (i.e., a single state), then that consideration should be evident from a comparison of the assignments to both distributional categories and to SEMARNAT categories. In order to determine whether this sort of bias is evident, such comparisons are presented in Table 10. These data demonstrate that the majority of the non-endemic species (61 of 92; 66.3%) currently remain unevaluated in the SEMARNAT system. The comparable figures are 44 of the 104 (42.3%) country



No. 25. *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, San Luis Potosí, Tlaxcala, Veracruz, and Ciudad de México (Ramírez-Bautista et al. 2014). This individual was found at Puenteceillas, in the municipality of Singuilucan. Wilson (2013a) determined its EVS as 13, placing it at the upper limit of the medium vulnerability category. Its conservation status is assessed as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Cristian Raúl Olvera-Olvera.*



No. 26. *Lampropeltis annulata*. Kennicott 1861. The Mexican Milksnake is distributed in Nuevo León, Querétaro, and Tamaulipas, and perhaps Coahuila, eastern San Luis Potosí, and Hidalgo (Ruane et al. 2014). This individual was encountered at Venados, in the municipality of Metztlán. Wilson et al. (2013a) calculated its EVS as 12, placing it in the upper portion of the medium vulnerability category. Its conservation status has not been evaluated by the IUCN, and this species is not listed by SEMARNAT. *Photo by Cristian Raúl Olvera-Olvera.*



No. 27. *Pituophis deppei* (Duméril 1853). The Mexican Bull Snake occurs in the states of Aguascalientes, Chihuahua, Coahuila, Durango, Guanajuato, Hidalgo, Jalisco, México, Michoacán, Nuevo León, Oaxaca, Puebla, San Luis Potosí, Querétaro, Tlaxcala, Veracruz, Zacatecas, and Ciudad de México (Ramírez-Bautista et al. 2014). This individual was encountered in the municipality of Mineral El Chico. Wilson et al. (2013a) calculated its EVS as 14, placing it at the lower limit of the high vulnerability category. Its conservation status has been considered as Least Concern by the IUCN, and it is placed in the Threatened (A) category by SEMARNAT. *Photo by Uriel Hernández-Salinas.*



No. 28. *Chersodromus rubriventris* (Taylor 1949). The Redbelly Earth Runner “is found in the Sierra Madre Oriental in the States of San Luis Potosí, Querétaro and Hidalgo” (Canseco-Márquez et al. 2018: 159). This individual was photographed at Chilijapa, in the municipality of Tepehuacan de Guerrero. Wilson et al. (2013a) calculated its EVS as 14, placing it at the lower limit of the high vulnerability category. Its conservation status has been considered as Endangered by the IUCN, and it is placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Christian Berriozabal-Islas.*

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

Family	Number of species	Distributional status			
		Non-endemic (NE)	Country Endemic (CE)	State Endemic (SE)	Non-native (NN)
Bufonidae	6	4	2	—	—
Craugastoridae	5	1	4	—	—
Eleutherodactylidae	5	2	3	—	—
Hylidae	15	5	10	—	—
Leptodactylidae	2	2	—	—	—
Microhylidae	1	1	—	—	—
Ranidae	5	1	3	—	1
Rhinophrynidae	1	1	—	—	—
Scaphiopodidae	2	2	—	—	—
Subtotal	42	19	22	—	1
Ambystomatidae	1	—	1	—	—
Plethodontidae	15	—	11	4	—
Salamandridae	1	1	—	—	—
Subtotal	17	1	12	4	—
Total	59	20	34	4	1
Crocodylidae	1	1	—	—	—
Subtotal	1	1	—	—	—
Anguidae	5	2	3	—	—
Corytophanidae	3	3	—	—	—
Dactyloidae	5	4	1	—	—
Dibamidae	1	—	1	—	—
Eublepharidae	1	1	—	—	—
Gekkonidae	1	—	—	—	1
Iguanidae	1	1	—	—	—
Phrynosomatidae	14	4	10	—	—
Scincidae	2	1	1	—	—
Sphenomorphidae	2	—	2	—	—
Teiidae	2	1	1	—	—
Xantusiidae	4	1	3	—	—
Xenosauridae	3	—	3	—	—
Subtotal	44	18	25	—	1
Boidae	1	1	—	—	—
Colubridae	32	19	13	—	—
Dipsadidae	27	16	11	—	—
Elapidae	2	2	—	—	—
Leptotyphlopidae	3	1	2	—	—
Natricidae	13	6	7	—	—
Sibynophiidae	1	1	—	—	—
Typhlopidae	1	—	—	—	1
Viperidae	13	4	9	—	—
Subtotal	93	50	42	—	1
Emydidae	2	1	1	—	—
Kinosternidae	4	2	2	—	—
Subtotal	6	3	3	—	—
Total	144	72	70	—	2
Sum Total	203	92	104	4	3

endemics and two of the four state endemics (50.0%). Although these figures do not indicate a clear bias in favor of the Mexican endemic species, they do demonstrate that the SEMARNAT system will not be of much use in assessing the conservation status of the Mexican herpetofauna, and specifically the Hidalgo herpetofauna,

until all species are included.

The IUCN System

The IUCN system of conservation assessment is intended to be applicable to all organisms, although most of its evaluations are applied to vertebrate animals and

Herpetofauna of Hidalgo, Mexico

Table 9. SEMARNAT categorizations for herpetofaunal species in Hidalgo, Mexico, arranged by family. Non-native species are excluded.

Family	Number of species	SEMARNAT categorization			
		Endangered (P)	Threatened (A)	Special protection (Pr)	No status (NS)
Bufonidae	6	—	—	—	6
Craugastoridae	5	—	—	2	3
Eleutherodactylidae	5	—	—	1	4
Hylidae	15	—	4	3	8
Leptodactylidae	2	—	—	—	2
Microhylidae	1	—	—	—	1
Ranidae	4	1	—	2	1
Rhinophrynidae	1	—	—	1	—
Scaphiopodidae	2	—	—	—	2
Subtotal	41	1	4	9	27
Ambystomatidae	1	—	—	1	—
Plethodontidae	15	—	3	9	3
Salamandridae	1	1	—	—	—
Subtotal	17	1	3	10	3
Total	58	2	7	19	30
Crocodylidae	1	—	—	1	—
Subtotal	1	—	—	1	—
Anguidae	5	—	—	3	2
Corytophanidae	3	—	—	2	1
Dactyloidae	5	—	—	1	4
Dibamidae	1	—	1	—	—
Eublepharidae	1	—	1	—	—
Iguanidae	1	—	—	1	—
Phrynosomatidae	14	—	1	2	11
Scincidae	2	—	—	1	1
Sphenomorphidae	2	—	1	1	—
Teiidae	2	—	—	—	2
Xantusiidae	4	—	—	4	—
Xenosauridae	3	—	—	1	2
Subtotal	43	—	4	16	23
Boidae	1	—	—	—	1
Colubridae	32	—	9	2	21
Dipsadidae	27	—	—	11	16
Elapidae	2	—	—	1	1
Leptotyphlopidae	3	—	—	—	3
Natricidae	13	—	8	—	5
Sibynophiidae	1	—	—	—	1
Viperidae	13	—	4	5	4
Subtotal	92	—	21	19	52
Emydidae	2	—	—	—	2
Kinosternidae	4	—	—	4	—
Subtotal	6	—	—	4	2
Total	142	—	25	40	77
Sum Total	200	2	32	59	107

flowering plants. For example, of 67,222 animal species assessed, 46,092 are vertebrates (68.6%); and of 24,230 plant species evaluated, 22,566 (93.1%) are flowering plants (IUCN Red List version 2017-3: Tables 3a,b in that list). The vertebrate animal assessments include 6,609 for amphibians and 6,278 for reptiles (IUCN Red List version 2017-3: Table 3a). The Reptile Database website (<http://www.reptile-database.org/>; accessed 17 April 2018) provides a February 2018 total count for

reptiles of 10,711; thus, 58.6% of the world's recognized reptile species have been assessed by the IUCN; while the figure for amphibians is 84.4% of 7,832 species (Amphibian Species of the World, <http://research.amnh.org/vz/herpetology/amphibia/>; accessed 17 April 2018). Thus, a significantly greater proportion of amphibian species have been assessed than reptile species. For the global herpetofauna, 12,887 (69.5%) of 18,543 total species have been assessed.

Table 10. Comparison of SEMARNAT and distributional categorizations.

Distributional category	SEMARNAT category				Total
	Endangered (P)	Threatened (A)	Special Protection (Pr)	No Status (NS)	
Non-endemic (NE)	1	9	21	61	92
Country-endemic (CE)	1	23	36	44	104
State-endemic (SE)	—	—	2	2	4
Total	2	32	59	107	200

Table 11. IUCN Red List categorizations for herpetofaunal families in Hidalgo, Mexico. Non-native species are excluded. The shaded columns to the left are the “threatened” categories, and those to the right are the categories which indicate that available conservation status data are too limited to allow the species to be placed in any other IUCN category, or the species has not been evaluated.

Family	Number of species	IUCN Red List categorization						
		Critically Endangered	Endangered	Vulnerable	Near Threatened	Least Concern	Data Deficient	Not Evaluated
Bufonidae	6	—	—	—	—	5	—	1
Craugastoridae	5	—	—	2	1	2	—	—
Eleutherodactylidae	5	—	—	2	—	3	—	—
Hylidae	15	1	3	1	2	8	—	—
Leptodactylidae	2	—	—	—	—	2	—	—
Microhylidae	1	—	—	—	—	1	—	—
Ranidae	4	—	1	—	—	3	—	—
Rhinophrynidae	1	—	—	—	—	1	—	—
Scaphiopodidae	2	—	—	—	—	2	—	—
Subtotal	41	1	4	5	3	27	—	1
Ambystomatidae	1	—	—	—	—	1	—	—
Plethodontidae	15	6	4	2	2	—	—	1
Salamandridae	1	—	1	—	—	—	—	—
Subtotal	17	6	5	2	2	1	—	1
Total	58	7	9	7	5	28	—	2
Crocodylidae	1	—	—	—	—	1	—	—
Subtotal	1	—	—	—	—	1	—	—
Anguidae	5	—	—	1	—	4	—	—
Corytophanidae	3	—	—	—	—	3	—	—
Dactyloidae	5	—	—	1	—	—	—	4
Dibamidae	1	—	—	—	—	1	—	—
Eublepharidae	1	—	—	—	—	1	—	—
Iguanidae	1	—	—	—	—	—	—	1
Phrynosomatidae	14	—	—	1	—	12	—	1
Scincidae	2	—	—	—	—	2	—	—
Sphenomorphidae	2	—	—	—	—	2	—	—
Teiidae	2	—	—	—	—	1	—	1
Xantusiidae	4	—	—	1	—	3	—	—
Xenosauridae	3	—	1	—	—	—	—	2
Subtotal	43	—	1	4	—	29	—	9
Boidae	1	—	—	—	—	—	—	1
Colubridae	32	—	1	—	1	24	—	6
Dipsadidae	27	—	2	—	—	13	4	8
Elapidae	2	—	—	—	—	2	—	—
Leptotyphlopidae	3	—	—	—	—	2	—	1
Natricidae	13	—	1	2	—	10	—	—
Sibynophiidae	1	—	—	—	—	1	—	—
Viperidae	13	—	—	—	—	10	—	3
Subtotal	92	—	4	2	1	62	4	19
Emydidae	2	—	—	1	—	—	—	1
Kinosternidae	4	—	—	—	1	2	—	1
Subtotal	6	—	—	1	1	2	—	2
Total	142	—	5	7	2	94	4	30
Sum Total	200	7	14	14	7	122	4	32
Category Total	200	35			129		36	

Table 12. Environmental Vulnerability Scores (EVS) for herpetofaunal species in Hidalgo, Mexico, arranged by family. Shaded area to the left encompasses low vulnerability scores, and the shaded area to the right indicates high vulnerability scores. Non-native species are excluded.

Family	Number of species	Environmental Vulnerability Score																	
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Bufo	6	1	—	1	2	—	—	—	—	2	—	—	—	—	—	—	—	—	
Craugastor	5	—	—	—	—	—	1	—	1	—	—	2	—	—	—	—	—	—	
Eleutheroactylid	5	—	—	—	—	—	—	—	—	1	2	—	—	1	—	—	—	—	
Hylid	15	1	2	—	—	1	1	2	1	2	—	3	1	—	1	—	—	—	
Leptodactylid	2	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	
Microhylid	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Ranid	4	—	—	—	—	1	—	—	—	—	1	1	—	—	—	—	—	—	
Rhinophrynid	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	
Scaphiopodid	2	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	
Subtotals	41	3	3	2	4	2	3	2	2	5	3	4	4	2	1	1	—	—	
Ambystomatid	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	
Plethodontid	15	—	—	—	—	—	—	—	—	—	1	—	1	2	4	3	4	—	
Salamandrid	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Subtotal	17	—	—	—	—	—	—	—	1	—	2	—	1	2	4	3	4	—	
Total	58	3	3	2	4	2	3	2	3	5	5	4	5	4	5	4	4	—	
Crocodylid	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Subtotal	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Anguid	5	—	—	—	1	—	—	—	—	—	1	1	1	—	—	—	—	—	
Corytophanid	3	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	
Dactyloid	5	—	—	—	—	—	2	2	—	—	—	—	—	—	—	—	—	—	
Dibamid	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	
Eublepharid	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Iguanid	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Phrynosomatid	14	—	—	1	1	—	—	1	—	1	3	4	2	1	—	—	—	—	
Scincid	2	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	
Sphenomorphid	2	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	
Tetrid	2	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	
Xantusid	4	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	
Xenosaurid	3	—	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	
Subtotal	43	—	—	1	2	1	4	5	2	4	7	8	4	3	2	—	—	—	
Boid	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	
Colubrid	32	—	—	2	7	—	2	3	3	2	2	6	2	2	1	—	—	—	
Dipsadid	27	—	1	1	3	3	2	3	4	—	2	2	3	3	—	—	—	—	
Elapid	2	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	
Leptotyphlopodid	3	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	
Natricid	13	—	—	—	—	—	3	1	—	2	1	1	1	4	—	—	—	—	
Sibynophiid	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	
Viperid	13	—	—	—	—	—	—	1	—	1	1	1	2	1	3	2	—	—	
Subtotal	92	—	1	3	10	6	7	7	10	6	5	13	8	10	4	2	—	—	
Emydid	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	
Kimosernid	4	—	—	—	—	—	—	—	2	1	—	—	1	—	—	—	—	—	
Subtotal	6	—	—	—	—	—	—	—	2	1	—	—	1	—	—	—	—	—	
Total	142	—	1	4	12	7	11	12	14	11	12	22	13	13	6	2	—	2	
Sum Total	200	3	4	6	16	9	14	14	17	16	17	26	18	17	11	6	4	2	
Category Total	200	66																	
		76																	
		58																	



No. 29. *Imantodes cenchoa* (Linnaeus 1758). The Bluntheaded Tree Snake is broadly distributed “from Tamaulipas and Oaxaca, Mexico, southward through much of Central America to Ecuador, on the Pacific versant, and to Paraguay on the cisandean side of South America” (Lemos-Espinal and Dixon 2013: 191). This individual was found at Cececamel in the municipality of San Felipe Orizatlán. Wilson et al. (2013a) assessed its EVS as 6, placing it in the middle of the low vulnerability category. Its conservation status has not been evaluated at the IUCN, but its SEMARNAT status is judged as Special Protection (Pr). *Photo by Cristian Raúl Olvera-Olvera.*



No. 30. *Micrurus diastema* (Duméril, Bibron, and Duméril 1854). The Variable Coral Snake is found “on the Atlantic versant from northern Veracruz and northern Oaxaca, Mexico, to northwestern Honduras” (McCranie 2011: 457). This individual was photographed at Laguna de Atezca, in the municipality of Molango de Escamilla. Wilson (2013a) calculated its EVS as 8, placing it in the upper portion of the low vulnerability category. Its conservation status has been assessed as Least Concern by the the IUCN, and this elapid is listed as a species of Special Protection (Pr) by SEMARNAT. *Photo by Christian Berriozabal-Islas.*



No. 31. *Metlapilcoatlus nummifer* (Rüppell 1845). The Mexican Jumping Viper is found “from San Luis Potosí southward through Hidalgo and west-central Veracruz to northern and southeastern Oaxaca (Lemos-Espinal and Dixon 2013: 246). This individual was found in El Pinalito, in the municipality of Jacala de Ledezma. Wilson et al. (2013a) estimated its EVS as 13, placing it at the upper limit of the medium vulnerability category. Its conservation status is indicated as Least Concern by the IUCN and as Threatened (A) by SEMARNAT. *Photo by Christian Berriozabal-Islas.*



No. 32. *Bothrops asper* (Garman 1884). The Terciopelo is a wide-ranging pit viper occurring “from southwestern Tamaulipas, Mexico, to coastal Venezuela on the Atlantic versant, and from Costa Rica to southern Ecuador on the Pacific versant, with a disjunct population occurring in southern Chiapas, Mexico, and adjacent Guatemala” (Lemos-Espinal and Dixon 2013: 247). This individual was found in La Esperanza II, in the municipality of Huehuetla. Wilson et al. (2013a) determined its EVS as 12, placing it in the upper portion of the medium vulnerability category. Its conservation status has not been determined by the IUCN, and this species is not listed by SEMARNAT. *Photo by Christian Berriozabal-Islas.*

In previous entries in the Mexican Conservation Series (e.g., Woolrich-Piña et al. 2017), the IUCN system of conservation evaluation has been criticized for several reasons. Nonetheless, the IUCN system is sufficiently broadly applied that its comparison here to the other systems is instructive. Thus, the IUCN categorizations for the members of the Hidalgo herpetofauna are shown in Table 7 and summarized in Table 11.

Of 200 native members of the herpetofauna, 164 (82.0%) have been assessed by the IUCN system. This percentage is similar to that found by Woolrich-Piña et al. (2017) for the herpetofauna of the adjacent state of Puebla (79.5%). Of these 164 species, 35 have been placed in one of the three IUCN “threat categories:” seven as CR, 14 as EN, and 14 as VU (Table 11). The seven CR species are *Bromeliophyla dendroscarta*, *Chiropterotriton arboreus*, *C. chiropterus*, *C. magnipes*, *C. mosaueri*, *C. terrestris*, and *Isthmura gigantea*. Five of these species are country endemics and two are state endemics; one is an anuran and six are salamanders. The 14 EN species are *Sarcohylla arborescandens*, *S. charadricola*, *S. robertorum*, *Lithobates johni*, *Chiropterotriton chondrostega*, *C. dimidiatus*, *C. multidentatus*, *Pseudoeurycea altamontana*, *Notophthalmus meridionalis*, *Xenosaurus newmanorum*, *Ficimia hardyi*, *Chersodromus rubriventris*, *Rhadinaea marcellae*, and *Thamnophis melanogaster*; and include 12 country endemics, one state endemic and one non-endemic. Four of these species are anurans, five are salamanders, one is a lizard, and four are snakes. The 14 VU species are *Craugastor decoratus*, *C. rhodopis*, *Eleutherodactylus longipes*, *E. verrucipes*, *Charadrahyla taeniopus*, *Isthmura bellii*, *Pseudoeurycea leprosa*, *Abronia taeniata*, *Norops naufragus*, *Sceloporus megalepidurus*, *Lepidophyma gaigeae*, *Storeria hidalgoensis*, *Thamnophis scaliger*, and *Trachemys venusta*; and include 13 country endemics and one non-endemic. Five of these species are anurans, two are salamanders, four are lizards, two are snakes, and one is a turtle. In total, of the 35 species in the IUCN “threatened categories,” 30 are endemic to Mexico or to Hidalgo (85.7%); 10 species are anurans, 13 are salamanders, five are lizards, six are snakes, and one is a turtle.

Of the 129 species placed in the IUCN “lower risk categories” (NT and LC), only seven (5.4%) are allocated to the NT category; the remaining 122 are placed in the LC category. The seven NT species are *Craugastor berkenbuschii*, *Dryophytes euphorbiaceus*, *Rheohyla miotypanum*, *Aquileurycea cephalica*, *Bolitoglossa platydactyla*, *Lampropeltis ruthveni*, and *Kinosternon herrerai*. All seven of these species are country endemics; three are anurans, two are salamanders, one is a snake, and one is a turtle.

The 122 LC species comprise 61.0% of the 200 native species in Hidalgo. Whether such a high proportion of these species are actually of “Least Concern” is questionable; and these allocations are examined in detail below.

Thirty-six of the members of the native Hidalgo herpetofauna have not been placed in either the “threatened categories” or the “lower risk categories,” including four allocated to the DD category and 32 to the NE categories. Inasmuch as these 36 species make up 18.0% of the native herpetofauna, they also are examined in greater detail in the following section.

The EVS System

The EVS (Environmental Vulnerability Score) system was developed originally for use in evaluating the conservation status of the Honduran herpetofauna, but has since been deployed in the assessment of other components of the Mexican and Central American herpetofaunas (Wilson et al. 2010, 2013a,b; and all entries in the Mexican Conservation Series [see above]). In the present study, the EVS values for the 200 native species are given in Table 7 and summarized in Table 12.

The EVS values range from 3 to 19, which is one less than the entire theoretical range of 3–20. The most frequent values (applied to 10 or more species) are 6 (16 species), 8 (14), 9 (14), 10 (17), 11 (16), 12 (17), 13 (26), 14 (18), 15 (17), and 16 (11). These ten values are applied to 166 of the 200 native species (83.0%). The lowest score of 3 was calculated for three anuran species (*Rhinella horribilis*, *Smilisca baudinii*, and *Scaphiopus couchii*) and the highest score of 19 was calculated for two turtles (*Terrapene mexicana* and *Trachemys venusta*).

As in prior MCS studies, the EVS are organized here into three categories of low, medium, and high vulnerability. As such, the species counts increase from low vulnerability (66) to medium vulnerability (76), and then decrease in the high vulnerability (58) category. Generally, 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. 2015), Tamaulipas (Terán-Juárez et al. 2016), Nuevo León (Nevárez-de los Reyes et al. 2016), and Coahuila (Lazcano et al. 2019).

When the IUCN categories for the Hidalgo herpetofauna are compared with those from the EVS system (Table 13), 35 of the 58 high vulnerability species (60.3%) are allocated to one of the three IUCN “threat categories.” This relatively high proportion is due primarily to the number of amphibians evaluated by the IUCN as CR, EN, or VU; 23 of 59 amphibian species (39.0%) are anurans (10 species) or salamanders (13), compared to 12 of 144 reptiles (8.3%). No squamates, turtles, or crocodylians are assessed as CR, only five squamates are assessed as EN, and six squamates and one turtle are assessed as VU. At the other extreme, the 66 low vulnerability species (by EVS) comprise 54.1% of the 122 LC species (by IUCN). As demonstrated in previous MCS entries, the results from the IUCN and EVS systems do not complement one another very well.

As reported in previous MCS studies, the main

Table 13. Comparison of Environmental Vulnerability Scores (EVS) and IUCN categorizations for members of the herpetofauna of Hidalgo, Mexico. Non-native species are excluded. Shaded area at the top (EVS scores from 3 to 9) encompasses low vulnerability category scores, and the shaded area at the bottom (EVS scores from 14 to 19) indicates 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	—	—	—	—	4	—	2	6
6	—	—	—	—	11	—	5	16
7	—	—	—	—	8	—	1	9
8	—	—	—	—	11	—	3	14
9	—	—	—	1	10	—	3	14
10	—	—	—	—	15	—	2	17
11	—	1	—	—	13	—	2	16
12	—	2	1	—	10	1	3	17
13	—	2	4	1	17	—	2	26
14	—	3	2	3	7	1	2	18
15	—	3	4	1	6	2	1	17
16	3	—	2	1	3	—	2	11
17	1	3	—	—	1	—	1	6
18	3	—	—	—	—	—	1	4
19	—	—	1	—	—	—	1	2
Total	7	14	14	7	122	4	32	200

reason for the poor correspondence between the IUCN and EVS systems is that a large proportion (158 of 200, 79.0%) of the species are assigned to the NE, DD, and LC categories. Interestingly, the four DD species are all country endemic snakes (*Geophis latifrontalis*, *Hypsiglena tanzeri*, *Rhadinaea gaigeae*, and *R. quinquelineata*). Three of these four species are categorized as high vulnerability species, and the fourth (*R. gaigeae*) has an EVS of 12 putting it in the medium vulnerability category (Table 14). As a result, we believe the conservation needs of these four species are ill-served by leaving them in the DD category of IUCN. Thus, we think that the two species with an EVS of 15 (*Hypsiglena tanzeri* and *Rhadinaea quinquelineata*) would be more appropriately placed in the EN category, the one with an EVS of 14 (*Geophis latifrontalis*) in the VU category, and the one with an EVS of 12 (*Rhadinaea gaigeae*) in the NT category.

Thirty-two of the 200 native species (16.0%) have not been evaluated by the IUCN (Table 15). These 32 species comprise an interesting amalgam of country/state endemics and non-endemic species. Of the 32

species, 11 are species endemic to Hidalgo (one species or to Mexico (11 species). One of the criticisms levelled against the IUCN system of conservation evaluation is that it is too slow to keep up with taxonomic innovation (Johnson et al. 2015). Of the 11 endemic species listed in Table 15, eight have been described, resurrected from synonymy, or elevated from subspecies to species level in the present decade (i.e., *Chiropterotriton chico*, *Holcosus amphigrammus*, *Xenosaurus mendozai*, *X. tzacualtipantecus*, *Lampropeltis polyzona*, *Geophis lorancai*, *G. turbidus*, *Epictia wynni*, and *Ophryacus smaragdinus*). Of the 20 non-endemic species not yet assessed by the IUCN, all range into the United States, Central America or both. Clearly, a more rapidly-applied system of conservation assessment is needed, especially given the rate at which anthropogenic habitat modification and destruction occur. As with the DD categorized species, we believe that the EVS provides a means for allocating the NE species to IUCN categories. Thus, we suggest that species with an EVS of 17 or 18 should be placed in the CR category (*Chiropterotriton chico*, *Xenosaurus tzacualtipantecus*, and *Crotalus*

Table 14. Components of the Environmental Vulnerability Scores (EVS) for members of the herpetofauna of Hidalgo, Mexico, that are allocated to the IUCN Data Deficient category. * = country endemic; ** = state endemic.

Species	Environmental Vulnerability Score (EVS)			
	Geographic Distribution	Ecological Distribution	Reproductive Mode/Degree of Persecution	Total Score
<i>Geophis latifrontalis</i> *	5	7	2	14
<i>Hypsiglena tanzeri</i> *	5	8	2	15
<i>Rhadinaea gaigeae</i> *	5	5	2	12
<i>Rhadinaea quinquelineata</i> *	5	8	2	15

Herpetofauna of Hidalgo, Mexico

Table 15. Components of the Environmental Vulnerability Scores (EVS) for members of the herpetofauna of Hidalgo, Mexico, currently classified as Not Evaluated (NE) by the IUCN. Non-native taxa are excluded. * = country endemic; ** = state endemic.

Species	Environmental Vulnerability Score (EVS)			
	Geographic Distribution	Ecological Distribution	Reproductive Mode/Degree of Persecution	Total Score
<i>Rhinella horribilis</i>	1	1	1	3
<i>Chiropterotriton chico</i> **	6	8	4	18
<i>Norops laeiventris</i>	3	3	3	9
<i>Norops lemuringus</i>	3	2	3	8
<i>Norops petersii</i>	2	4	3	9
<i>Norops sericeus</i>	2	3	3	8
<i>Ctenosaura acanthura</i>	2	4	6	12
<i>Sceloporus cyanogenys</i> *	4	6	3	13
<i>Holcosus amphigrammus</i> *	5	3	3	11
<i>Xenosaurus mendozai</i> *	5	8	3	16
<i>Xenosaurus tzacualtipantecus</i> *	6	8	3	17
<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 annulata</i>	4	3	5	12
<i>Lampropeltis polyzona</i> *	1	3	5	9
<i>Oxybelis aeneus</i>	1	1	3	5
<i>Spilotes pullatus</i>	1	1	4	6
<i>Coniophanes fissidens</i>	1	3	3	7
<i>Geophis lorancai</i> *	5	7	2	14
<i>Geophis turbidus</i> *	5	8	2	15
<i>Hypsiglena jani</i>	1	3	2	6
<i>Imantodes cenchoa</i>	1	3	2	6
<i>Imantodes gemmistratus</i>	1	3	2	6
<i>Leptodeira septentrionalis</i>	2	2	4	8
<i>Sibon nebulatus</i>	1	2	2	5
<i>Epictia wynnii</i> *	5	7	1	13
<i>Bothrops asper</i>	3	4	5	12
<i>Crotalus totonacus</i>	5	7	5	17
<i>Ophryacus smaragdinus</i> *	3	6	5	14
<i>Terrapene mexicana</i> *	5	8	6	19
<i>Kinosternon scorpioides</i>	3	4	3	10

tononacus), those with an EVS of 15 or 16 in the EN category (*Xenosaurus mendozai* and *Geophis turbidus*), and those with an EVS of 13 or 14 in the VU category (*Sceloporus cyanogenys*, *Geophis lorancai*, *Epictia wynnii*, and *Ophryacus smaragdinus*). The three species with an EVS of 12 perhaps should be allocated to the NT category (*Ctenosaura acanthura*, *Lampropeltis annulata*, and *Bothrops asper*). The remaining species with EVS of 3 to 11 probably should be placed in the LC category.

Previous studies in the MCS series have demonstrated that the largest proportions of the herpetofaunal species found in any of the regions examined were allocated to the LC category by the IUCN. Such is also the case in this study of the Hidalgo herpetofauna. As noted above, 122 of the 200 native species (61.0%) are in this category (Table 16), 52 (42.6%) of which are country endemics. We believe it is unlikely that such a large proportion of these 122 species are really of “Least Concern.” Based on the same reasoning employed with the DD and NE species above, our opinion is that the species with an EVS

of 17 (*Agkistrodon taylori*) should be allocated to the CR category, those with an EVS of 15 or 16 (*Craugastor mexicanus*, *Sceloporus parvus*, *Lampropeltis mexicana*, *Salvadora bairdi*, *Thamnophis pulchrilatus*, *T. sumichrasti*, *Crotalus aquilus*, *C. intermedius*, *C. polystictus*, and *C. triseriatus*) to the EN category, and those with an EVS of 13 or 14 (*Lithobates montezumae*, *L. spectabilis*, *Crocodylus moreletii*, *Barisia imbricata*, *Gerrhonotus infernalis*, *Corytophanes hernandezii*, *Sceloporus aeneus*, *S. bicanthalis*, *S. minor*, *S. mucronatus*, *Lepidophyma occulor*, *Conopsis biserialis*, *C. lineata*, *Leptophis diplotropis*, *Masticophis schotti*, *Pantherophis emoryi*, *Pituophis deppei*, *Trimorphodon tau*, *Geophis mutitorques*, *G. semidoliatus*, *Rena dulcis*, *R. myopica*, *Thamnophis scalaris*, *Metlapilcoatlus nummifer*, and *Crotalus ravus*) to the VU category. Thus, these 31 species comprise 25.4% of the 122 LC species, leaving 91 species that likely should remain in the LC category, at least until more targeted surveys can be undertaken.

Table 16. Components of the Environmental Vulnerability Scores (EVS) for members of the herpetofauna of Hidalgo, Mexico, currently assigned to the IUCN Least Concern (LC) category. Non-native taxa are not included. * = country endemic.

Species	Environmental Vulnerability Score (EVS)			
	Geographic Distribution	Ecological Distribution	Reproductive Mode/Degree of Persecution	Total Score
<i>Anaxyrus punctatus</i>	1	3	1	5
<i>Incilius marmoreus</i> *	5	5	1	11
<i>Incilius nebulifer</i>	1	4	1	6
<i>Incilius occidentalis</i> *	5	5	1	11
<i>Incilius valliceps</i>	3	2	1	6
<i>Craugastor augusti</i>	2	2	4	8
<i>Craugastor mexicanus</i> *	5	7	4	16
<i>Eleutherodactylus cystignathoides</i>	2	6	4	12
<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>Dryophytes plicatus</i> *	5	5	1	11
<i>Sarcohyla bistrincta</i> *	5	3	1	9
<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 typhonius</i>	1	2	1	4
<i>Leptodactylus fragilis</i>	1	2	2	5
<i>Leptodactylus melanonotus</i>	1	3	2	6
<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>Rhinophrynus dorsalis</i>	2	5	1	8
<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>Crocodylus moreletii</i>	2	5	6	13
<i>Barisia imbricata</i> *	5	6	3	14
<i>Gerrhonotus infernalis</i>	5	5	3	13
<i>Gerrhonotus liocephalus</i>	2	1	3	6
<i>Gerrhonotus ophiurus</i> *	5	4	3	12
<i>Basiliscus vittatus</i>	1	3	3	7
<i>Corytophanes hernandezii</i>	4	6	3	13
<i>Laemactis serratus</i>	2	3	3	8
<i>Anelytropsis papillosus</i> *	5	4	1	10
<i>Coleonyx elegans</i>	2	3	4	9
<i>Phrynosoma orbiculare</i> *	5	4	3	12
<i>Sceloporus aeneus</i> *	5	5	3	13
<i>Sceloporus bicanthalis</i> *	5	5	3	13
<i>Sceloporus grammicus</i>	2	4	3	9
<i>Sceloporus minor</i> *	5	6	3	14
<i>Sceloporus mucronatus</i> *	5	5	3	13
<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 silvicola</i> *	5	4	3	12
<i>Aspidoscelis gularis</i>	2	4	3	9
<i>Lepidophyma flavimaculatum</i>	1	5	2	8
<i>Lepidophyma oculor</i> *	5	7	2	14
<i>Lepidophyma sylvaticum</i> *	5	4	2	11
<i>Coluber constrictor</i>	1	6	3	10
<i>Conopsis biserialis</i> *	5	6	2	13

Herpetofauna of Hidalgo, Mexico

Table 16 (continued). Components of the Environmental Vulnerability Scores (EVS) for members of the herpetofauna of Hidalgo, Mexico, currently assigned to the IUCN Least Concern (LC) category. Non-native taxa are not included. * = country endemic.

Species	Environmental Vulnerability Score (EVS)			
	Geographic Distribution	Ecological Distribution	Reproductive Mode/Degree of Persecution	Total Score
<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>Drymobius chloroticus</i>	1	3	4	8
<i>Ficimia streckeri</i> *	3	7	2	12
<i>Lampropeltis mexicana</i> *	5	7	3	15
<i>Leptophis diplotropis</i> *	5	5	4	14
<i>Leptophis mexicanus</i>	1	1	4	6
<i>Masticophis flagellum</i>	1	3	4	8
<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>Pantherophis emoryi</i>	3	6	4	13
<i>Pituophis catenifer</i>	4	1	4	9
<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 imperialis</i>	2	3	3	8
<i>Coniophanes piceivittis</i>	1	3	3	7
<i>Diadophis punctatus</i>	1	1	2	4
<i>Geophis mutitorques</i> *	5	6	2	13
<i>Geophis semidoliatus</i> *	5	6	2	13
<i>Leptodeira maculata</i>	2	1	4	7
<i>Ninia diademata</i>	4	3	2	9
<i>Pliocercus elapoides</i>	4	1	5	10
<i>Rhadinaea decorata</i>	1	6	2	9
<i>Rhadinaea hesperia</i>	5	3	2	10
<i>Tropidodipsas sartorii</i>	2	2	5	9
<i>Micrurus diastema</i>	2	1	5	8
<i>Micrurus tener</i>	1	5	5	11
<i>Rena dulcis</i>	4	8	1	13
<i>Rena myopica</i> *	5	7	1	13
<i>Nerodia rhombifer</i>	1	5	4	10
<i>Storeria dekayi</i>	1	4	2	7
<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 marcianus</i>	1	5	4	10
<i>Thamnophis proximus</i>	1	2	4	7
<i>Thamnophis pulchrlatus</i> *	5	6	4	15
<i>Thamnophis scalaris</i> *	5	5	4	14
<i>Thamnophis sumichrasti</i> *	5	6	4	15
<i>Scaphiodontophis annulatus</i>	1	5	5	11
<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 intermedius</i> *	5	5	5	15
<i>Crotalus molossus</i>	2	1	5	8
<i>Crotalus polystictus</i> *	5	6	5	16
<i>Crotalus ravus</i> *	5	4	5	14
<i>Crotalus scutulatus</i>	2	4	5	11
<i>Crotalus triseriatus</i> *	5	6	5	16
<i>Metlapilcoatlus nummifer</i> *	5	3	5	13
<i>Kinosternon hirtipes</i>	2	5	3	10
<i>Kinosternon integrum</i> *	5	3	3	11

Table 17. Number of herpetofaunal species in the four distributional status categories among the four physiographic regions of Hidalgo, Mexico. Rank Order is determined by adding the numbers of Country Endemics and State Endemics.

Physiographic Region	Distributional Status Category				Total	Rank Order
	Non-endemics	Country Endemics	State Endemics	Non-natives		
Sierra Madre Oriental	74	90	1	1	166	1
Trans-Mexican Volcanic Belt	20	59	4	2	84	2
Mexican Plateau	27	49	2	1	79	3
Gulf Coastal Lowlands	60	31	—	2	93	4

Relative Herpetofaunal Priority

Johnson et al. (2015a) developed the concept of Relative Herpetofaunal Priority (RHP), a simple metric 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) calculation of the proportion of state and country endemics as related to the entire physiographic regional herpetofauna, and (2) computation of the absolute number of high EVS category species in each physiographic regional herpetofauna. The pertinent data for these two methods are shown in Tables 17 and 18.

Based on the relative number of country and state endemic species in each physiographic region and the rank the regions occupy, the SMO region occupies rank 1, with 91 endemics out of a total of 166 species (54.8%, Table 17). The other ranks are as follows: second = TMV (63 of 84; 75.0%); third = MXP (51 of 79; 64.6%); and fourth = GCL (31 of 93; 33.3%).

The data in Table 18 indicate that the rank ordering of the four physiographic regions is the same as that documented in Table 17. Based on the relative numbers of high vulnerability species, the SMO region again holds rank 1, with 47 high vulnerability species of a total of 166 species (28.3%). The other ranks are as follows: second = TMV (29 of 82; 35.4%); third = MXP (23 of 77; 29.9%); and fourth = GCL (15 of 91; 16.5%).

Based on the RHP analysis (Tables 17 and 18), the most important physiographic region from a conservation standpoint is clearly the SMO, because it harbors by far the largest number of country and state endemics and the greatest number of high vulnerability species. The 91 endemic species comprise 20 anurans (all country endemics), 11 salamanders (eight country endemics and three state endemics), 57 squamates (all country endemics), and three turtles (all country endemics). These 91 species are indicated in Table 4 with either

single or double asterisks. The SMO also contains 47 high vulnerability species, including seven anurans, nine salamanders, 29 squamates, and two turtles. These 47 species and their respective EVS values are as follows:

- Craugastor decoratus** (15)
- Craugastor rhodopis** (14)
- Eleutherodactylus longipes** (15)
- Eleutherodactylus verrucipes** (16)
- Bromeliohyala dendrocarta** (17)
- Sarcophyla charadricola** (14)
- Lithobates johni** (14)
- Aquiloerycea cephalica** (14)
- Chiropterotriton arboreus** (18)
- Chiropterotriton chondrostega** (17)
- Chiropterotriton dimidiatus** (17)
- Chiropterotriton mosaueri*** (18)
- Chiropterotriton multidentatus** (15)
- Chiropterotriton terrestris** (18)
- Isthmura gigantea** (16)
- Pseudoeurycea leprosa** (16)
- Abronia taeniata** (15)
- Barisia imbricata** (14)
- Sceloporus megalepidurus** (14)
- Sceloporus minor** (14)
- Sceloporus parvus** (15)
- Lepidophyma occulor** (14)
- Xenosaurus mendozai** (16)
- Xenosaurus newmanorum** (15)
- Xenosaurus tzacualtipantecus** (16)
- Lampropeltis mexicana** (15)
- Pituophis deppei** (14)
- Salvadora bairdi** (15)
- Chersodromus rubriventris** (14)
- Geophis latifrontalis** (14)
- Geophis lorancai** (14)
- Geophis turbidus** (15)
- Hypsigena tanzeri** (15)
- Rhadinaea quinque-lineata** (15)

Table 18. Number of herpetofaunal species in the three EVS categories among the four physiographic regions of Hidalgo, Mexico. Rank Order is determined by the relative number of High EVS species. Non-native species are excluded.

Physiographic Region	Low EVS	Medium EVS	High EVS	Total	Rank Order
Sierra Madre Oriental	58	60	47	165	1
Trans-Mexican Volcanic Belt	17	36	29	82	2
Mexican Plateau	21	33	23	77	3
Gulf Coastal Lowlands	43	33	15	91	4

*Thamnophis melanogaster** (15)
*Thamnophis scalaris** (14)
*Thamnophis sumichrasti** (15)
*Agkistrodon taylori** (17)
*Crotalus aquilus** (16)
*Crotalus intermedius** (15)
*Crotalus polystictus** (16)
*Crotalus ravus** (14)
*Crotalus totonacus** (17)
*Crotalus triseriatus** (16)
*Ophryacus smaragdinus** (14)
*Terrapene mexicana** (19)
*Kinosternon herrerai** (14)

Of these 47 species, 46 are country endemics and one is a state endemic; their EVS values range from 14 to 19.

The TMV region occupies the second RHP rank, with 63 country and state endemics (Table 17), including 12 anurans (all country endemics), 14 salamanders (10 country endemics and four state endemics), 36 squamates (all country endemics), and one turtle (a state endemic; Table 4). This region also harbors 29 high vulnerability species (Table 18), including the following two anurans, 12 salamanders, and 15 squamates:

*Eleutherodactylus longipes** (15)
*Eleutherodactylus verrucipes** (16)
*Aquiloerycea cephalica** (14)
*Chiropterotriton arboreus** (18)
*Chiropterotriton chico*** (18)
*Chiropterotriton chiropterus** (16)
*Chiropterotriton chondrostega** (17)
*Chiropterotriton dimidiatus** (17)
*Chiropterotriton magnipes** (16)
*Chiropterotriton mosaueri*** (18)
*Chiropterotriton multidentatus** (15)
*Chiropterotriton terrestris** (18)
*Pseudoeurycea altamontana** (17)
*Pseudoeurycea leprosa** (16)
*Abronia taeniata** (15)
*Barisia imbricata** (14)
*Sceloporus megalepidurus** (14)
*Sceloporus minor** (14)
*Lampropeltis ruthveni** (16)
*Pituophis deppei** (14)
*Rhadinaea quinquelineata** (15)
*Thamnophis pulchrilatus** (15)
*Thamnophis scalaris** (14)
*Thamnophis scaliger** (15)
*Crotalus aquilus** (16)
*Crotalus intermedius** (15)
*Crotalus polystictus** (16)
*Crotalus ravus** (14)
*Crotalus triseriatus** (16)

Twenty-seven of these species are country endemics and the other two are state endemics, and their EVS vary from 14 to 18.

The Mexican Plateau occupies rank three, with 51 country and state endemic species (Table 17), including 10 anurans (all country endemics), seven salamanders (five country endemics and two state endemics), 33 squamates (all country endemics), and one turtle (a country endemic; Table 4). The region also contains 23 high vulnerability species (Table 18), including the following one anuran, five salamanders, and 17 squamates:

*Sarcohyala charadricola** (14)
*Chiropterotriton chiropterus** (16)
*Chiropterotriton dimidiatus*** (17)
*Chiropterotriton mosaueri*** (18)
*Chiropterotriton multidentatus** (15)
*Pseudoeurycea leprosa** (16)
*Abronia taeniata** (15)
*Barisia imbricata** (14)
*Sceloporus megalepidurus** (14)
*Sceloporus minor** (14)
*Sceloporus parvus** (15)
*Lampropeltis mexicana** (15)
*Lampropeltis ruthveni** (16)
*Pituophis deppei** (14)
*Salvadora bairdi** (15)
*Rhadinaea quinquelineata** (15)
*Thamnophis melanogaster** (15)
*Thamnophis scaliger** (15)
*Thamnophis sumichrasti** (15)
*Crotalus aquilus** (16)
*Crotalus polystictus** (16)
*Crotalus ravus** (14)
*Crotalus triseriatus** (16)

Twenty-one of these species are country endemics and the other two are state endemics, and their EVS vary from 14 to 18.

The region occupying the fourth rank is the Gulf Coastal Lowlands, which contains 31 country endemic species (Table 17), including eight anurans (all country endemics), one salamander (a country endemic), 22 squamates (all country endemics), and one turtle (a country endemic; Table 4). This region also harbors 15 high vulnerability species (Table 18), including the following five anurans, one salamander, seven squamates, and two turtles:

*Craugastor berkenbuschii** (14)
*Craugastor decoratus** (15)
*Craugastor rhodopis** (14)
*Bromeliohyala dendroscarta** (17)
*Lithobates johni** (14)
*Bolitoglossa platydactyla** (15)
*Lepidophyma occulor** (14)
*Leptophis diplotropis** (14)
*Chersodromus rubriventris** (14)
*Rhadinaea quinquelineata** (15)
*Thamnophis pulchrilatus** (15)
*Agkistrodon taylori** (17)



No. 33. *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 near Nopalillo, in the municipality of Singuilucan. Wilson (2013a) ascertained its EVS as 16, placing it in the middle portion of the high vulnerability category. It is allocated to the Least Concern category by the IUCN, and is placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Cristian Raúl Olvera-Olvera.*



No. 34. *Crotalus atrox* Baird and Girard 1853. The Western Diamond-backed Rattlesnake is broadly distributed in the United States and in Mexico. “In the United States, the distribution...extends from Arkansas and north-central Oklahoma westward to southeastern California and southward through parts of Arizona, New Mexico, and much of Texas. In Mexico, this species ranges from northeastern Baja California through Sonora and northern Sinaloa, across most of Chihuahua except for the Sierra Madre Occidental, throughout Coahuila, Nuevo León, and Tamaulipas, and in the northeastern parts of Durango and Zacatecas. It also occurs in Hidalgo and Querétaro, and in parts of central and eastern San Luis Potosí, as well as in extreme northern Veracruz” (Lemos-Espinal and Dixon 2013: 250). This individual was found at Rancho Alegre, in the municipality of San Agustín Metzquitlán. Wilson et al. (2013a) calculated its EVS as 9, placing it at the upper limit of the low vulnerability category. Its conservation status has been evaluated as Least Concern by the IUCN, and it is allocated to the Special Protection (Pr) category by SEMARNAT. *Photo by Cristian Raúl Olvera-Olvera.*



No. 35. *Crotalus intermedius* Troschel 1865. The Mexican Small-headed Rattlesnake is distributed in “several disjunct populations...in the central and southern highland region of Mexico” (Campbell and Lamar 2004: 553). This individual was found in El Encinal in the municipality of Singuilucan. Wilson et al. (2013b) calculated its EVS as 15, placing it in the lower portion of the high vulnerability category, the IUCN has assessed it as Least Concern, and SEMARNAT listed this rattlesnake as Threatened (A). *Photo by Ferdinand Torres-Angeles.*



No. 36. *Crotalus ravus* Cope 1865. The Mexican Pygmy Rattlesnake is distributed in “temperate montane regions of south-central Mexico” (Heimes 2016: 463). This individual was found at Cerro Hihuingo in the municipality of Tepeapulco. Wilson et al. (2013b) calculated its EVS as 14, placing it at the lower limit of the high vulnerability category, the IUCN has evaluated it as Least Concern, and SEMARNAT lists this rattlesnake as Threatened (A). *Photo by Christian Berriozabal-Islas.*

Table 19. Characteristics of Natural Protected Areas in Hidalgo, Mexico. Abbreviations for **Facilities available** 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
Barranca de Metztlán	Reserva de la Biosfera	27-11-2000	96,042.9	Acatlán, Atotonilco El Grande, Eloxochitlán, Huasca de Ocampo, Meztlán, San Agustín Metzquitlán, Metepec, Zacualtipán de Ángeles, El Cardonal	Mexican Federal Government	Trans-Mexican Volcanic Belt	A, R	Yes	Yes	Yes
Cuenca Hidrográfica del Río Necaxa	APRN	20-10-1938	42,129.4	Acaxochitlán, Cuauhtepc de Hinojosa	Mexican Federal Government	Gulf Coastal Lowlands	A, S, V	Yes	Yes	No
El Chico	PN	06-07-1982	2,739.0	Mineral del Chico, Mineral del Monte y Pachuca de Soto	Mexican Federal Government	Transmexican Volcanic Belt	A, R, S, V	Yes	Yes	Yes
Los Mármoles	PN	08-09-1936	23,150.0	Pacula, Jacala de Ledezma, Zimapán y Nicolás Flores	Mexican Federal Government	Transmexican Volcanic Belt	A, R, V	Yes	Yes	No
Tula	PN	27-05-1981	99.5	Tula de Allende	Mexican Federal Government	Transmexican Volcanic Belt	A, R, S, V	Yes	No	No

- Crotalus totonacus** (17)
- Trachemys venusta* (19)
- Kinosternon herrerai** (14)

Fourteen of these species are country endemics and the other one is a non-endemic, and their EVS range from 14 to 19.

Fifty-eight members of the Hidalgo herpetofauna are allocated to the high vulnerability category (Table 12), thus the proportion of these species recorded in the four physiographic regions are as follows: SMO (81.0%); TMV (52.7%); MXP (41.8%); and GCL (27.3%). These data should figure prominently in conservation management plans for the state.

Protected Areas in Hidalgo

Generally, the purpose of natural protected areas is to allow for the continued functioning of ecosystem services that are dependent on the interactions among the components of the atmosphere, hydrosphere, lithosphere, and biosphere. Thus, the protected areas that do the best job of guarding ecosystem services are those left in a state that is as close to a natural state as possible (Ervin 2003; Gaston et al. 2008). Unfortunately, in a world overrun by populations of the principal invasive species, *Homo sapiens*, areas can be maintained in a natural state only if they are overseen by professional conservation managers who are assigned to legally constituted protected areas.

In an effort to assess the state of Hidalgo’s protected areas, a variety of data on these areas was assembled (Table 19). The number of these protected areas in Hidalgo is relatively small (five) compared to, for example, the 14 found in the adjacent state of Puebla (Woolrich-Piña et al. 2017). These five areas are all administered by the Mexican federal government and include a biosphere reserve, an Area of Protection of Natural Resources, and three national parks (Table 19). The five areas range in size from 99.5 to 96,042.9 ha. The total area is 164,160.8 ha or 1,641.6 km², which is 7.9% of the area of the state (20,813 km²; <http://cuentame.inegi.org.mx/monografias/informacion/hgo/>). They were established during the period of 1936 to 2000.

The representation of these areas among the four physiographic regions is skewed heavily toward the Trans-Mexican Volcanic Belt; inasmuch as four of the five areas are located in this region, while the other area is found within the Gulf Coastal Lowlands. Thus, there is no representation within the Mexican Plateau or the Sierra Madre Oriental. This fact has major consequences for the protection of the herpetofauna of Hidalgo, especially since the Sierra Madre Oriental is shown above to be the most significant region in Hidalgo for the herpetofauna, due to the presence of high numbers of endemic and high vulnerability species.

Considering the range of facilities available in these protected areas, only two of them have a full range (as

Table 20. Distribution of herpetofaunal species in Natural Protected Areas of Hidalgo, Mexico, based on herpetofaunal surveys. * = species endemic to Mexico; ** = species endemic to Hidalgo; and *** = non-native species.

Taxa	Natural Protected Areas				
	Barranca de Metztitlán	Cuenca Hidrográfica del Río Necaxa	El Chico	Los Mármoles	Tula
Anura (15 species)					
Bufonidae (3 species)					
<i>Incilius occidentalis</i> *		+			
<i>Incilius valliceps</i>	+			+	
<i>Rhinella horribilis</i>	+			+	
Craugastoridae (2 species)					
<i>Craugastor augusti</i>	+			+	
<i>Craugastor rhodopis</i> *		+			
Eleutherodactylidae (1 species)					
<i>Eleutherodactylus verrucipes</i> *				+	
Hylidae (6 species)					
<i>Charadrahyla taeniopus</i> *		+			
<i>Dryophytes arenicolor</i>		+		+	
<i>Dryophytes euphorbiaceus</i> *		+			
<i>Dryophytes eximius</i> *	+	+	+	+	
<i>Dryophytes plicatus</i> *			+	+	
<i>Rheohyla miotympanum</i> *	+	+		+	
Ranidae (2 species)					
<i>Lithobates berlandieri</i>	+			+	+
<i>Lithobates spectabilis</i> *		+	+	+	+
Scaphiopodidae (1 species)					
<i>Spea multiplicata</i>	+			+	
Caudata (8 species)					
Ambystomatidae (1 species)					
<i>Ambystoma velasci</i> *		+	+		
Plethodontidae (7 species)					
<i>Aquiloerycea cephalica</i> *			+	+	
<i>Chiropterotriton chondrostega</i> *		+		+	
<i>Chiropterotriton dimidiatus</i> **			+		
<i>Chiropterotriton mosaueri</i> **				+	
<i>Chiropterotriton multidentatus</i> *			+		
<i>Isthmura bellii</i> *				+	
<i>Pseudoerycea altamontana</i> *			+		
Squamata (54 species)					
Anguidae (5 species)					
<i>Abronia taeniata</i> *			+	+	
<i>Barisia imbricata</i> *		+	+	+	+
<i>Gerrhonotus infernalis</i>	+				
<i>Gerrhonotus liocephalus</i>					+

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Table 20 (continued). Distribution of herpetofaunal species in Natural Protected Areas of Hidalgo, Mexico, based on herpetofaunal surveys. * = species endemic to Mexico; ** = species endemic to Hidalgo; and *** = non-native species.

Taxa	Natural Protected Areas				
	Barranca de Metztitlán	Cuenca Hidrográfica del Río Necaxa	El Chico	Los Mármoles	Tula
<i>Gerrhonotus ophiurus</i> *				+	
Phrynosomatidae (10 species)					
<i>Phrynosoma orbiculare</i> *	+	+	+	+	+
<i>Sceloporus aeneus</i> *		+			
<i>Sceloporus bicanthalis</i> *			+		
<i>Sceloporus grammicus</i>	+	+	+	+	+
<i>Sceloporus minor</i> *	+			+	
<i>Sceloporus mucronatus</i> *	+	+	+		+
<i>Sceloporus parvus</i> *	+			+	
<i>Sceloporus spinosus</i> *	+		+	+	+
<i>Sceloporus torquatus</i> *	+			+	
<i>Sceloporus variabilis</i>	+	+		+	
Scincidae (1 species)					
<i>Plestiodon lynxe</i> *	+	+	+	+	
Sphenomorphidae (1 species)					
<i>Scincella gemmingeri</i> *	+	+			
Teiidae (1 species)					
<i>Aspidoscelis gularis</i>	+			+	
Xantusiidae (2 species)					
<i>Lepidophyma gaigeae</i> *				+	
<i>Lepidophyma occulor</i> *	+				
Colubridae (10 species)					
<i>Conopsis biserialis</i> *					
<i>Conopsis lineata</i> *	+		+	+	+
<i>Drymarchon melanurus</i>	+				
<i>Ficimia hardyi</i> *				+	
<i>Masticophis schotti</i>				+	
<i>Pantherophis emoryi</i>				+	
<i>Pituophis deppei</i> *		+	+	+	+
<i>Salvadora bairdi</i> *				+	+
<i>Senticolis triaspis</i>	+				
<i>Trimorphodon tau</i> *	+				
Dipsadidae (7 species)					
<i>Coniophanes fissidens</i>		+			
<i>Diadophis punctatus</i>		+		+	+
<i>Geophis mutitorques</i> *		+		+	
<i>Geophis semidoliatus</i> *	+		+	+	
<i>Hypsiglena tanzeri</i> *	+				

Table 20 (continued). Distribution of herpetofaunal species in Natural Protected Areas of Hidalgo, Mexico, based on herpetofaunal surveys. * = species endemic to Mexico; ** = species endemic to Hidalgo; and *** = non-native species.

Taxa	Natural Protected Areas				
	Barranca de Metztitlán	Cuenca Hidrográfica del Río Necaxa	El Chico	Los Mármoles	Tula
<i>Leptodeira septentrionalis</i>	+				
<i>Rhadinaea gaigeae</i> *			+	+	
Elapidae (1 species)					
<i>Micrurus tener</i>	+				
Leptotyphlopidae (1 species)					
<i>Rena myopica</i> *	+				
Natricidae (10 species)					
<i>Nerodia rhombifer</i>	+				
<i>Storeria hidalgoensis</i> *				+	
<i>Storeria storerioides</i> *		+			
<i>Thamnophis cyrtopsis</i>	+				
<i>Thamnophis eques</i>		+			
<i>Thamnophis proximus</i>	+				
<i>Thamnophis pulchrilatus</i> *			+		
<i>Thamnophis scalaris</i> *		+			
<i>Thamnophis scaliger</i> *		+			
<i>Thamnophis sumichrasti</i> *		+			
Viperidae (5 species)					
<i>Crotalus aquilus</i> *			+	+	+
<i>Crotalus atrox</i>	+			+	
<i>Crotalus molossus</i>	+			+	
<i>Crotalus triseriatus</i> *	+	+		+	
<i>Ophryacus smaragdinus</i> *		+			
Testudines (1 species)					
Kinosternidae (1 species)					
<i>Kinosternon integrum</i> *				+	
Total (78 species)	35	29	22	44	13

indicated in Table 19). A major problem with all of these five areas is that some amount of each is occupied by landowners. Fortunately, however, management plans are available for four of the five areas.

Herpetofaunal surveys have been completed for only two of the five areas, so obviously surveys need to be completed for the remaining three. Even though surveys are incomplete for the protected areas in Hidalgo, the available information on the distribution status of species known to occur in each of these areas have been collated, and are shown in Table 20 and summarized in Table 21.

Of the 200 native species that make up the herpetofauna of Hidalgo, only 78 (39.2%) have been recorded from the five areas combined. The numbers of species recorded from these areas range from 13 in

Parque Nacional Tula to 44 in Parque Nacional Los Mármoles. Of the 103 country endemic species known from Hidalgo, 51 (49.5%) are found in the five areas combined. Of the 92 non-endemic species in the country, only 25 (27.2%) are recorded for these areas. Two of the four state endemic species (50.0%) are documented for only two of the five areas (Parques Nacionales El Chico and Los Mármoles). Finally, on the positive side, none of the three non-native species has been recorded in any of the protected areas. These data demonstrate that completion of herpetofaunal surveys will be a major step toward assessing the conservation needs of the Hidalgo herpetofauna.

Of the 122 native species not found in any of the five protected areas, 53 are country endemics, two are

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Table 21. Summary of the distributional status of herpetofaunal species in Protected Areas in Hidalgo, 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)	State Endemic (SE)	Non-native (NN)
RB Barranca de Metztlán	35	18	17	—	—
APRN Cuenca Hidrográfica del Río Necaxa	29	6	23	—	—
PN El Chico	22	1	21	—	—
PN Los Mármoles	44	14	29	1	—
PN Tula	13	3	10	—	—
Total	78	25	51	2	—

state endemics, and 67 are non-endemics. The 53 country endemics not recorded in any of the protected areas are:

Incilius marmoreus
Craugastor berkenbuschii
Craugastor decoratus
Craugastor mexicanus
Eleutherodactylus longipes
Eleutherodactylus nitidus
Bromelohyla dendroscarta
Sarcohyla arborescandens
Sarcohyla bistincta
Sarcohyla charadricola
Sarcohyla robertsorum
Lithobates johnei
Lithobates montezumae
Bolitoglossa platydactyla
Chiropterotriton arboreus
Chiropterotriton chiropterus
Chiropterotriton magnipes
Isthmura gigantea
Pseudoeurycea leprosa
Norops naufragus
Anelytropsis papillosus
Sceloporus megalepidurus
Sceloporus scalaris
Scincella silvicola
Holcosus amphigrammus
Lepidophyma sylvaticum
Xenosaurus mendozai
Xenosaurus newmanorum
Xenosaurus tzacualtipantecus
Conopsis nasus
Ficimia olivacea
Lampropeltis mexicana
Lampropeltis polyzona
Lampropeltis ruthveni
Leptophis diplotropis
Tantilla bocourti
Chersodromus rubriventris
Geophis latifrontalis
Geophis lorancai
Geophis turbidus
Rhadinaea hesperia
Rhadinaea marcellae

Rhadinaea quinquelineata
Epictia wynnii
Thamnophis melanogaster
Agkistrodon taylori
Crotalus intermedius
Crotalus polystictus
Crotalus ravus
Crotalus totonacus
Metlapilcoatlus nummifer
Terrapene mexicana
Kinosternon herrerai

The two unrecorded state endemics are:

Chiropterotriton chico
Chiropterotriton terrestris

The 67 non-endemics are:

Anaxyrus punctatus
Incilius nebulifer
Eleutherodactylus cystignathoides
Eleutherodactylus guttillatus
Scinax staufferi
Smilisca baudinii
Tlalocohyla picta
Trachycephalus vermiculatus
Leptodactylus fragilis
Leptodactylus melanonotus
Hypopachus variolosus
Rhinophrynus dorsalis
Scaphiopus couchii
Notophthalmus meridionalis
Crocodylus moreletii
Basiliscus vittatus
Corytophanes hernandezii
Laemanctus serratus
Norops laeviventris
Norops lemuringus
Norops petersii
Norops sericeus
Coleonyx elegans
Ctenosaura acanthura
Sceloporus cyanogenys
Sceloporus serrifer



No. 37. *Crotalus scutulatus* Kennicott 1861. The Mohave Rattlesnake occurs “from the Mohave Desert to northern Sonora, and from extreme southern New Mexico and the Big Bend region of Texas southward across the Mexican Plateau to its southern edge” (Heimes 2016: 467). This individual was found San José Atlán, in the municipality of Nopala. Wilson et al. (2013b) calculated its EVS as 11, placing it in the lower portion of the medium vulnerability category, the IUCN assessed it as Least Concern, and SEMARNAT lists this rattlesnake under the category of Special Protection (Pr). *Photo by Christian Berriozabal-Islas.*



No. 38. *Crotalus triseriatus* (Wagler 1830). The Central Plateau Dusky Rattlesnake is distributed in Aguascalientes, Ciudad de México, Durango, Estado de México, Guanajuato, Guerrero, Hidalgo, Michoacán, Morelos, Nayarit, Puebla, Querétaro, San Luis Potosí, Tamaulipas, Tlaxcala, Veracruz, and Zacatecas (Ramírez-Bautista et al. 2014). This individual was secured at Los Reyes, in the municipality of Acaxochitlan. Wilson et al. (2013a) estimated its EVS as 16, placing it in the middle portion of the high vulnerability category. Its conservation status is evaluated as Least Concern by the IUCN, but this species is not listed by SEMARNAT. *Photo by Ferdinand Torres-Angeles.*



No. 39. *Ophryacus smaragdinus* Grünwald, Jones, Franz-Chávez, and Ahumada-Carillo 2015. The Emerald Horned Viper is known from “east-central Hidalgo, west-central Veracruz, northeastern Puebla, and north-central Oaxaca” (Grünwald et al. 2015: 398). This individual was located at Santa Catarina, in the municipality of Tenango de Doria. Woolrich et al. (2017) indicated its EVS to be 14, placing it at the lower limit of the high vulnerability category. Its conservation status has not been determined by the IUCN and this species is not listed by SEMARNAT. *Photo by Ferdinand Torres-Angeles.*



No. 40. *Kinosternon herrerae* (Stejneger, 1925). Herrera's Mud Turtle is distributed “in east-central Mexico, in southern Tamaulipas, eastern San Luis Potosí, northern Veracruz, Hidalgo, and Puebla” (Lemos-Espinal and Dixon 2013: 84). This individual was found at Laguna de Atezca, in the municipality of Molango de Escamilla. Wilson et al. (2013a) calculated its EVS as 14, placing it at the lower limit of the high vulnerability category. Its conservation status has been considered as Near Threatened by the IUCN, and is placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Christian Berriozabal-Islas.*

Plestiodon tetragrammus
Lepidophyma flavimaculatum
Boa imperator
Coluber constrictor
Drymobius chloroticus
Drymobius margaritiferus
Ficimia streckeri
Lampropeltis annulata
Leptophis mexicanus
Masticophis flagellum
Masticophis mentovarius
Mastigodryas melanolomus
Oxybelis aeneus
Pituophis catenifer
Pseudoelaphe flavirufa
Salvadora grahamiae
Spilotes pullatus
Tantilla rubra
Adelphicos quadrivirgatum
Amastridium sapperi
Coniophanes imperialis
Coniophanes piceivittis
Hypsiglena jani
Imantodes cenchoa
Imantodes gemmistratus
Leptodeira maculata
Ninia diademata
Pliocercus elapoides
Rhadinaea decorata
Sibon nebulatus
Tropidodipsas sartorii
Micrurus diastema
Rena dulcis
Storeria dekayi
Thamnophis marcianus
Scaphiodontophis annulatus
Bothrops asper
Crotalus scutulatus
Trachemys venusta
Kinosternon hirtipes
Kinosternon scorpioides

Clearly, a major conservation goal regarding the Hidalgo herpetofauna is to document the occurrence of these 122 species, which comprise 61.0% of the native herpetofauna, in one or more of the extant protected areas in the state, as well as determining what other areas could be designated in order to provide perpetual protection for the entire herpetofauna. Based on the distributions noted above, it is likely that such additional areas would need to be established in the Sierra Madre Oriental and the Mexican Plateau regions of the state.

Conclusions and Recommendations

Conclusions

A. Currently the herpetofauna of Hidalgo consists of 203 species, including 42 anurans, 17 salamanders, one Amphib. Reptile Conserv.

crocodilian, 137 squamates (44 lizards and 92 snakes), and six turtles.

B. The four physiographic regions recognized in Hidalgo harbor from 77 species in the Mexican Plateau to 166 in the Sierra Madre Oriental.

C. The number of species that are shared among physiographic regions varies from 13 between the Trans-Mexican Volcanic Belt and the Gulf Coastal Lowlands to 72 between the Sierra Madre Oriental and the Gulf Coastal Lowlands. The Coefficient of Biogeographic Resemblance values range from 0.14 between the Trans-Mexican Volcanic Belt and the Gulf Coastal Lowlands to 0.65 between the Mexican Plateau and the Trans-Mexican Volcanic Belt. The UPGMA dendrogram depicts two distinct clusters; one between the Mexican Plateau and Trans-Mexican Volcanic Belt (two montane regions), and another between the mountainous Sierra Madre Oriental and Gulf Coastal Lowlands. That the latter two regions cluster is predicated on them sharing a significant number of generalist species that typically occur on the Atlantic/Gulf versant from the southern USA, through Mexico and Central America, and into northern South America.

D. The level of herpetofaunal endemism in Hidalgo is relatively high. Of the 200 species making up the native herpetofauna, 108 (54.0%) are endemic to either the country of Mexico or the state of Hidalgo. Most of the endemic species are country endemics (104 or 96.3%), while only four are limited to the state of Hidalgo. All four of the state endemics are plethodontid salamanders of the genus *Chiropterotriton*.

E. The distribution status of the 203 species comprising the Hidalgo herpetofauna is as follows (in order of decreasing species numbers): country endemics (104; 51.2%); non-endemics (92; 45.3%); state endemics (four; 2.0%); and non-natives (three; 1.5%).

F. The principal environmental threats are deforestation, livestock, roads, pollution of water bodies, myths and other cultural factors, and diseases.

G. The conservation status of the Hidalgo herpetofauna was assessed using the SEMARNAT, IUCN, and EVS systems. As in prior MCS papers, the SEMARNAT system was found to be of minimal value, inasmuch as only 93 (46.5%) of the 200 native species have been evaluated by this system. Of the 93 species presently assessed, two are considered Endangered (P), 32 Threatened (A), and 59 Special Protection (Pr). A comparison of the SEMARNAT and distributional categorizations indicates that one of the two Endangered species is a non-endemic and the other is a country endemic species. Of the 32 Threatened species, nine are non-endemics and 23 are country endemics. Of the 59 Special Protection species,



No. 41. *Kinosternon integrum* LeConte, 1854. The Mexican Mud Turtle ranges from “central Sonora to the Río Verde in Oaxaca, but it also is widespread throughout the central and southern portion of the Mexican Plateau (Lemos-Espinal and Dixon 2013: 86–87). This individual was found in the Valle del Mezquital, in the municipality of Alfajayucan. Wilson et al. (2013a) determined its EVS as 11, placing it in the lower portion of the middle vulnerability category. Its conservation status has been ascertained as Least Concern by the IUCN, and it is placed in the Special Protection (Pr) category by SEMARNAT. *Photo by Christian Berriozabal-Islas.*

21 are non-endemics, 36 are country endemics, and two are state endemics.

H. The results of the IUCN assessment system (by category and proportion) are: CR (seven of 200 species; 3.5%); EN (14; 7.0%); VU (14; 7.0%); NT (seven; 3.5%); LC (122; 61.0%); DD (four; 2.0%); and NE (32; 16.0%).

I. In addition, application of the EVS system of conservation assessment to the 200 native species of Hidalgo, showed that the categorical values increase from low vulnerability (66 species; 33.0%) to medium (76; 38.0%), and then decrease to high vulnerability (58; 29.0%).

J. Comparing IUCN and EVS conservation status categorizations to one another showed that 60.3% of the EVS high vulnerability species are placed in one of the three IUCN threatened categories (CR, EN, or VU), and 54.1% of the low vulnerability species are in the LC category. As noted previously for other areas, the results of the application of these two conservation assessment systems to the Hidalgo herpetofauna do not correspond well with one another.

K. An examination of the conservation status of the species placed in the IUCN DD, NE, and LC categories demonstrates that many of these 158 species (79.0% of the 200 native species) have been evaluated inadequately compared to their respective EVS values, so we highly recommend these species be reevaluated to better indicate their prospects for survival.

L. The Relative Herpetofaunal Priority (RHP) measure was used to ascertain the conservation significance of

the four regional herpetofaunas in Hidalgo. This analysis indicates that the most significant regional herpetofauna is that of the Sierra Madre Oriental, as it contains the largest numbers of endemic species and high vulnerability species. The other three physiographic regions arranged in decreasing order of significance based on numbers of both endemic and high vulnerability species are: Trans-Mexican Volcanic Belt; Mexican Plateau; and Gulf Coastal Lowlands.

M. Only five protected areas are established in Hidalgo, all administered by the federal government. Collectively, the size of these areas comprises only 7.9% of the area of the state. Four of these five areas are located in the Trans-Mexican Volcanic Belt, which is only the second most significant physiographic region in the state. None of the areas is located in the Sierra Madre Oriental, which is by far the most significant region, based on the numbers of both endemic and high vulnerability species. Only two of the five areas feature the full array of necessary facilities. In addition, all five areas are occupied by landowners. Management plans, however, are available for four of the five areas. Herpetofaunal surveys are completed for only two of the five areas.

N. Collated herpetofaunal records for each of the five protected areas indicate that only 78 of the 203 species occupying the state have been recorded from the five areas combined. Of these 78 species, 51 are country endemics, which is 49.0% of the total of 104 such species in Hidalgo. Non-endemic species comprise 25 of 92 (27.2%) in the state. Only two of the four state endemic species (50.0%) are recorded and only in one of the protected areas. One good sign is that, to date, none of the three non-native species recorded in Hidalgo are known from any of the protected areas.

O. Future conservation efforts need to be directed toward establishing the presence of the remaining 122 herpetofaunal species in the existing system of protected areas, as well as determining what other protected areas could be developed in order to provide perpetual protection for the entire herpetofauna of Hidalgo. Presumably, such areas would need to be established in the Sierra Madre Oriental and the Mexican Plateau.

Recommendations

A. Our purpose for writing this eleventh entry in the Mexican Conservation Series is to document the composition, physiographic distribution, and conservation status of the 200 native species comprising the herpetofauna of Hidalgo. In examining the conservation status of these species, the EVS methodology placed them into low, medium, and high vulnerability categories in numbers which increased from 66 (low) to 76 (medium) and then decreased to

58 (high). The Relative Herpetofaunal Priority measure revealed that the most significant physiographic region in Hidalgo for conservation is the Sierra Madre Oriental, as it contains the most endemic species and species of high vulnerability. Unfortunately, there are no protected areas located within this region in Hidalgo, so the most fundamental conservation challenge is to correct this imbalance in the design of the protected area system in Hidalgo.

B. The next most important conservation challenge is to determine the presence in the existing protected areas of the 122 herpetofaunal species that have not been previously recorded in any of them and, beyond this step, to ascertain which additional protected areas could be established so that the entire native herpetofauna can be protected in perpetuity. Likely, such additional areas would need to be established in the Sierra Madre Oriental and Mexican Plateau regions.

C. After the presence of the entire native herpetofauna of Hidalgo in the protected areas system has been ascertained, then the next step will be to establish monitoring programs to guarantee the long-term survival of these creatures.

D. Such steps need to be taken with the greatest dispatch, as Hidalgo is the 17th most populous state in Mexico and the eighth most densely populated.

“At this point in the fight to solve the climate crisis, there are only three questions remaining: Must we change? Can we change? Will we change?”

—Al Gore (2017)

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Aurelio Ramírez-Bautista began his herpetological research career as an undergraduate student at the Los Tuxtlas Biological Field Station, Veracruz, Mexico. Aurelio received his Bachelor's in Biology from Universidad Veracruzana in Veracruz, Mexico, while his Master's in Science and doctorate were from the Universidad Nacional Autónoma de México (UNAM); and he received a postdoctoral appointment at the University of Oklahoma, Norman, Oklahoma, USA. His main research involves studies on ecology, demography, reproduction, conservation, and life history evolution, using amphibians and reptiles of Mexico as models. Aurelio was president of the Sociedad Herpetologica Mexicana and is currently Associate Editor of *Mesoamerican Herpetology*. Aurelio was a professor at UNAM, and is currently a professor at Universidad Autónoma del Estado de Hidalgo (UAEH) teaching population ecology, herpetology, and 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. He has graduated 71 students (44 undergraduates, 18 Masters, and seven Ph.D. students); and served as an external advisor for Ph.D. students at Brigham Young University, University of Miami, and Eastern Carolina University, USA. Aurelio has received several national (Helia Bravo Hollis Award by the Technical Council of Scientific Research of UNAM, member of the National System of Researchers level II), and international awards (Donald Tinkle Award by Southwestern Association of Naturalists), and he has the profile PRODEP (Programa para el Desarrollo Profesional Docente) at UAEH.



Uriel Hernández-Salinas earned his Bachelor's, Master's and Ph.D. degrees at the Universidad Autónoma del Estado de Hidalgo. Uriel is a herpetologist and co-author of three books: *Herpetofauna del Valle de México: Diversidad y Conservación*, *Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México*, and *Los Anfibios y Reptiles del Estado de Hidalgo: Diversidad, Biogeografía y Conservación*. He is a full-time professor and curator-in-charge of the scientific collection of amphibians and reptiles at CIIDIR Durango. Uriel has authored or co-authored several peer-reviewed papers, and teaches Environmental Management II and Fauna Management in the master's and doctoral programs. In 2015, he became a member of the National System of Researchers, level 1. His main topics of interest are biodiversity, species richness, biogeography, and evolution of life histories of various species of the amphibians and reptiles of Mexico.



Raciél Cruz-Elizalde is a Mexican herpetologist who received his B.Sc. in Biology, and M.Sc. and Ph.D. in Biodiversity and Conservation, from the Universidad Autónoma del Estado de Hidalgo (UAEH). Raciél is interested in the ecology, life history evolution, diversity, and conservation of the amphibians and reptiles of Mexico. He has authored or co-authored several publications including papers, notes, book chapters and books about the ecology, life history evolution, sexual size dimorphism, reproduction, and conservation of amphibians and reptiles. Raciél's current research includes the life history evolution of diverse lizard species of genus *Sceloporus*, conservation issues in natural protected areas, and the analysis of ecological and morphological traits in the composition of amphibian and reptile assemblages.



Christian Berriozabal-Islas earned his bachelor's degree and his master's and Ph.D. degrees in the Biodiversity and Conservation program, all at Universidad Autónoma del Estado de Hidalgo. Christian is a herpetologist interested in species diversity, thermal ecology, functional diversity, climatic change, and distributional patterns using amphibians and reptiles as biological models. Currently, he is a professor at the Universidad Autónoma del Estado de Hidalgo. Christian has been involved in projects regarding environmental education and wildlife conservation in rural communities, was a co-author of the book *Los Anfibios y Reptiles del Estado de Hidalgo, México: Diversidad, Biogeografía y Conservación* (2014), and has authored or co-authored several papers on diversity, ecology, and climate change. He has a great interest in the natural history of the turtles of Mexico.



Israel Moreno-Lara is a herpetologist who recently graduated from the Universidad Autónoma del Estado de Hidalgo (UAEH) after completing a thesis project on the conservation, protection, and trafficking of arboreal lizards of the genus *Abronía* (Anguidae) under the mentorship of Aurelio Ramírez-Bautista and Raciél Cruz-Elizalde. Israel is working on the conservation of herpetofauna through educational projects using identification cards for the amphibian and reptile species of Hidalgo, and he is actively involved in scientific dissemination campaigns at UAEH.

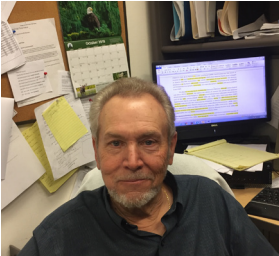


Dominic L. DeSantis is an Assistant Professor of Biology at Georgia College and State University, Milledgeville, Georgia, USA, in the Department of Biological and Environmental Sciences. Dominic's research interests broadly include the behavioral ecology, conservation biology, and natural history of herpetofauna. Much of his current research focusses on integrating multiple longitudinal monitoring technologies to study the proximate and ultimate drivers of spatial strategies and activity patterns in snakes. 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, along with an invited book chapter on the conservation outlook for herpetofauna in the Sierra Madre del Sur of Oaxaca. Overall, Dominic has authored or co-authored over 50 peer-reviewed scientific publications.

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Eli García-Padilla is a herpetologist primarily focused on the ecology and natural history of the Mexican herpetofauna, particularly the Mexican states of Baja California, Tamaulipas, Chiapas, and Oaxaca. His first experience in the field was researching the ecology of the insular endemic populations of the rattlesnakes in the Gulf of California, and his Bachelor's degree thesis was on the ecology of *C. muertensis* (*C. pyrrhus*) on Isla El Muerto, Baja California, Mexico. To date, he has authored or co-authored over 100 peer-reviewed scientific publications. Eli is currently the 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; <http://www.naturalista.mx>). One of his main passions is environmental education, and for several years he has been using audiovisual media to reach large audiences in promoting the importance of the knowledge, protection, and conservation of Mexican biodiversity. Eli's interests include wildlife and conservation photography, and his art has been published in several recognized scientific, artistic, and educational books, magazines, and websites. His present research project involves an evaluation of 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, USA, and he has extensive experience studying the herpetofauna of Mesoamerica, especially southern Mexico. Jerry is the Director of the 40,000-acre Indio Mountains Research Station, was a co-editor of *Conservation of Mesoamerican Amphibians and Reptiles* and co-author of four of its chapters. Jerry has authored or co-authored over 100 peer-reviewed papers and is the Mesoamerica/Caribbean editor for the Geographic Distribution section of *Herpetological Review*. One species, *Tantilla johnsoni*, has been named in his honor. Presently, he is an Associate Editor and Co-chair of the Taxonomic Board for the journal *Mesoamerican Herpetology*.



Vicente Mata-Silva is a herpetologist originally from Río Grande, Oaxaca, Mexico, whose interests include ecology, conservation, natural history, and biogeography of the herpetofaunas of Mexico, Central America, and the southwestern United States. Vicente received his B.S. degree from the Universidad Nacional Autónoma de México (UNAM), and his M.S. and Ph.D. degrees from the University of Texas at El Paso, USA (UTEP). Vicente is an Assistant Professor of Biological Sciences at UTEP in the Ecology and Evolutionary Biology Program, and Co-Director of UTEP's 40,000-acre Indio Mountains Research Station, located in the Chihuahuan Desert of Trans-Pecos, Texas. 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*.



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). Larry has authored or co-authored more than 420 peer-reviewed papers and books on herpetology, including 18 papers from 2013–2019 on the EVS measure and the MCS surveys of the composition, distribution, and conservation status of the herpetofauna of different states in Mexico and other regions in Central America. Larry is the senior editor of *Conservation of Mesoamerican Amphibians and Reptiles* and a co-author of seven of its chapters. His other major 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 71 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 journal *Mesoamerican Herpetology*.