



Crotalus tancitarensis. The Tancítaro cross-banded mountain rattlesnake is a small species (maximum recorded total length = 434 mm) known only from the upper elevations (3,220–3,225 m) of Cerro Tancítaro, the highest mountain in Michoacán, Mexico, where it inhabits pine-fir forest (Alvarado and Campbell 2004; Alvarado et al. 2007). Cerro Tancítaro lies in the western portion of the Transverse Volcanic Axis, which extends across Mexico from Jalisco to central Veracruz near the 20°N latitude. Its entire range is located within Parque Nacional Pico de Tancítaro (Campbell 2007), an area under threat from manmade fires, logging, avocado culture, and cattle raising. This attractive rattlesnake was described in 2004 by the senior author and Jonathan A. Campbell, and placed in the *Crotalus intermedius* group of Mexican montane rattlesnakes by Bryson et al. (2011). We calculated its EVS as 19, which is near the upper end of the high vulnerability category (see text for explanation), its IUCN status has been reported as Data Deficient (Campbell 2007), and this species is not listed by SEMARNAT. More information on the natural history and distribution of this species is available, however, which affects its conservation status (especially its IUCN status; Alvarado-Díaz et al. 2007). We consider *C. tancitarensis* one of the pre-eminent flagship reptile species for the state of Michoacán, and for Mexico in general. Photo by Javier Alvarado-Díaz.

Patterns of physiographic distribution and conservation status of the herpetofauna of Michoacán, Mexico

¹Javier Alvarado-Díaz, ²Ileri Suazo-Ortuño,
³Larry David Wilson, and ⁴Oscar Medina-Aguilar

^{1,2,4}*Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana de San Nicolás de Hidalgo, Av. San Juanito Itz'icuaro s/n Col. Nva. Esperanza, Morelia, Michoacán, MÉXICO, 58337* ³*Centro Zamorano de Biodiversidad, Escuela Agrícola Panamericana Zamorano, Departamento de Francisco Morazán, HONDURAS*

Abstract.—At their respective levels, the country of Mexico and the state of Michoacán are major centers of herpetofaunal diversity and endemism. Three of us (JAD, ISO, OMA) conducted extensive fieldwork in Michoacán from 1998 to 2011, and recorded 169 herpetofaunal species. With additional species reported in the literature and specimens available in scientific collections, the number of species in Michoacán has grown to 215. We examined the distribution of these species within the framework of the five physiographic provinces within the state, i.e., the Coastal Plain, the Sierra Madre del Sur, the Balsas-Tepalcatepec Depression, the Transverse Volcanic Axis, and the Central Plateau, which briefly are characterized geomorphologically and climatically. The herpetofauna consists of 54 amphibians and 161 reptiles (17.5% of the total for Mexico), classified in 38 families and 96 genera. Almost one-half of Michoacán's herpetofaunal species occur in a single physiographic province, and the percentage of species decreases with an increase in the number of provinces. The province with the most species is the Sierra Madre del Sur, with slightly fewer numbers in the Balsas-Tepalcatepec Depression and the Transverse Volcanic Axis. An intermediate number is found in the Coastal Plain, and the lowest in the Central Plateau province. We constructed a Coefficient of Biogeographic Resemblance matrix and found the greatest degree of herpetofaunal resemblance between the Balsas-Tepalcatepec Depression and the Sierra Madre del Sur. The greatest resemblance of the Coastal Plain herpetofauna is to that of Balsas-Tepalcatepec Depression, that of the Transverse Volcanic Axis to that of the Central Plateau, and vice versa. Of the species limited to one physiographic province, 47 occur only in the Transverse Volcanic Axis, 23 in the Coastal Plain, 15 in the Balsas-Tepalcatepec, 14 in the Sierra Madre del Sur, and one in the Central Plateau. We employed three systems for determining the conservation status of the herpetofauna of Michoacán: SEMARNAT, IUCN, and EVS. Almost one-half of the species in the state are not assessed by the SEMARNAT system, with the remainder allocated to the Endangered (four species), Threatened (31), and Special Protection (79) categories. The IUCN system provides an assessment for 184 of the 212 native species, allocating them to the Critically Endangered (five species), Endangered (10), Vulnerable (12), Near Threatened (four), Least Concern (127), and Data Deficient (26) categories. The EVS system provides a numerical assessment for all of the native non-marine species (four marine species occur in the state), with the values ranging from three to 19. The resulting 208 species were placed in low, medium, and high categories of vulnerability, as follows: low (17 amphibians, 39 reptiles); medium (23 amphibians, 45 reptiles); and high (13 amphibians, 71 reptiles). The EVS system is the only one that provides an assessment for all the species (except for the four marine taxa), as well as the only one that considers the distributional status of Michoacán's herpetofauna (state-level endemic, country-level endemic, and non-endemic). Furthermore, the values indicate that ca. 40% of the state's herpetofauna is categorized at the highest level of environmental vulnerability. Based on these conclusions, we provide recommendations for protecting Michoacán's herpetofauna in perpetuity.

Key words. Amphibians, reptiles, physiographic provinces, conservation status, recommendations

Correspondence. Emails: ¹jvr.alvarado@gmail.com (Corresponding author) ²ireri.suazo@gmail.com
³bufodoc@aol.com ⁴mineo_osc@hotmail.com

Resumen.—México es un importante centro de diversidad y endemismo herpetofaunístico y el estado de Michoacán también presenta estas características. Durante el período de 1998–2011, tres de nosotros (JAD, ISO, OMA) conducimos un extenso trabajo de campo en Michoacán, registrando 169 especies de anfibios y reptiles. Con la adición de especies reportadas en la literatura y los registros disponibles en colecciones científicas, el número total de especies de la herpetofauna michoacana es de 215. Examinamos la distribución de estas especies en Michoacán, considerando las cinco provincias fisiográficas representadas en el Estado: la Llanura Costera, la Sierra Madre del Sur, la Depresión del Balsas-Tepalcatepec, el Eje Volcánico Transversal, y la Meseta Central, las que de manera resumida son caracterizadas en base a su geomorfología y clima. La herpetofauna consiste de 54 anfibios y 161 reptiles (17.5% del total de México), clasificadas en 38 familias y 96 géneros. Casi la mitad de las especies de la herpetofauna de Michoacán ocurre en una sola provincia fisiográfica, con un cada vez menor porcentaje de especies a medida que el número de provincias se incrementa. El mayor número de especies se encuentra en la Sierra Madre del Sur, con cifras ligeramente menores en la Depresión del Balsas-Tepalcatepec y el Eje Volcánico Transversal. Un número intermedio de especies se encuentra en la provincia Planicie Costera y el menor número se encuentra en la provincia Meseta Central. Implementamos una matriz del Coeficiente de Semejanza Biogeográfica, la que muestra que el mayor grado de semejanza herpetofaunística se encuentra entre la Depresión del Balsas-Tepalcatepec y la Sierra Madre del Sur. La mayor similitud de la herpetofauna de la Planicie Costera es con la herpetofauna de la Depresión Balsas-Tepalcatepec, la del Eje Volcánico Transversal con la de la Meseta Central y viceversa. De las especies restringidas a una sola provincia fisiográfica, 47 ocurren solamente en el Eje Volcánico Transversal, 23 en la Planicie Costera, 15 en la Depresión del Balsas-Tepalcatepec, 14 en la Sierra Madre del Sur, y una en la Meseta Central. Usamos tres sistemas para determinar el estado de conservación: SEMARNAT, UICN, y EVS. Casi la mitad de las especies de Michoacán no han sido evaluadas por el sistema de SEMARNAT, y las evaluadas han sido asignadas a las categorías de Peligro (cuatro especies), Amenazadas (31), y Protección Especial (79). El sistema de la UICN ha evaluado 184 de las 212 especies nativas de Michoacán, asignadas a las siguientes categorías: Peligro Crítico (cinco especies), En Peligro (10), Vulnerable (12), Casi Amenazado (cuatro), Preocupación Menor (127), y Datos Insuficientes (26). El sistema EVS proporciona una evaluación numérica para todas las especies nativas que no son marinas (cuatro especies marinas ocurren en el estado), con valores de tres a 18. Las 209 especies evaluadas mediante el EVS fueron asignadas a las categorías de baja, media y alta vulnerabilidad de la siguiente manera: baja (17 anfibios, 39 reptiles); media (23 anfibios, 45 reptiles); y alta (13 anfibios, 71 reptiles). El sistema EVS es el único de los tres que proporciona una evaluación de todas las especies (excepto para los cuatro taxa marinos) y el único que considera el estado distribucional de los componentes de la herpetofauna de Michoacán (endémico a nivel estatal, endémico a nivel de país, y no endémico). Además, los valores muestran que cerca del 40% de la herpetofauna del estado se encuentra en la categoría más alta de vulnerabilidad ambiental. En base a estas conclusiones, proponemos recomendaciones para la protección a perpetuidad de la herpetofauna de Michoacán.

Palabras claves. Anfibios, reptiles, provincias fisiográficas, estatus de conservación, recomendaciones

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The publication of On the Origin of Species in 1859 is a recognized watershed in biological science. Perhaps the greatest threat to Western ideology was not the common origin of all beings, as is assumed, but rather the possibility of a common ending: that all beings, humans among them were subjected to the same forces and vulnerabilities.

Chernela 2012: 22.

Introduction

Mesoamerica is one of the principal biodiversity hotspots in the world (Wilson and Johnson 2010), and the country of Mexico comprises about 79% of the land surface of Mesoamerica (CIA World Factbook). The documented amphibian fauna of Mexico currently consists of 379 species, including 237 anurans, 140 salamanders, and two caecilians (Wilson et al. 2013b). Based on this



Incilius pisinnus. The Michoacán toad is a state endemic, with a distribution in the Balsas-Tepalcatepec Depression and the Sierra Madre del Sur. Its EVS was estimated as 15, which is unusually high for a bufonid anuran, its IUCN ranking has been judged as Data Deficient, and a SEMARNAT status has not been provided. This individual is from Apatzingán, Michoacán. Photo by Oscar Medina-Aguilar.



Eleutherodactylus rufescens. The blunt-toed chirping frog is endemic to the Sierra de Coalcomán region of the Sierra Madre del Sur. Its EVS has been assessed as 17, placing this species in the middle of the high vulnerability category, this frog is considered as Critically Endangered by IUCN, and as a Special Protection species by SEMARNAT. This individual was found at Dos Aguas in the Sierra de Coalcomán (Sierra Madre del Sur) in Michoacán. Photo by Oscar Medina-Aguilar.

figure, Mexico is the country with the 5th largest number of amphibian species in the world (Llorente-Bousquets and Ocegueda 2008; Stuart et al. 2010a), after Brazil, Colombia, Ecuador, and Peru. The country also is inhabited by 849 species of reptiles, including 798 squamates, 48 turtles, and three crocodylians (Wilson et al. 2013a), which globally is the second largest reptile fauna (Llorente-Bousquets and Ocegueda 2008), after Australia. The total number of 1,227 species makes the Mexican herpetofauna the second largest in the world (Llorente-Bousquets and Ocegueda 2008), comprising 7.3% of the global herpetofauna (7,044 amphibian species, according to the Amphibian Species of the World website, accessed 21 February 2013, and 9,766 reptile species, according to the Reptile Database website, also accessed 21 February 2013, for a total of 16,810).

Beyond its highly significant herpetofaunal diversity, Mexico also contains an amazing amount of endemism. Currently, 254 of 379 (67.0%) of the known amphibian species and 480 of 849 (56.5%) of the known reptile species are endemic (Wilson et al. 2013a,b). The combined figure for both groups is 734 species (59.8%), a percentage 2.4 times as high as the next highest rate of endemism for the Central American countries (24.8% for Honduras; Townsend and Wilson 2010).

Michoacán (the formal name is Michoacán de Ocampo) is the 16th largest state in Mexico, with an area of 58,599 km² (www.en.wikipedia.org/wiki/List_of_Mexican_states_by_area), which comprises about 3.0% of the

country's land surface. The state is located in southwestern Mexico between latitudes 20°23'44" and 18°09'49" N and longitudes 100°04'48" and 103°44'20" W, and is bounded to the northwest by Colima and Jalisco, to the north by Guanajuato and Querétaro, to the east by México, and to the southeast by Guerrero. Michoacán is physiographically and vegetationally diverse, inasmuch as elevations range from sea level to 3,840 m (at the top of Volcán Tancítaro). The state encompasses a portion of the Pacific coastal plain, a long stretch of the Balsas-Tepalcatepec Depression, a segment of the Sierra Madre del Sur called the Sierra de Coalcomán, and a significant portion of the Transverse Volcanic Axis.

Mexico is known for its high level of herpetofaunal endemism, but compared with the country the herpetofauna of Michoacán is several percentage points higher, with a number of the country endemics limited in distribution to the state (see below). Any attempt to assess the conservation status of a herpetofaunal group depends on an accurate accounting of the distribution and composition of the species involved. Thus, our objectives with this study are to update the list of amphibians and reptiles in Michoacán, to discuss their distribution among the physiographic provinces, and to use these data to gauge the conservation status of the entire herpetofauna using various measures. Finally, based on our conservation assessment, we provide recommendations to enhance current efforts to protect the state's amphibians and reptiles.



Diaglena spatulata. The shovel-headed treefrog is distributed along the Pacific coastal lowlands from Sinaloa to Oaxaca, and thus is a Mexican endemic hylid anuran. In Michoacán, it occurs in the Balsas-Tepalcatepec Depression and along the Coastal Plain. Its EVS was gauged as 13, placing it at the upper end of the medium vulnerability category, IUCN has assessed this anuran as Least Concern, and it is not listed by SEMARNAT. This individual was photographed at the Reserva de la Biosfera Chamela-Cuixmala on the coast of Jalisco. *Photo by Oscar Medina-Aguilar.*

Materials and Methods

1. Sampling procedures

From 1998 to 2011, three of us (JAD, ISO, OMA) conducted fieldwork in 280 localities (58 municipalities) of Michoacán, representing all of the state's physiographic provinces, with significant attention paid to poorly sampled areas, as part of the “Diversidad Herpetofaunística del Estado de Michoacán” project undertaken by personnel from the Laboratorio de Herpetología of the Instituto de Investigaciones sobre los Recursos Naturales (INIRENA) of the Universidad Michoacana de San Nicolás de Hidalgo (UMSNH). Importantly, due to unsafe conditions in certain parts of the state in recent years, large areas have not been explored. During each visit to the sampling sites, we used visual encounter surveys (Crump and Scott 1994) to locate amphibians and reptiles during the day and at night. This work was conducted under scientific collecting permits (DGVS/FAUT-0113), and used the collection techniques described by Casas et al. (1991). In cases where we could not identify individuals in the field, they were sacrificed and subsequently deposited in the herpetological collections of INIRENA-UMSNH. We identified specimens by using taxonomic keys and other information in Smith and Taylor (1945, 1948, 1950), Duellman (1961, 1965, 2001), Casas-Andréu and McCoy (1979), Ramírez-Bautista (1994), Flores-Villela et al. (1995), and Huacuz (1995), and updated scientific names by using Flores-Villela and Canseco-Márquez (2004), Faivovich et al. (2005), Wilson and Johnson (2010), and Wilson et al. (2013a,b).

2. Updating the herpetofaunal list

In addition to the specimens recorded during the fieldwork, the list of species was augmented using material donated by others. We also used records from the Colección Nacional de Anfibios y Reptiles-UNAM (CNAR), the California Academy of Sciences (CAS), the University of Colorado Museum of Natural History, Herpetology Collection (CUMNH), the Museum of Natural Sciences, Louisiana State University (LSUMZ), the Field Museum of Natural History (FMNH), and the Royal Ontario Museum (ROM). Additionally, we included records for Michoacán from the Catálogo de la Biodiversidad en Michoacán (SEDUE [Secretaría de Desarrollo Urbano y Ecología], UMSNH 2000), la Biodiversidad en Michoacán Estudio de Estado (Villaseñor 2005), various distribution notes published in *Herpetological Review* and otherwise posted at the IUCN Red List website, as well as data presented by Flores-Villela and Canseco-Márquez (2004), Vargas-Santamaría and Flores-Villela (2006), González-Hernández and Garza-Castro (2006), Medina-Aguilar et al. (2011), and Torres (2011). We follow the taxonomy used in Wilson (2013a, b), with the exception

of the deletion of the nominal species *Anolis schmidtii*, which recently was synonymized by Nieto et al. (2013).

3. Systems for determining conservation status

We used the following three systems to determine the conservation status of the 212 native species of amphibians and reptiles in Michoacán: SEMARNAT, IUCN, and EVS. The SEMARNAT system, established by the Secretaría de Medio Ambiente y Recursos Naturales, employs three categories—Endangered (P), Threatened (A), and Subject to Special Protection (Pr). The results of the application of this system are reported in the NORMA Oficial Mexicana NOM-059-SEMARNAT-2010 (www.semarnat.gob.mx). For species not assessed by this system, we use the designation “No Status.”

The IUCN system is utilized widely to assess the conservation status of species on a global basis. The categories used are explained in the document *IUCN Red List of Categories and Criteria* (2010), and include Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD), and Not Evaluated (NE). The categories Critically Endangered, Endangered, and Vulnerable collectively are termed “threat categories,” to distinguish them from the other six.

The EVS system was developed initially for use in Honduras by Wilson and McCranie (2004), and subsequently was used in several chapters on Central American countries in Wilson et al. (2010). Wilson et al. (2013a,b) modified this system and explained its use for the amphibians and reptiles of Mexico, and we follow their prescriptions. The EVS measure is not designed for use with marine species (e.g., marine turtles and sea snakes), and generally is not applied to non-native species.

Physiography and Climate

1. Physiographic provinces

Based on geological history, morphology, structure, hydrography, and soils, five physiographic provinces can be recognized within the state of Michoacán, including the Pacific Coastal Plain, the Sierra Madre del Sur, the Balsas-Tepalcatepec Depression, the Transverse Volcanic Axis, and the Central Plateau (Fig. 1). The Coastal Plain province comprises a narrow strip of land between the Pacific Ocean and the Sierra Madre del Sur, and consists of small alluvial plains extending from the mouth of the Río Balsas to the east and the Río Coahuayana to the west. The Sierra Madre del Sur (Sierra de Coalcomán) lies between the Coastal Plain and the Balsas-Tepalcatepec Depression, extends for over 100 km in a north-west-southeast direction, and contains elevations reaching about 2,200 m. The Balsas-Tepalcatepec Depression

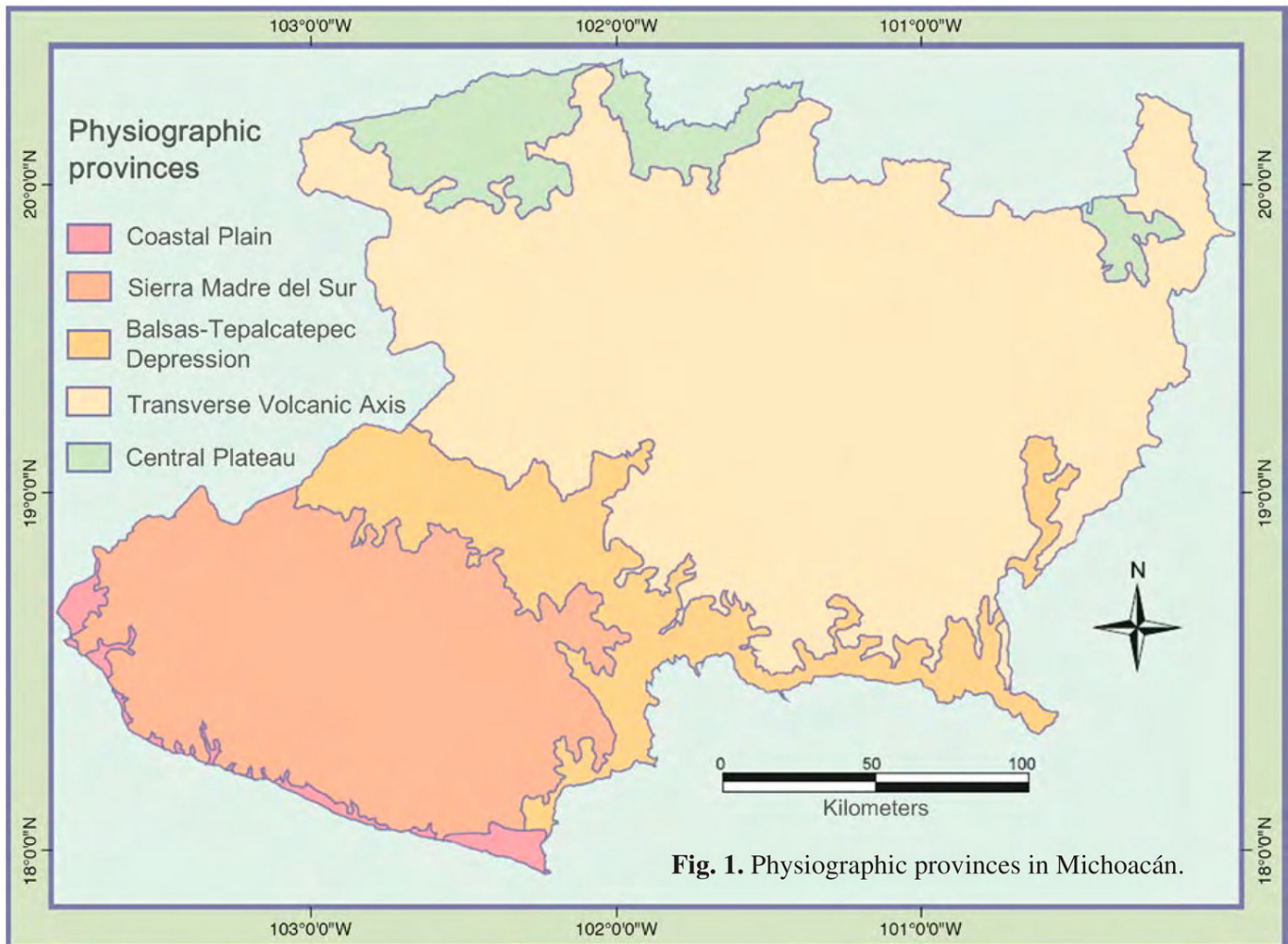


Fig. 1. Physiographic provinces in Michoacán.

is located between the Sierra Madre del Sur to the southwest and the Transverse Volcanic Axis to the northeast. This intermontane area is a broad structural basin that lies at elevations ranging from 200 to 700 m. As noted by Duellman (1961:10), “the western part of this basin... is the valley of the Río Tepalcatepec, a major tributary of the Río Balsas. The eastern part of the basin is the valley of the Río Balsas.” The Transverse Volcanic Axis is located to the south of the Central Plateau and crosses Mexico at about the 20th parallel. The region is composed of volcanic ejecta and is volcanically active. This area is home to Mexico’s highest mountains, such as Pico de Orizaba (5,636 m) and Popocatepetl (5,426 m), which in Michoacán is represented by Pico de Tancítaro, with an elevation of 3,850 m. In addition, several endorheic lakes are located in this province, including Pátzcuaro, Zirahuén, and Cuitzeo. The Central Plateau is a vast tableland bordered on the south by the Transverse Volcanic Axis, on the west by the Sierra Madre Occidental, on the east by the Sierra Madre Oriental, and on the north by the Río Bravo (Río Grande). Elevations in this province range from 1,100 m in the northern portion of the country to 2,000 m. In Michoacán, this province is represented by a relatively small area (3,905 km²) along the northern border of the state; the Río Lerma flows from it, and empties into the Pacific Ocean (Duellman 1961).

2. Climate

Given its location in the tropical region of Mexico, south of the Tropic of Cancer, temperatures in Michoacán vary as a consequence of differences in elevation and the effects of prevailing winds. To illustrate variation in ambient temperatures in the state, we extracted data for one locality from each of the five physiographic provinces from the Servicio Meteorológico Nacional, Michoacán, and placed them in Table 1. These data are organized in the table from top to bottom based on the elevation of the localities (from low to high). As expected, a decrease in the mean annual temperature occurs from lower to higher elevations. The same pattern is seen for annual minimum and maximum temperatures, except for the Coastal Plain compared to the Balsas-Tepalcatepec Depression (33.0 vs. 34.4 °C).

As expected in the tropics, relatively little temperature variation occurs throughout the year. The differences between the low and high mean monthly temperatures (in °C) for the localities in the five physiographic provinces are as follows: Coastal Plain (Lázaro Cárdenas, 50 m) = 1.9; Balsas-Tepalcatepec Depression (Apatzingán, 320 m) = 5.5; Sierra Madre del Sur (Coalcomán, 1,100 m) = 5.2; Central Plateau (Morelia, 1,915 m) = 5.9; and Transverse Volcanic Axis (Pátzcuaro, 2,035 m) = 6.6.

The lowest mean monthly temperatures are for January, and the highest for May or June. Essentially the same pattern occurs with minimum and maximum monthly temperatures, except for minor departures in a few areas (Table 1).

The highest mean monthly temperature (34.4 °C) is at Apatzingán in the Balsas-Tepalcatepec Depression. Duellman (1961) stated that the highest mean annual temperatures (29.3 °C) in this depression have been recorded at Churumuco (251 m), as reported by Contreras (1942). More recent data at the Servicio Meteorológico Nacional website for Michoacán indicates that the highest daily temperature of 46 °C was recorded at this locality on 9 April 1982. At the other extreme are

temperatures on the peak of Volcán Tancítaro, where the mean annual temperature is less than 10 °C and it snows during the winter.

In tropical locales, heavy or light precipitation typically occurs during the rainy and dry seasons, respectively. In Michoacán, the rainy season extends from June to October, when 80% or more of the annual precipitation is deposited. As with temperature data, we extracted information on mean annual precipitation and variation in monthly precipitation recorded at one locality for each of the five physiographic provinces, and placed the data in Table 2. The results demonstrate that at each locality the highest amount of precipitation occurs from June to October. The percentage of annual precipitation

Table 1. Monthly minimum, mean (in parentheses), maximum, and annual temperature data (in °C) for the physiographic provinces of Michoacán, Mexico. Localities and their elevation for each of the provinces are as follows: Coastal Plain (Lázaro Cárdenas, 50 m); Balsas-Tepalcatepec Depression (Apatzingán, 320 m); Sierra Madre del Sur (Coalcomán de Vázquez Pallares, 1,100 m); Central Plateau (Morelia, 1,915 m); Transverse Volcanic Axis (Pátzcuaro, 2,035 m). Data (1971–2000) from the Sistema Meteorológico Nacional, Michoacán (smn.cna.gob.mx/index).

Physiographic Province	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Coastal Plain	20.6 (26.6) 32.6	20.6 (26.8) 33.1	20.8 (27.0) 33.2	21.2 (27.3) 33.5	22.8 (28.3) 33.8	23.9 (28.5) 33.1	23.4 (28.0) 32.7	23.7 (28.1) 32.6	23.3 (27.7) 32.0	23.5 (28.1) 32.6	22.7 (27.9) 33.2	21.1 (27.1) 33.2	22.3 (27.6) 33.0
Balsas-Tepalcatepec Depression	16.7 (24.6) 32.5	17.6 (25.9) 34.1	19.1 (27.7) 36.3	20.7 (29.2) 37.6	22.3 (30.3) 38.3	22.7 (29.1) 35.6	21.6 (27.3) 33.1	21.6 (27.3) 33.1	21.7 (27.3) 33.0	21.5 (27.7) 33.8	19.5 (26.4) 33.3	17.7 (25.1) 32.5	20.2 (27.3) 34.4
Sierra Madre del Sur	10.2 (19.9) 29.7	10.7 (20.8) 30.9	11.6 (22.1) 32.7	12.3 (23.5) 34.6	14.3 (24.8) 35.3	17.9 (25.1) 32.4	18.2 (24.1) 30.1	17.4 (23.8) 30.2	17.7 (23.8) 30.0	16.7 (23.7) 30.8	13.9 (22.2) 30.4	11.9 (21.0) 30.0	14.4 (22.9) 31.4
Central Plateau	6.8 (15.8) 24.7	7.6 (17.0) 26.4	9.6 (19.0) 28.4	11.1 (20.4) 29.7	12.6 (21.7) 30.9	13.3 (21.2) 29.1	12.8 (19.6) 26.5	13.1 (19.8) 26.4	12.9 (19.4) 26.0	11.3 (18.7) 26.1	9.3 (17.7) 26.2	7.3 (16.4) 25.5	10.6 (18.9) 27.2
Transverse Volcanic Axis	3.3 (12.9) 22.5	4.0 (14.1) 24.1	5.4 (16.0) 26.6	7.3 (17.8) 28.2	9.4 (19.1) 28.7	12.5 (19.5) 26.4	12.0 (18.0) 23.9	11.9 (18.0) 24.1	11.5 (17.7) 23.9	9.2 (16.7) 24.1	5.9 (14.8) 23.7	4.3 (13.4) 22.6	8.1 (16.5) 24.9

Table 2. Monthly and annual precipitation data (in mm.) for the physiographic provinces of Michoacán, Mexico. Localities and their elevation for each of the provinces are as follows: Coastal Plain (Lázaro Cárdenas, 50 m); Sierra Madre del Sur (Coalcomán de Vázquez Pallares, 1,100 m); Balsas-Tepalcatepec Depression (Apatzingán, 320 m); Transverse Volcanic Axis (Pátzcuaro, 2,035 m); Central Plateau (Morelia, 1,915 m). The shaded area indicates the months of the rainy season. Data taken from Servicio Meteorológico Nacional, Michoacán (smn.cna.gob.mx/index).

Physiographic Province	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Coastal Plain	7.5	0.4	1.0	0.0	17.0	240.4	269.0	257.0	374.2	150.1	23.7	34.0	1,374.3
Balsas-Tepalcatepec Depression	19.8	22.0	9.0	2.5	24.1	138.0	167.9	160.8	133.6	78.8	36.9	15.3	808.7
Sierra Madre del Sur	33.7	42.8	24.8	7.8	37.2	272.2	284.1	258.0	225.7	166.8	93.0	42.1	1,488.2
Central Plateau	15.8	5.6	7.5	9.9	37.9	146.5	166.1	167.8	131.6	51.6	10.4	4.2	754.9
Transverse Volcanic Axis	27.1	5.0	5.1	9.7	37.8	150.3	219.6	204.1	157.9	71.2	17.6	13.4	918.8

during this period ranges from 81.1% at Coalcomán in the Sierra Madre del Sur to 93.9% at Lázaro Cárdenas on the Coastal Plain (mean 86.9%). Generally, the driest month is April (except on the Central Plateau, where it is December) and the wettest month is July (except on the Central Plateau, where it is August). Annual precipitation is lowest on the Central Plateau, with 754.9 mm for the capital city of Morelia, and highest at Coalcomán in the Sierra Madre del Sur, with 1,488.2 mm (Table 2).

Composition of the Herpetofauna

Field surveys and a review of the published literature and databases yielded a total of 215 species of amphibians and reptiles for the state of Michoacán (54 amphibians, 161 reptiles). Of the amphibians, 44 are anurans (81.1%, including the non-native *Lithobates catesbeianus*), nine are salamanders (17.0%), and one is a caecilian (1.9%). Of the 161 reptiles, 153 are squamates (95.0%, including the non-native *Hemidactylus frenatus* and *Ramphotyphlops braminus*), seven are turtles (4.4%), and one is a crocodylian (0.6%). The number of species occurring in Michoacán is 17.5% of the total for the Mexican herpetofauna (1,227 species; Wilson et al. 2013a,b; Table 3).

Table 3. Composition of the amphibians and reptiles of Mexico and the state of Michoacán. In each column, the number to the left is that indicated in Wilson et al. (2013a,b) for the country of Mexico; the number to the right is that recorded in this study for the state of Michoacán. These numbers include the marine and non-native taxa.

Taxa	Families	Genera	Species
Anura	11/9	35/19	237/44
Caudata	4/2	15/2	139/9
Gymnophiona	1/1	1/1	2/1
Subtotals	16/12	51/22	378/54
Squamata	31/21	139/68	798/153
Testudines	9/4	18/5	48/7
Crocodylia	2/1	2/1	3/1
Subtotals	42/26	159/74	849/161
Totals	58/38	210/96	1,227/215

1. Families

The herpetofauna of Michoacán (215 species) is classified in 38 families (65.5% of the number in Mexico), with the 54 species of amphibians in 12 of the 16 families known from the country (75.0%; Wilson et al. 2013a, b; Table 3). About one-half of the amphibian species are classified in one of three families (Hylidae, Ranidae, and

Ambystomatidae). The 161 species of reptiles are classified in 26 families (including the family Gekkonidae, occupied by a single non-native species, *H. frenatus*, and the family Typhlopidae, occupied by a single non-native species, *R. braminus*), 61.9% of the 42 families found in Mexico (Wilson et al. 2013a; Table 3). One-half of the species of reptiles in the state are classified in one of three families (Phrynosomatidae, Colubridae, and Dipsadidae).

2. Genera

The herpetofauna of Michoacán is represented by 96 genera (45.7% of the 210 known from Mexico; Wilson et al. 2013a,b), with the amphibians composed of 22 genera (43.1% of the 51 known from the country). The reptiles consist of 74 genera (46.5% of the country total of 159). The largest amphibian genera are *Incilius* (four species), *Craugastor* (five), *Eleutherodactylus* (five), *Lithobates* (11), and *Ambystoma* (seven). Together, these 32 species comprise 59.3% of the amphibians known from the state (Table 3). The most sizable reptilian genera are *Sceloporus* (16), *Geophis* (nine), *Thamnophis* (nine), *Crotalus* (eight), *Aspidoscelis* (seven), *Phyllodactylus* (five), *Plestiodon* (five), *Coniophanes* (five), and *Leptodeira* (five). These 69 species constitute 42.9% of the reptiles known from the state (Table 3).

3. Species

Mexico is home to 378 amphibian species, of which 54 (14.3%) occur in Michoacán (Table 3). Anurans are better represented in the state (18.6% of 237 Mexican species) than salamanders (6.5% of 139). Only two caecilian species are known from Mexico, and one occurs in Michoacán (50.0%). Mexico also is inhabited by 849 reptile species, of which 161 (19.0%) are found in Michoacán. Squamates are somewhat better represented in the state (19.2% of 798) than turtles (14.6% of 48). Only three crocodylian species occur in Mexico, and one is found in Michoacán (Table 3).

Patterns of Physiographic Distribution

We recognize five physiographic provinces in Michoacán (Fig. 1), and their herpetofaunal distribution is indicated in Table 4 and summarized by family in Table 5.

Of the 215 species recorded from the state, 100 (46.5%, 24 amphibians, 76 reptiles) are limited in distribution to a single physiographic province. In addition, 64 (29.8%, 15 amphibians, 49 reptiles) are known from two provinces, 37 (17.2%, eight amphibians, 29 reptiles) from three, 11 (5.1%, seven amphibians, four reptiles) from four, and only three (1.4%, 0 amphibians, three reptiles) from all five provinces (Table 4). In both amphibians and reptiles, the number of species steadily drops from the lowest to the highest occupancy figures. This distributional feature is significant to conservation

efforts, inasmuch as the more restricted their distribution the more difficult it will be to provide species with effective protective measures. This feature is obvious when examining the mean occupancy figure, which is 2.0 for amphibians and 1.8 for reptiles, indicating that on average both groups occupy two or slightly fewer physiographic provinces. The three most broadly distributed species (i.e., occurring in all five provinces) all are reptiles and include the anole *Anolis nebulosus*, the whipsnake *Masticophis mentovarius*, and the mud turtle *Kinosternon integrum* (Table 4). The most broadly distributed amphibians all are anurans and include the following seven species: the toad *Rhinella marina*, the chirping frog *Eleutherodactylus nitidus*, the treefrogs

Exerodonta smaragdina and *Hyla arenicolor*, the white-lipped frog *Leptodactylus fragilis*, the sheep frog *Hypopachus variolosus*, and the leopard frog *Lithobates neovolcanicus* (Table 4).

Similar numbers of species have been recorded from the Balsas-Tepalcatepec Depression, the Sierra Madre del Sur, and the Transverse Volcanic Axis. A smaller number occupies the Coastal Plain and the smallest number is found on the Central Plateau. The distinction between the species numbers in the higher-species areas (Balsas-Tepalcatepec Depression, Sierra Madre del Sur, and the Transverse Volcanic Axis) and the lower-species areas (Coastal Plain and Central Plateau) is more marked for amphibians than for reptiles (Table 5).

Table 4. Distribution of the native and non-native amphibian and reptiles of Michoacán, Mexico, by physiographic province.

Taxa	Physiographic Provinces				
	Coastal Plain (COP)	Balsas-Tepalcatepec Depression (BTD)	Sierra Madre del Sur (SMS)	Transverse Volcanic Axis (TVA)	Central Plateau (CEP)
Amphibia (54 species)					
Anura (44 species)					
Bufonidae (6 species)					
<i>Anaxyrus compactilis</i>				+	+
<i>Incilius marmoreus</i>	+	+	+		
<i>Incilius occidentalis</i>			+	+	
<i>Incilius perplexus</i>		+	+		
<i>Incilius pisinnus</i>		+	+		
<i>Rhinella marina</i>	+	+	+		+
Craugastoridae (5 species)					
<i>Craugastor augusti</i>			+	+	
<i>Craugastor hobartsmithi</i>				+	
<i>Craugastor occidentalis</i>				+	
<i>Craugastor pygmaeus</i>		+	+	+	
<i>Craugastor vocalis</i>		+	+	+	
Eleutherodactylidae (5 species)					
<i>Eleutherodactylus angustidigitorum</i>				+	
<i>Eleutherodactylus maurus</i>		+			
<i>Eleutherodactylus modestus</i>			+		
<i>Eleutherodactylus nitidus</i>		+	+	+	+
<i>Eleutherodactylus rufescens</i>			+		
Hylidae (11 species)					
<i>Agalychnis dacnicolor</i>	+	+	+		
<i>Diaglena spatulata</i>	+	+			
<i>Exerodonta smaragdina</i>		+	+	+	+
<i>Hyla arenicolor</i>		+	+	+	+
<i>Hyla eximia</i>				+	+

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<i>Hyla plicata</i>				+	
<i>Plectrohyla bistincta</i>			+	+	
<i>Smilisca baudinii</i>	+	+	+		
<i>Smilisca fodiens</i>		+			+
<i>Tlalocohyla smithii</i>	+	+	+		
<i>Trachycephalus typhonius</i>	+				
Leptodactylidae (2 species)					
<i>Leptodactylus fragilis</i>	+	+	+	+	
<i>Leptodactylus melanonotus</i>	+	+	+		
Microhylidae (2 species)					
<i>Hypopachus ustus</i>	+				
<i>Hypopachus variolosus</i>		+	+	+	+
Ranidae (11 species)					
<i>Lithobates berlandieri</i>		+			
<i>Lithobates catesbeianus</i>				+	
<i>Lithobates dunni</i>				+	
<i>Lithobates forreri</i>		+	+		
<i>Lithobates magnaocularis</i>		+			
<i>Lithobates megapoda</i>				+	+
<i>Lithobates montezumae</i>				+	+
<i>Lithobates neovolcanicus</i>		+	+	+	+
<i>Lithobates pustulosus</i>		+	+	+	
<i>Lithobates spectabilis</i>				+	
<i>Lithobates zweifeli</i>		+	+		
Rhinophrynidae (1 species)					
<i>Rhinophrynus dorsalis</i>		+			
Scaphiopodidae (1 species)					
<i>Spea multiplicata</i>				+	+
Caudata (9 species)					
Ambystomatidae (6 species)					
<i>Ambystoma amblycephalum</i>				+	
<i>Ambystoma andersoni</i>				+	
<i>Ambystoma dumerilii</i>				+	
<i>Ambystoma ordinarium</i>				+	
<i>Ambystoma rivulare</i>				+	
<i>Ambystoma velasci</i>				+	
Plethodontidae (3 species)					
<i>Pseudoeurycea bellii</i>				+	
<i>Pseudoeurycea leprosa</i>				+	
<i>Pseudoeurycea longicauda</i>				+	
Gymnophiona (1 species)					
Caeciliidae (1 species)					
<i>Dermophis oaxacae</i>	+			+	
Reptilia (161 species)					
Crocodylia (1 species)					
Crocodylidae (1 species)					
<i>Crocodylus acutus</i>	+				

Squamata (153 species)					
Bipedidae (1 species)					
<i>Bipes canaliculatus</i>		+			
Anguidae (6 species)					
<i>Abronia deppii</i>				+	
<i>Barisia imbricata</i>				+	
<i>Barisia jonesi</i>			+		
<i>Barisia rudicollis</i>				+	
<i>Elgaria kingii</i>			+		
<i>Gerrhonotus liocephalus</i>				+	
Corytophanidae (1 species)					
<i>Basiliscus vittatus</i>	+	+	+		
Dactyloidae (2 species)					
<i>Anolis dunni</i>		+	+		
<i>Anolis nebulosus</i>	+	+	+	+	+
Eublepharidae (1 species)					
<i>Coleonyx elegans</i>	+	+			
Gekkonidae (1 species)					
<i>Hemidactylus frenatus</i>	+	+	+		
Helodermatidae (1 species)					
<i>Heloderma horridum</i>	+	+	+		
Iguanidae (3 species)					
<i>Ctenosaura clarki</i>		+			
<i>Ctenosaura pectinata</i>	+	+	+		
<i>Iguana iguana</i>	+	+	+		
Mabuyidae (1 species)					
<i>Marisora brachypoda</i>	+	+			
Phrynosomatidae (20 species)					
<i>Phrynosoma asio</i>		+	+		
<i>Phrynosoma orbiculare</i>				+	
<i>Sceloporus aeneus</i>				+	
<i>Sceloporus asper</i>		+	+	+	
<i>Sceloporus bulleri</i>			+		
<i>Sceloporus dugesii</i>				+	+
<i>Sceloporus gadoviae</i>		+	+		
<i>Sceloporus grammicus</i>				+	
<i>Sceloporus heterolepis</i>			+	+	
<i>Sceloporus horridus</i>	+	+	+	+	
<i>Sceloporus insignis</i>			+		
<i>Sceloporus melanorhinus</i>	+	+	+		
<i>Sceloporus pyrocephalus</i>	+	+	+		
<i>Sceloporus scalaris</i>				+	+
<i>Sceloporus siniferus</i>	+		+		
<i>Sceloporus spinosus</i>				+	+
<i>Sceloporus torquatus</i>				+	+
<i>Sceloporus utiformis</i>	+	+	+	+	
<i>Urosaurus bicarinatus</i>	+	+	+	+	

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<i>Urosaurus gadovi</i>		+	+		
Phyllodactylidae (5 species)					
<i>Phyllodactylus davisii</i>	+				
<i>Phyllodactylus duellmani</i>		+	+		
<i>Phyllodactylus homolepidurus</i>	+				
<i>Phyllodactylus lanei</i>	+	+	+	+	
<i>Phyllodactylus paucituberculatus</i>		+			
Scincidae (6 species)					
<i>Mesoscincus altamirani</i>		+	+		
<i>Plestiodon colimensis</i>	+		+		
<i>Plestiodon copei</i>				+	
<i>Plestiodon dugesii</i>				+	
<i>Plestiodon indubitus</i>			+	+	
<i>Plestiodon parvulus</i>	+				
Sphenomorphidae (1 species)					
<i>Scincella assata</i>	+	+	+		
Teiidae (8 species)					
<i>Aspidoscelis calidipes</i>		+	+		
<i>Aspidoscelis communis</i>	+	+	+		
<i>Aspidoscelis costata</i>		+	+		
<i>Aspidoscelis deppei</i>	+	+	+		
<i>Aspidoscelis gularis</i>				+	+
<i>Aspidoscelis lineatissima</i>	+	+	+		
<i>Aspidoscelis sacki</i>		+			
<i>Holcosus undulatus</i>	+	+	+		
Xantusiidae (1 species)					
<i>Lepidophyma tarascae</i>	+	+			
Boidae (1 species)					
<i>Boa constrictor</i>	+	+	+		
Colubridae (28 species)					
<i>Conopsis biserialis</i>				+	
<i>Conopsis lineatus</i>				+	+
<i>Conopsis nasus</i>				+	
<i>Drymarchon melanurus</i>	+	+	+		
<i>Drymobius margaritiferus</i>	+	+	+		
<i>Geagras redimitus</i>	+				
<i>Gyalopion canum</i>				+	
<i>Lampropeltis ruthveni</i>				+	
<i>Lampropeltis triangulum</i>				+	
<i>Leptophis diplotropis</i>	+	+	+		
<i>Masticophis flagellum</i>		+		+	
<i>Masticophis mentovarius</i>	+	+	+	+	+
<i>Masticophis taeniatus</i>				+	+
<i>Mastigodryas melanolomus</i>	+		+		
<i>Oxybelis aeneus</i>	+	+	+		
<i>Pituophis deppei</i>				+	+

<i>Pituophis lineaticollis</i>			+	+	
<i>Pseudoficimia frontalis</i>	+	+	+		
<i>Salvadora bairdi</i>				+	+
<i>Salvadora mexicana</i>		+	+		
<i>Senticolis triaspis</i>		+	+		
<i>Sonora michoacanensis</i>		+	+		
<i>Symphimus leucostomus</i>	+				
<i>Tantilla bocourti</i>				+	
<i>Tantilla calamarina</i>	+	+	+		
<i>Tantilla cascadae</i>				+	
<i>Trimorphodon biscutatus</i>	+	+	+		
<i>Trimorphodon tau</i>		+		+	+
Dipsadidae (33 species)					
<i>Coniophanes fissidens</i>		+	+		
<i>Coniophanes lateritius</i>		+	+		
<i>Coniophanes michoacanensis</i>	+				
<i>Coniophanes piceivittis</i>	+				
<i>Coniophanes sarae</i>			+		
<i>Diadophis punctatus</i>				+	
<i>Dipsas gaigeae</i>			+		
<i>Enulius flavitorques</i>		+	+		
<i>Enulius oligostichus</i>	+				
<i>Geophis bicolor</i>				+	
<i>Geophis dugesii</i>				+	
<i>Geophis incomptus</i>			+		
<i>Geophis maculiferus</i>				+	
<i>Geophis nigrocinctus</i>			+		
<i>Geophis petersii</i>			+	+	
<i>Geophis pyburni</i>			+		
<i>Geophis sieboldi</i>			+		
<i>Geophis tarascae</i>				+	
<i>Hypsiglena torquata</i>		+	+		
<i>Imantodes gemmistratus</i>		+			
<i>Leptodeira maculata</i>	+	+	+		
<i>Leptodeira nigrofasciata</i>	+				
<i>Leptodeira septentrionalis</i>		+			
<i>Leptodeira splendida</i>		+	+	+	
<i>Leptodeira uribei</i>	+				
<i>Pseudoleptodeira latifasciata</i>		+	+		
<i>Rhadinaea hesperia</i>		+	+		
<i>Rhadinaea laureata</i>				+	
<i>Rhadinaea taeniata</i>				+	
<i>Sibon nebulata</i>	+		+		
<i>Tropidodipsas annulifera</i>			+		
<i>Tropidodipsas fasciata</i>			+		
<i>Tropidodipsas philippii</i>	+		+		

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Elapidae (4 species)					
<i>Micrurus distans</i>		+	+		
<i>Micrurus laticollaris</i>		+			
<i>Micrurus tener</i>				+	
<i>Pelamis platura</i>	+				
Leptotyphlopidae (4 species)					
<i>Epictia goudotii</i>		+	+		
<i>Rena bressoni</i>		+			
<i>Rena humilis</i>		+			
<i>Rena maxima</i>		+			
Loxocemidae (1 species)					
<i>Loxocemus bicolor</i>		+	+		
Natricidae (11 species)					
<i>Adelophis copei</i>					+
<i>Storeria storerioides</i>			+	+	
<i>Thamnophis cyrtopsis</i>			+	+	
<i>Thamnophis eques</i>				+	+
<i>Thamnophis melanogaster</i>				+	
<i>Thamnophis postremus</i>		+			
<i>Thamnophis proximus</i>	+				
<i>Thamnophis pulchrilatus</i>				+	
<i>Thamnophis scalaris</i>				+	
<i>Thamnophis scaliger</i>				+	+
<i>Thamnophis validus</i>	+				
Typhlopidae (1 species)					
<i>Ramphotyphlops braminus</i>		+	+	+	
Viperidae (10 species)					
<i>Agkistrodon bilineatus</i>	+	+	+		
<i>Crotalus aquilus</i>				+	
<i>Crotalus basiliscus</i>	+	+	+		
<i>Crotalus culminatus</i>		+			
<i>Crotalus molossus</i>				+	
<i>Crotalus polystictus</i>				+	
<i>Crotalus pusillus</i>			+	+	
<i>Crotalus tancitarensis</i>				+	
<i>Crotalus triseriatus</i>				+	
<i>Porthidium hespere</i>	+				
Xenodontidae (2 species)					
<i>Conopsis vittatus</i>	+	+	+		
<i>Manolepis putnami</i>	+	+			
Testudines (7 species)					
Cheloniidae (2 species)					
<i>Chelonia mydas</i>	+				
<i>Lepidochelys olivacea</i>	+				
Dermochelyidae (1 species)					
<i>Dermochelys coriacea</i>	+				

Geoemydidae (2 species)					
<i>Rhinoclemmys pulcherrima</i>	+				
<i>Rhinoclemmys rubida</i>	+	+	+		
Kinosternidae (2 species)					
<i>Kinosternon hirtipes</i>				+	+
<i>Kinosternon integrum</i>	+	+	+	+	+

Table 5. Summary of the distributional occurrence of families of amphibians and reptiles in Michoacán by physiographic province.

Families	Number of Species	Distributional Occurrence				
		Coastal Plain (COP)	Balsas-Tepalcatepec Depression (BTD)	Sierra Madre del Sur (SMS)	Transverse Volcanic Axis (TVA)	Central Plateau (CEP)
Bufonidae	6	2	4	5	2	2
Craugastoridae	5	—	2	3	5	—
Eleutherodactylidae	5	—	2	3	2	1
Hylidae	11	5	7	6	5	4
Leptodactylidae	2	2	2	2	1	—
Microhylidae	2	1	1	1	1	1
Ranidae	11	—	6	4	7	3
Rhinophrynidae	1	—	1	—	—	—
Scaphiopodidae	1	—	—	—	1	1
Subtotals	44	10	25	24	24	12
Ambystomatidae	6	—	—	—	6	—
Plethodontidae	3	—	—	—	3	—
Subtotals	9	—	—	—	9	—
Caeciliidae	1	1	—	—	1	—
Subtotals	1	1	—	—	1	—
Totals	54	11	25	24	34	12
Crocodylidae	1	1	—	—	—	—
Subtotals	1	1	—	—	—	—
Cheloniidae	2	2	—	—	—	—
Dermochelyidae	1	1	—	—	—	—
Geoemydidae	2	2	1	1	—	—
Kinosternidae	2	1	1	1	2	2
Subtotals	7	6	2	2	2	2
Bipedidae	1	—	1	—	—	—
Anguidae	6	—	—	2	4	—
Corytophanidae	1	1	1	1	—	—
Dactyloidae	2	1	2	2	1	1
Eublepharidae	1	1	1	—	—	—
Gekkonidae	1	1	1	1	—	—
Helodermatidae	1	1	1	1	—	—
Iguanidae	3	2	3	2	—	—
Mabuyidae	1	1	1	—	—	—
Phrynosomatidae	20	6	9	13	12	4

Phyllodactylidae	5	3	3	2	1	—
Scincidae	6	2	1	3	3	—
Sphenomorphidae	1	1	1	1	—	—
Teiidae	8	4	7	6	1	1
Xantusiidae	1	1	1	—	—	—
Subtotals	58	25	33	34	22	6
Boidae	1	1	1	1	—	—
Colubridae	28	11	13	13	15	6
Dipsadidae	33	8	10	19	9	—
Elapidae	4	1	2	1	1	—
Leptotyphlopidae	4	—	4	1	—	—
Loxocemidae	1	—	1	1	—	—
Natricidae	11	2	1	2	7	3
Typhlopidae	1	—	1	1	1	—
Viperidae	10	3	3	3	6	—
Xenodontidae	2	2	2	1	—	—
Subtotals	95	28	38	43	39	9
Totals	161	60	73	79	63	17
Sum Totals	215	71	98	103	97	29

Anurans are more broadly represented in the Balsas-Tepalcatepec Depression, where 25 species classified in all but one of the nine families occurring in the state are found. These anurans are represented most narrowly on the Coastal



Plectrohyla bistrincta. The Mexican fringe-limbed treefrog is distributed from Durango and Veracruz southward to México and Oaxaca. Its EVS has been assessed as 9, placing at the upper end of the low vulnerability category, this species is considered as Least Concern by IUCN, and as a Special Protection species by SEMARNAT. This individual came from San José de las Torres, near Morelia, in Michoacán.

Photo by Javier Alvarado-Díaz.

Plain, where only 10 species assigned to four families occur. One or more species in the families Bufonidae, Hylidae, and Microhylidae are distributed in each of the five provinces (Table 5). As expected, the family Hylidae is best represented in each of the provinces except for the Transverse Volcanic Axis, where more ranids (sev-

en species) than hylids (five) occur. All nine species of salamanders are limited in occurrence to the Transverse Volcanic Axis and the single caecilian to the Transverse Volcanic Axis and the Coastal Plain (Table 5).

Lizards are best represented in the Sierra Madre del Sur, with 34 species, but the Balsas-Tepalcatepec Depression falls only one behind, with 33 (Table 5). Both of these figures comprise more than one-half of the 58 species of lizards known from the state. Fewer than one-half of this number occurs on the Coastal Plain (25) and the Transverse Volcanic Axis (22). Only a few species (six) occur on the Central Plateau. In the families Dactyloidae, Phrynosomatidae, and Teiidae, one or more species is distributed in each of the five provinces (Table 5). Due to the size of the Phrynosomatidae in Michoacán (20 species), this family is the best represented in each of the provinces. Several lizard families are represented by a single species in each of the provinces, but only one with a single species (the Bipedidae) is limited to a single province (Table 5).

The largest number of snake species is known from the Sierra Madre del Sur, with 43 species. Fewer numbers are found in the Transverse Volcanic Axis (39), Balsas-Tepalcatepec Depression (38), Coastal Plain (28), and the Central Plateau (nine). One or more representatives of only two snake families, the Colubridae and Natricidae, are found in each of the five provinces (Table 5). Interestingly, although the Colubridae in Michoacán is represented by five fewer species than the Dipsadidae, it is the best-represented family in all of the provinces except for the Sierra Madre del Sur, in which the Dip-



Ambystoma velasci. The plateau tiger salamander is found along the Transverse Volcanic Axis in Michoacán and elsewhere, thence northward into both the Sierra Madre Occidental to northwestern Chihuahua and the Sierra Madre Oriental to southern Nuevo León. Its EVS has been assigned a value of 10, placing it at the lower end of the medium vulnerability category, its status has been judged as Least Concern by IUCN, and it is considered a Special Protection species by SEMARNAT. This individual came from Los Azufres, in the Transverse Volcanic Axis. *Photo by Javier Alvarado-Díaz.*

sadidae is the best represented. Only three snake families are represented by a single species (including the Typhlopidae, containing the non-native blindsnake *Ramphotyphlops braminus*), but in all three cases they occur in two or three provinces (Table 5).

Relatively few species of turtles have been recorded in Michoacán, and given that three of the seven are sea turtles, most of them (six) are known from the Coastal Plain (obviously, sea turtles come on land for egg deposition). Only two species of the families Geoemydidae and/or Kinosternidae are found in the remaining four provinces (Table 5). The single crocodylian species is found only in the Coastal Plain (Table 5).

We constructed a Coefficient of Biogeographic Resemblance (CBR) matrix to examine the herpetofaunal relationships among the five physiographic provinces (Table 6). The data in this table demonstrate that the greatest degree of resemblance (74 species shared, CBR value of 0.74) occurs between the Balsas-Tepalcatepec Depression and the Sierra Madre del Sur (Table 6). Whereas this fact might be considered counterintuitive, given the elevational distinction between the two areas, these two provinces broadly contact one another along

the northern and eastern face of the mountain mass (Fig. 1). A greater degree of resemblance might be expected between the Balsas-Tepalcatepec Depression and the Coastal Plain, inasmuch as these are relatively low-elevation areas, but they only contact one another where the Río Balsas flows onto the coastal plain prior to entering the Pacific Ocean. As a consequence, these two provinces share only 44 species and their CBR value is 0.52 (Table 6). Nonetheless, these values are the highest that the Coastal Plain shares with any of the other four provinces, with the exception of the Sierra Madre del Sur (44 species and 0.51). For a similar reason, it might be expected that the Balsas-Tepalcatepec Depression would share a relatively large number of species with the Transverse Volcanic Axis to the north, but this is not the case. Only 21 species are shared and the CBR value is only 0.22 (Table 6).

One might also presume that the Transverse Volcanic Axis and the Sierra Madre del Sur would share a sizable number of montane-distributed species, but the two provinces only share 29 species and their CBR value is 0.29. The Central Plateau is adjacent to the Transverse Volcanic Axis and the data in Table 6 demonstrate that

Table 6. CBR matrix of herpetofaunal relationships for the five physiographic provinces in Michoacán. **N** = species in each province; **N** = species in common between two provinces; **N** = Coefficients of Biogeographic Resemblance. The formula for this algorithm is $CBR = 2C/N_1 + N_2$, where **C** is the number of species in common to both provinces, **N**₁ is the number of species in the first province, and **N**₂ is the number of species in the second province.

	COP	BTD	SMS	TVA	CEP
COP	71	44	44	9	4
BTD	0.52	98	74	21	11
SMS	0.51	0.74	103	29	9
TVA	0.11	0.22	0.29	97	26
CEP	0.08	0.17	0.14	0.41	29

26 of the 29 species found in the Central Plateau also are recorded from the Transverse Volcanic Axis, but because of the disparity in the size of their respective herpetofaunas their CBR value is only 0.41. Nonetheless, this is the Central Plateau's greatest degree of resemblance with any of the other four provinces.

As opposed to species shared between or among physiographic provinces, the distribution of some species is confined to a single province (Table 4), although sometimes these are more broadly distributed outside the state. In the Coastal Plain, the following 22 species are involved:

Trachycephalus typhonius
Hypopachus ustus
Crocodylus acutus
Phyllodactylus davisi
Phyllodactylus homolepidurus
Plestiodon parvulus
Geagras redimitus
Symphimus leucostomus
Coniophanes michoacanensis
Coniophanes piceivittis
Enulius oligostichus
Leptodeira nigrofasciata
Leptodeira uribei
Pelamis platura
Thamnophis proximus
Thamnophis validus
Porthidium hespere
Plestiodon parvulus
Chelonia mydas
Lepidochelys olivacea
Dermochelys coriacea
Rhinoclemmys pulcherrima

In the Balsas-Tepalcatepec Depression, the following 16 species are confined to this province:

Eleutherodactylus maurus
Lithobates berlandieri
Lithobates magnaocularis
Rhinophrynus dorsalis

Bipes canaliculatus
Ctenosaura clarki
Phyllodactylus paucituberculatus
Aspidoscelis sacki
Imantodes gemmistratus
Leptodeira septentrionalis
Micrurus laticollaris
Rena bressoni
Rena humilis
Rena maxima
Thamnophis postremus
Crotalus culminatus

The following 14 species are limited to the Sierra Madre del Sur, within the state:

Eleutherodactylus modestus
Eleutherodactylus rufescens
Barisia jonesi
Elgaria kingii
Sceloporus bulleri
Sceloporus insignis
Coniophanes sarae
Dipsas gaigeae
Geophis incomptus
Geophis nigrocinctus
Geophis pyburni
Geophis sieboldi
Tropidodipsas annulifera
Tropidodipsas fasciata

The herpetofauna of the Transverse Volcanic Axis in Michoacán contains the following 47 single-province species (*Lithobates catesbeianus*, a non-native species, is not listed):

Craugastor hobartsmithi
Craugastor occidentalis
Eleutherodactylus angustidigitum
Hyla plicata
Lithobates dunni
Lithobates spectabilis
Ambystoma amblycephalum
Ambystoma andersoni

Ambystoma dumerilii
Ambystoma ordinarium
Ambystoma rivulare
Ambystoma velasci
Pseudoeurycea bellii
Pseudoeurycea leprosa
Pseudoeurycea longicauda
Abronia deppii
Barisia imbricata
Barisia rudicollis
Gerrhonotus liocephalus
Phrynosoma orbiculare
Sceloporus aeneus
Sceloporus grammicus
Plestiodon copei
Plestiodon dugesii
Conopsis biserialis
Conopsis nasus
Gyalopion canum
Lampropeltis ruthveni
Lampropeltis triangulum
Tantilla bocourti
Tantilla cascadeae
Diadophis punctatus
Geophis bicolor

Geophis dugesii
Geophis maculiferus
Geophis tarascae
Rhadinaea laureata
Rhadinaea taeniata
Micrurus tener
Thamnophis melanogaster
Thamnophis pulchrilatus
Thamnophis scalaris
Crotalus aquilus
Crotalus molossus
Crotalus polystictus
Crotalus tancitarensis
Crotalus triseriatus

Finally, the Central Plateau herpetofauna includes only one species limited to this province, as follows:

Adelophis copei

In total, of the 212 native species, 100 (47.2%) are confined to a single physiographic province within the state. Organizing these single-province species by their distributional status (Table 7) indicates the following (listed in order of state endemics, country endemics, and non-endemic species): Coastal plain (22 total species) = 1 (4.5%), 10 (45.5%), 11 (50.0%); Balsas-Tepalcate-



Pseudoeurycea bellii. Bell's false brook salamander occurs from southern Tamaulipas and southern Nayarit southward to Tlaxcala and Guerrero, Mexico, with a disjunct population found in east-central Sonora and adjacent Chihuahua. Its EVS has been gauged as 12, placing it in the upper portion of the medium vulnerability category, its status has been judged as Vulnerable by IUCN, and it is regarded as Threatened by SEMARNAT. This individual was found and photographed on Cerro Tancítaro, Michoacán.
 Photo by Javier Alvarado-Díaz.

pec Depression (16 species) = 3 (18.8%), 7 (43.8%), 6 (37.4%); Sierra Madre del Sur (14 species) = 5 (35.7%), 8 (57.2%), 1 (7.1%); Transverse Volcanic Axis = 8 (17.0%), 32 (68.1%), 7 (14.9%); Central Plateau = 0 (0.0%), 1 (100%), 0 (0.0%). Most of these single-province species are country-level endemics (58 [58.0%]); and the remaining are non-endemics (25 [25.0%]) or state-level endemics (17 [17.0%]).

Conservation Status

We employed three systems in creating a comprehensive view of the conservation status of the amphibians and reptiles of Michoacán (see Materials and Methods), of which one was developed for use in Mexico (the SEMARNAT

system), another developed for use in Central America (the EVS system, Wilson and Johnson 2010) and later applied to Mexico (Wilson et al. 2013a,b), and a third developed for use on a global basis (the IUCN system). We discuss the application of these systems to the herpetofauna of Michoacán below.

Table 7. Distributional and conservation status measures for members of the herpetofauna of Michoacán, Mexico. Distributional Status: SE = endemic to state of Michoacán; CE = endemic to country of Mexico; NE = not endemic to state or country; NN = non-native. Environmental Vulnerability Score (taken from Wilson et al. 2013a,b): low vulnerability species (EVS of 3–9); medium vulnerability species (EVS of 10–13); high vulnerability species (EVS of 14–20). IUCN Categorization: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; NE = Not Evaluated. SEMARNAT Status: A = Threatened; P = Endangered; Pr = Special Protection; NS = No Status. See text for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Taxa	Distributional Status	Environmental Vulnerability Score	IUCN Categorization	SEMARNAT Status
Amphibia (54 species)				
Anura (44 species)				
Bufonidae (6 species)				
<i>Anaxyrus compactilis</i>	CE	14	LC	NS
<i>Incilius marmoreus</i>	CE	11	LC	NS
<i>Incilius occidentalis</i>	CE	11	LC	NS
<i>Incilius perplexus</i>	CE	11	EN	NS
<i>Incilius pisinnus</i>	SE	15	DD	NS
<i>Rhinella marina</i>	NE	3	LC	NS
Craugastoridae (5 species)				
<i>Craugastor augusti</i>	NE	8	LC	NS
<i>Craugastor hobartsmithi</i>	CE	15	EN	NS
<i>Craugastor occidentalis</i>	CE	13	DD	NS
<i>Craugastor pygmaeus</i>	NE	9	VU	NS
<i>Craugastor vocalis</i>	CE	13	LC	NS
Eleutherodactylidae (5 species)				
<i>Eleutherodactylus angustidigitorum</i>	SE	17	VU	Pr
<i>Eleutherodactylus maurus</i>	CE	17	DD	Pr
<i>Eleutherodactylus modestus</i>	CE	16	VU	Pr
<i>Eleutherodactylus nitidus</i>	CE	12	LC	NS
<i>Eleutherodactylus rufescens</i>	SE	17	CR	Pr
Hylidae (11 species)				
<i>Agalychnis dacnicolor</i>	CE	13	LC	NS
<i>Diaglena spatulata</i>	CE	13	LC	NS

<i>Exerodonta smaragdina</i>	CE	12	LC	Pr
<i>Hyla arenicolor</i>	NE	7	LC	NS
<i>Hyla eximia</i>	NE	10	LC	NS
<i>Hyla plicata</i>	CE	11	LC	A
<i>Plectrohyla bistincta</i>	CE	9	LC	Pr
<i>Smilisca baudinii</i>	NE	3	LC	NS
<i>Smilisca fodiens</i>	NE	8	LC	NS
<i>Tlalocohyla smithii</i>	CE	11	LC	NS
<i>Trachycephalus typhonius</i>	NE	4	LC	NS
Leptodactylidae (2 species)				
<i>Leptodactylus fragilis</i>	NE	5	LC	NS
<i>Leptodactylus melanonotus</i>	NE	6	LC	NS
Microhylidae (2 species)				
<i>Hypopachus ustus</i>	NE	7	LC	Pr
<i>Hypopachus variolosus</i>	NE	4	LC	NS
Ranidae (11 species)				
<i>Lithobates berlandieri</i>	NE	7	LC	Pr
<i>Lithobates catesbeianus</i>	NN	—	—	—
<i>Lithobates dunni</i>	SE	14	EN	Pr
<i>Lithobates forreri</i>	NE	3	LC	Pr
<i>Lithobates magnaocularis</i>	CE	12	LC	NS
<i>Lithobates megapoda</i>	CE	14	VU	Pr
<i>Lithobates montezumae</i>	CE	13	LC	Pr
<i>Lithobates neovolcanicus</i>	CE	13	NT	A
<i>Lithobates pustulosus</i>	CE	9	LC	Pr
<i>Lithobates spectabilis</i>	CE	12	LC	NS
<i>Lithobates zweifeli</i>	CE	11	LC	NS
Rhinophrynidae (1 species)				
<i>Rhinophrynus dorsalis</i>	NE	8	LC	Pr
Scaphiopodidae (1 species)				
<i>Spea multiplicata</i>	NE	6	LC	NS
Caudata (9 species)				
Ambystomatidae (6 species)				
<i>Ambystoma amblycephalum</i>	SE	13	CR	Pr
<i>Ambystoma andersoni</i>	SE	15	CR	Pr
<i>Ambystoma dumerilii</i>	SE	15	CR	Pr
<i>Ambystoma ordinarium</i>	CE	13	EN	Pr
<i>Ambystoma rivulare</i>	CE	13	DD	A
<i>Ambystoma velasci</i>	CE	10	LC	Pr
Plethodontidae (3 species)				
<i>Pseudoeurycea bellii</i>	CE	12	VU	A
<i>Pseudoeurycea leprosa</i>	CE	16	VU	A
<i>Pseudoeurycea longicauda</i>	CE	17	EN	Pr
Gymnophiona (1 species)				
Caeciliidae (1 species)				
<i>Dermophis oaxacae</i>	CE	12	DD	Pr
Reptilia (161 species)				

Crocodylia (1 species)				
Crocodylidae (1 species)				
<i>Crocodylus acutus</i>	NE	14	VU	Pr
Squamata (153 species)				
Bipedidae (1 species)				
<i>Bipes canaliculatus</i>	CE	12	LC	Pr
Anguidae (6 species)				
<i>Abronia deppii</i>	CE	16	EN	A
<i>Barisia imbricata</i>	CE	14	LC	Pr
<i>Barisia jonesi</i>	SE	16	NE	NS
<i>Barisia rudicollis</i>	CE	15	EN	P
<i>Elgaria kingii</i>	NE	10	LC	Pr
<i>Gerrhonotus liocephalus</i>	NE	6	LC	Pr
Corytophanidae (1 species)				
<i>Basiliscus vittatus</i>	NE	7	NE	NS
Dactyloidae (2 species)				
<i>Anolis dunni</i>	CE	16	LC	A
<i>Anolis nebulosus</i>	CE	13	LC	NS
Eublepharidae (1 species)				
<i>Coleonyx elegans</i>	NE	9	NE	A
Gekkonidae (1 species)				
<i>Hemidactylus frenatus</i>	NN	—	—	—
Helodermatidae (1 species)				
<i>Heloderma horridum</i>	NE	11	LC	A
Iguanidae (3 species)				
<i>Ctenosaura clarki</i>	CE	15	VU	A
<i>Ctenosaura pectinata</i>	CE	15	NE	A
<i>Iguana iguana</i>	NE	12	NE	Pr
Mabuyidae (1 species)				
<i>Marisora brachypoda</i>	NE	6	NE	NS
Phrynosomatidae (20 species)				
<i>Phrynosoma asio</i>	NE	11	NE	Pr
<i>Phrynosoma orbiculare</i>	CE	12	LC	A
<i>Sceloporus aeneus</i>	CE	13	LC	NS
<i>Sceloporus asper</i>	CE	14	LC	Pr
<i>Sceloporus bulleri</i>	CE	15	LC	NS
<i>Sceloporus dugesii</i>	CE	13	LC	NS
<i>Sceloporus gadoviae</i>	CE	11	LC	NS
<i>Sceloporus grammicus</i>	NE	9	LC	Pr
<i>Sceloporus heterolepis</i>	CE	14	LC	NS
<i>Sceloporus horridus</i>	CE	11	LC	NS
<i>Sceloporus insignis</i>	CE	16	LC	Pr
<i>Sceloporus melanorhinus</i>	NE	9	LC	NS
<i>Sceloporus pyrocephalus</i>	CE	12	LC	NS
<i>Sceloporus scalaris</i>	NE	12	LC	NS
<i>Sceloporus siniferus</i>	NE	11	LC	NS
<i>Sceloporus spinosus</i>	CE	12	LC	NS

<i>Sceloporus torquatus</i>	CE	11	LC	NS
<i>Sceloporus utiformis</i>	CE	15	LC	NS
<i>Urosaurus bicarinatus</i>	CE	12	LC	NS
<i>Urosaurus gadovi</i>	CE	12	LC	NS
Phyllodactylidae (5 species)				
<i>Phyllodactylus davisii</i>	CE	16	LC	A
<i>Phyllodactylus duellmani</i>	SE	16	LC	Pr
<i>Phyllodactylus homolepidurus</i>	CE	15	LC	Pr
<i>Phyllodactylus lanei</i>	CE	15	LC	NS
<i>Phyllodactylus paucituberculatus</i>	SE	16	DD	A
Scincidae (6 species)				
<i>Mesoscincus altamirani</i>	CE	14	DD	Pr
<i>Plestiodon colimensis</i>	CE	14	DD	Pr
<i>Plestiodon copei</i>	CE	14	LC	Pr
<i>Plestiodon dugesii</i>	CE	16	VU	Pr
<i>Plestiodon indubitus</i>	CE	15	LC	NS
<i>Plestiodon parvulus</i>	CE	15	DD	NS
Sphenomorphidae (1 species)				
<i>Sphenomorphus assatus</i>	NE	7	NE	NS
Teiidae (8 species)				
<i>Aspidoscelis calidipes</i>	SE	14	LC	Pr
<i>Aspidoscelis communis</i>	CE	14	LC	Pr
<i>Aspidoscelis costata</i>	CE	11	LC	Pr
<i>Aspidoscelis deppei</i>	NE	8	LC	NS
<i>Aspidoscelis gularis</i>	NE	9	LC	NS
<i>Aspidoscelis lineatissima</i>	CE	14	LC	Pr
<i>Aspidoscelis sacki</i>	CE	14	LC	NS
<i>Holcosus undulatus</i>	NE	7	NE	NS
Xantusiidae (1 species)				
<i>Lepidophyma tarascae</i>	CE	14	DD	A
Boidae (1 species)				
<i>Boa constrictor</i>	NE	10	NE	A
Colubridae (28 species)				
<i>Conopsis biserialis</i>	CE	13	LC	A
<i>Conopsis lineata</i>	CE	13	LC	NS
<i>Conopsis nasus</i>	CE	11	LC	NS
<i>Drymarchon melanurus</i>	NE	6	LC	NS
<i>Drymobius margaritiferus</i>	NE	6	NE	NS
<i>Geagras redimitus</i>	CE	14	DD	Pr
<i>Gyalopion canum</i>	NE	9	LC	NS
<i>Lampropeltis ruthveni</i>	CE	16	NT	A
<i>Lampropeltis triangulum</i>	NE	7	NE	A
<i>Leptophis diplotropis</i>	CE	14	LC	A
<i>Masticophis flagellum</i>	NE	8	LC	A
<i>Masticophis mentovarius</i>	NE	6	NE	A
<i>Masticophis taeniatus</i>	NE	10	LC	NS
<i>Mastigodryas melanolomus</i>	NE	6	LC	NS

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<i>Oxybelis aeneus</i>	NE	5	NE	NS
<i>Pituophis deppei</i>	CE	14	LC	A
<i>Pituophis lineaticollis</i>	NE	8	LC	NS
<i>Pseudoficimia frontalis</i>	CE	13	LC	Pr
<i>Salvadora bairdi</i>	CE	15	LC	Pr
<i>Salvadora mexicana</i>	CE	15	LC	Pr
<i>Senticolis triaspis</i>	NE	6	NE	NS
<i>Sonora michoacanensis</i>	CE	14	LC	NS
<i>Symphimus leucostomus</i>	CE	14	LC	Pr
<i>Tantilla bocourti</i>	CE	9	LC	NS
<i>Tantilla calamarina</i>	CE	12	LC	Pr
<i>Tantilla cascadae</i>	SE	16	DD	A
<i>Trimorphodon biscutatus</i>	NE	7	NE	NS
<i>Trimorphodon tau</i>	CE	13	LC	NS
Dipsadidae (33 species)				
<i>Coniophanes fissidens</i>	NE	7	NE	NS
<i>Coniophanes lateritius</i>	CE	13	DD	NS
<i>Coniophanes michoacanensis</i>	SE	17	NE	NS
<i>Coniophanes piceivittis</i>	NE	7	LC	NS
<i>Coniophanes sarae</i>	SE	16	DD	NS
<i>Diadophis punctatus</i>	NE	4	LC	NS
<i>Dipsas gaigeae</i>	CE	17	LC	Pr
<i>Enulius flavitorques</i>	NE	5	NE	NS
<i>Enulius oligostichus</i>	CE	15	DD	Pr
<i>Geophis bicolor</i>	CE	15	DD	Pr
<i>Geophis dugesii</i>	CE	13	LC	NS
<i>Geophis incomptus</i>	SE	16	DD	Pr
<i>Geophis maculiferus</i>	SE	16	DD	Pr
<i>Geophis nigrocinctus</i>	CE	15	DD	Pr
<i>Geophis petersii</i>	CE	15	DD	Pr
<i>Geophis pyburni</i>	SE	16	DD	Pr
<i>Geophis sieboldi</i>	CE	13	DD	Pr
<i>Geophis tarascae</i>	CE	15	DD	Pr
<i>Hypsiglena torquata</i>	NE	8	LC	Pr
<i>Imantodes gemmistratus</i>	NE	6	NE	Pr
<i>Leptodeira maculata</i>	CE	7	LC	Pr
<i>Leptodeira nigrofasciata</i>	NE	8	LC	NS
<i>Leptodeira septentrionalis</i>	NE	8	NE	NS
<i>Leptodeira splendida</i>	CE	14	LC	NS
<i>Leptodeira uribei</i>	CE	17	LC	Pr
<i>Pseudoleptodeira latifasciata</i>	CE	14	LC	Pr
<i>Rhadinaea hesperia</i>	CE	10	LC	Pr
<i>Rhadinaea laureata</i>	CE	12	LC	NS
<i>Rhadinaea taeniata</i>	CE	13	LC	NS
<i>Sibon nebulatus</i>	NE	5	NE	NS
<i>Tropidodipsas annulifera</i>	CE	13	LC	Pr
<i>Tropidodipsas fasciata</i>	CE	13	NE	NS

<i>Tropidodipsas philippii</i>	CE	14	LC	Pr
Elapidae (4 species)				
<i>Micrurus distans</i>	CE	14	LC	Pr
<i>Micrurus laticollaris</i>	CE	14	LC	Pr
<i>Micrurus tener</i>	NE	11	LC	NS
<i>Pelamis platura</i>	NE	—	LC	NS
Leptotyphlopidae (4 species)				
<i>Epictia goudotii</i>	NE	3	NE	NS
<i>Rena bressoni</i>	SE	14	DD	Pr
<i>Rena humilis</i>	NE	8	LC	NS
<i>Rena maxima</i>	CE	11	LC	NS
Loxocemidae (1 species)				
<i>Loxocemus bicolor</i>	NE	10	NE	Pr
Natricidae (11 species)				
<i>Adelophis copei</i>	CE	15	VU	Pr
<i>Storeria storerioides</i>	CE	11	LC	NS
<i>Thamnophis cyrtopsis</i>	NE	7	LC	A
<i>Thamnophis eques</i>	NE	8	LC	A
<i>Thamnophis melanogaster</i>	CE	15	EN	A
<i>Thamnophis postremus</i>	SE	15	LC	NS
<i>Thamnophis proximus</i>	NE	7	NE	NS
<i>Thamnophis pulchrilatus</i>	CE	15	LC	NS
<i>Thamnophis scalaris</i>	CE	14	LC	A
<i>Thamnophis scaliger</i>	CE	15	VU	A
<i>Thamnophis validus</i>	CE	12	LC	NS
Typhlopidae (1 species)				
<i>Ramphotyphlops braminus</i>	NN	—	—	—
Viperidae (10 species)				
<i>Agkistrodon bilineatus</i>	NE	11	NT	Pr
<i>Crotalus aquilus</i>	CE	16	LC	Pr
<i>Crotalus basiliscus</i>	CE	16	LC	Pr
<i>Crotalus culminatus</i>	CE	15	NE	NS
<i>Crotalus molossus</i>	NE	8	LC	Pr
<i>Crotalus polystictus</i>	CE	16	LC	Pr
<i>Crotalus pusillus</i>	CE	18	EN	A
<i>Crotalus tancitarensis</i>	SE	19	DD	NS
<i>Crotalus triseriatus</i>	CE	16	LC	NS
<i>Porthidium hespere</i>	CE	18	DD	Pr
Xenodontidae (2 species)				
<i>Conophis vittatus</i>	CE	11	LC	NS
<i>Manolepis putnami</i>	CE	13	LC	NS
Testudines (7 species)				
Cheloniidae (2 species)				
<i>Chelonia mydas</i>	NE	—	EN	P
<i>Lepidochelys olivacea</i>	NE	—	VU	P
Dermochelyidae (1 species)				
<i>Dermochelys coriacea</i>	NE	—	CR	P

Geoemydidae (2 species)				
<i>Rhinoclemmys pulcherrima</i>	NE	8	NE	A
<i>Rhinoclemmys rubida</i>	CE	14	NT	Pr
Kinosternidae (2 species)				
<i>Kinosternon hirtipes</i>	NE	10	LC	Pr
<i>Kinosternon integrum</i>	CE	11	LC	Pr



Pseudoeurycea leprosa. The leprous false brook salamander occurs in Veracruz, Puebla, Distrito Federal, México, Morelos, Guerrero, and Oaxaca. Its EVS has been judged as 16, placing it in the middle of the high vulnerability category, IUCN has assessed this species as Vulnerable, and it is considered as Threatened by SEMARNAT. This individual was encountered on Cerro Cacique, near Zitacuaro, in Michoacán. Photo by Oscar Medina-Aguilar.



Abronia deppii. Deppé's arboreal alligator lizard is found in the mountains of the Transverse Volcanic Axis in Michoacán, México, and Jalisco. Its EVS has been judged as 16, placing it in the middle of the high vulnerability category, IUCN considers this species as Endangered, and it has been provided a Threatened status by SEMARNAT. This individual came from San José de las Torres, near Morelia, in Michoacán. Photo by Javier Alvarado-Díaz.



Barisia imbricata. In Michoacán, the imbricate alligator lizard occurs in the Transverse Volcanic Axis. The systematics of this species, however, is currently in flux, and based on indications in recent molecular work this taxon likely will be divided into a number of species. Its EVS has been estimated as 14, placing it at the lower end of the high vulnerability category, this species has been judged as Least Concern by IUCN, and given a Special Protected status by SEMARNAT. This individual is from Tacámbaro, in the Transverse Volcanic Axis of Michoacán. Photo by Oscar Medina-Aguilar.

1. The SEMARNAT system

The application of the SEMARNAT system appears in NOM-059-SEMARNAT-2010 (available at www.semarnat.gob.mx), and uses three categories: Endangered (P), Threatened (A), and Special Protection (Pr). In addition to these categories, we considered the species left untreated in the SEMARNAT system as having “No status.” We listed the SEMARNAT categorizations in Table 7 and summarized the results of the partitioning of the 212 native species in Table 8.

Perusal of the tabular data reveals one important conclusion—almost one-half of the species in Michoacán (98 [46.2%]) are not considered in the SEMARNAT system (Table 8). The missing species include 27 anurans, 27 lizards, and 44 snakes, and include the following: all six of the bufonids, of which five are Mexican endemic species (one is endemic to Michoacán); all five of the craugas-torids, of which three are Mexican endemics; eight of 11 hylids, of which three are Mexican endemics; one of two dactyloids, which one is a Mexican endemic; 15 of

20 phrynosomatids, of which 12 are Mexican endemics; one-half of the 28 colubrids, of which five are Mexican endemics; 15 of 33 dipsadids, of which eight are Mexican endemics (two also are state endemics); four of 11 natri-cids, of which four are Mexican endemics (one also is a state endemic); and two of 10 viperids, of which two are Mexican endemics (one also is a state endemic).

Of the 212 total species, only four (1.9%) are judged as Endangered (three are sea turtles from the coastal waters of the state and one is the anguid *Abronia deppii*). Thirty-one species (14.6%) are considered as Threatened and 79 (37.1%) as needing Special Protection (Table 8).

In the end, any system purporting to at least identify species in need of conservation attention is better than no system at all. The SEMARNAT system, however, is seriously deficient because a high percentage of species are not provided with a conservation status, and a significant portion of these taxa are state or country level endemics. We address our concerns in the Conclusions and Recommendations section.

Table 8. SEMARNAT categorizations for amphibians and reptiles in Michoacán arranged by families. Non-native species are excluded.

Families	Number of Species	SEMARNAT Categorizations			
		Endangered (P)	Threatened (A)	Special Protection (Pr)	No Status
Bufonidae	6	—	—	—	6
Craugastoridae	5	—	—	—	5
Eleutherodactylidae	5	—	—	4	1
Hylidae	11	—	1	2	8
Leptodactylidae	2	—	—	—	2
Microhylidae	2	—	—	1	1
Ranidae	10	—	1	6	3
Rhinophrynidae	1	—	—	1	—
Scaphiopodidae	1	—	—	—	1
Subtotals	43	—	2	14	27
Ambystomatidae	6	—	1	5	—
Plethodontidae	3	—	2	1	—
Subtotals	9	—	3	6	—
Caeciliidae	1	—	—	1	—
Subtotals	1	—	—	1	—
Totals	53	—	5	21	27
Crocodylidae	1	—	—	1	—
Subtotals	1	—	—	1	—
Cheloniidae	2	2	—	—	—
Dermochelyidae	1	1	—	—	—
Geoemydidae	2	—	1	1	—
Kinosternidae	2	—	—	2	—
Subtotals	7	3	1	3	—
Bipedidae	1	—	—	1	—
Anguidae	6	1	1	3	1
Corytophanidae	1	—	—	—	1
Dactyloidae	2	—	1	—	1
Eublepharidae	1	—	1	—	—
Helodermatidae	1	—	1	—	—
Iguanidae	3	—	2	1	—
Mabuyidae	1	—	—	—	1
Phrynosomatidae	20	—	1	4	15
Phyllodactylidae	5	—	2	2	1
Scincidae	6	—	—	4	2
Sphenomorphidae	1	—	—	—	1
Teiidae	8	—	—	4	4
Xantusiidae	1	—	1	—	—
Subtotals	57	1	10	19	27
Boidae	1	—	1	—	—
Colubridae	28	—	8	6	14
Dipsadidae	33	—	—	18	15

Leptotyphlopidae	4	—	—	1	3
Loxocemidae	1	—	—	1	—
Natricidae	11	—	5	1	5
Viperidae	10	—	1	6	3
Xenodontidae	2	—	—	—	2
Subtotals	94	—	15	35	44
Totals	159	4	26	58	71
Sum Totals	212	4	31	79	98

2. The IUCN system



Coleonyx elegans. The elegant banded gecko is broadly distributed on both versants, from southern Nayarit and Veracruz in Mexico southward to Guatemala and Belize. In Michoacán, it inhabits the Coastal Plain and Balsas-Tepalcatepec Depression physiographic provinces. Its EVS has been indicated as 9, placing it at the upper end of the low vulnerability category, its IUCN status has not been assessed, and this gecko is regarded as Threatened by SEMARNAT. This individual came from Colola, on the coast of Michoacán. *Photo by Javier Alvarado-Díaz.*



Ctenosaura clarki. The Balsas armed lizard is endemic to the Balsas-Tepalcatepec Depression. Its EVS has been gauged as 15, placing it in the lower portion of the high vulnerability category, this species has been judged as Vulnerable by IUCN, and considered as Threatened by SEMARNAT. This individual is from Nuevo Centro, Reserva de la Biósfera Infiernillo-Zicuirán, near the Presa Infiernillo on the Río Balsas in southeastern Michoacán. *Photo by Javier Alvarado-Díaz.*

The IUCN system is the most widely used system for categorizing the conservation status of the world's organisms, although it is skewed heavily toward chordate animals, as assessed by Stuart et al. (2010b). Of the 64,788 described chordate species, 27,882 (43.0%) had been assessed on the IUCN Red List by the year 2009; comparatively, only 7,615 of 1,359,365 species of other described animals had been assessed, a miniscule 0.56%. In fact, if all of the 1,424,153 animal species treated in Stuart et al. (2010b) are considered, only 2.5% have been assessed on the IUCN Red List. This extant situation is not so much of a criticism of the effectiveness of the IUCN system, but rather a criticism of the lack of attention given to conservation of the world's organisms by humanity at large (Wilson 2002). As a case in point, Stuart et al. (2010b) reported that if a provisional target number of 106,979 animal species (only 7.5% of the total number of described species) were established in attempting to develop a broader taxonomic base of threatened animal species, the estimated cost to complete would be about \$36,000,000. Completion of a threatened species assess-

ment, however, is only the first step toward providing a given species adequate protection for perpetuity.

We listed the current IUCN Red List categorizations for the Michoacán herpetofauna in Table 7 and summarized the results in Table 9. The allocations of the 212 species assessed to the seven IUCN categories are as follows: Critically Endangered (CR) = 5 species (2.3%); Endangered (E) = 10 (4.7%); Vulnerable (VU) = 12 (5.6%); Near Threatened (NT) = 4 (1.9%); Least Concern (LC) = 127 (60.0%); Data Deficient (DD) = 26 (12.3%); and Not Evaluated (NE) = 28 (13.2%). These results are typical of those allocated for all Mexican amphibians and reptiles (see Wilson et al. 2013a,b). As a consequence, only 27 of the 213 species (12.7%) occupy the threatened categories (CR, EN, or VU). Six of every 10 species are judged at the lowest level of concern (LC). Finally, 54 species (25.5%) have been assessed either as DD or have not been assessed (NE).

Table 9. IUCN Red List categorizations for amphibian and reptile families in Michoacán. Non-native species are excluded.

Families	Number of Species	IUCN Red List categorizations						
		Critically Endangered	Endangered	Vulnerable	Near Threatened	Least Concern	Data Deficient	Not Evaluated
Bufo	6	—	1	—	—	4	1	—
Craugastor	5	—	1	1	—	2	1	—
Eleutherodactyl	5	1	—	2	—	1	1	—
Hyla	11	—	—	—	—	11	—	—
Leptodactyl	2	—	—	—	—	2	—	—
Microhyla	2	—	—	—	—	2	—	—
Rana	10	—	1	1	1	7	—	—
Rhinophryn	1	—	—	—	—	1	—	—
Scaphiopod	1	—	—	—	—	1	—	—
Subtotals	43	1	3	4	1	31	3	—
Ambystomat	6	3	1	—	—	1	1	—
Plethodont	3	—	1	2	—	—	—	—
Subtotals	9	3	2	2	—	1	1	—
Caecili	1	—	—	—	—	—	1	—
Subtotals	1	—	—	—	—	—	1	—
Totals	53	4	5	6	1	32	5	—
Crocodyl	1	—	—	1	—	—	—	—
Subtotals	1	—	—	1	—	—	—	—
Cheloni	2	—	1	1	—	—	—	—
Dermochely	1	1	—	—	—	—	—	—
Geoemyd	2	—	—	—	1	—	—	1
Kinostern	2	—	—	—	—	2	—	—
Subtotals	7	1	1	1	1	2	—	1
Biped	1	—	—	—	—	1	—	—
Angu	6	—	2	—	—	3	—	1

Corytophanidae	1							1
Dactyloidae	2	—	—	—	—	2	—	—
Eublepharidae	1	—	—	—	—	—	—	1
Helodermatidae	1	—	—	—	—	1	—	—
Iguanidae	3	—	—	1	—	—	—	2
Mabuyidae	1	—	—	—	—	—	—	1
Phrynosomatidae	20	—	—	—	—	19	—	1
Phyllodactylidae	5	—	—	—	—	4	1	—
Scincidae	6	—	—	1	—	2	3	—
Sphenomorphidae	1	—	—	—	—	—	—	1
Teiidae	8	—	—	—	—	7	—	1
Xantusiidae	1	—	—	—	—	—	1	—
Subtotals	57	—	2	2	—	39	5	9
Boidae	1	—	—	—	—	—	—	1
Colubridae	28	—	—	—	1	19	2	6
Dipsadidae	33	—	—	—	—	15	11	7
Elapidae	4	—	—	—	—	4	—	—
Leptotyphlopidae	4	—	—	—	—	2	1	1
Loxocemidae	1	—	—	—	—	—	—	1
Natricidae	11	—	1	2	—	7	—	1
Viperidae	10	—	1	—	1	5	2	1
Xenodontidae	2	—	—	—	—	2	—	—
Subtotals	94	—	2	2	2	54	16	19
Totals	151	1	5	6	3	96	21	28
Sum Totals	212	5	10	12	4	127	26	28



Phyllodactylus duellmani. Duellman's pigmy leaf-toed gecko is endemic to Michoacán, where it is found in the Balsas-Tepalcatepec Depression and the Sierra Madre del Sur. Its EVS has been assigned a value of 16, placing it in the middle of the high vulnerability category, this species has been judged as Least Concern by IUCN, and accorded a Special Protection status by SEMARNAT. This individual was photographed at Nuevo Centro, Reserva de la Biósfera Infiernillo-Zicuirán, near the Presa Infiernillo on the Río Balsas in southeastern Michoacán. *Photo by Oscar Medina-Aguilar.*



Leptodeira uribei. Uribe's cat-eyed snake is distributed along the coastal plain in Michoacán, and northward through the lowlands to Jalisco and southward to Oaxaca. Its EVS has been gauged as 17, placing it in the middle of the high vulnerability category, its IUCN status has been assessed as Least Concern, and it is considered a Special Protection species by SEMARNAT. This individual was found at San Mateo, near the Reserva de la Biosfera Chamela-Cuixmala on the coast of Jalisco. Photo by Javier Alvarado-Díaz.



Thamnophis postremus. The Michoacán gartersnake is a state endemic. Its EVS has been allocated as 15, placing it in the lower portion of the high vulnerability category, it has been judged as Least Concern by IUCN, and this species has not been provided a status by SEMARNAT. This individual came from San Lucas in the Balsas-Tepalcatepec Depression in Michoacán. Photo by Javier Alvarado-Díaz.

Based on the application of this system, only a small percentage of the species in the state would be scheduled to receive the greatest amount of attention. These 27 species include eight anurans, seven salamanders, one crocodylian, three turtles, four lizards, and four snakes. Whereas most of these species appear to merit a threatened status, inasmuch as 16 of the 27 species are country-level endemics and six are state-level endemics (22 species, 81.5% of the 27), the herpetofauna of Michoacán is characterized by a higher level of endemism than for the entire country of Mexico (140 of 212 species [66.0%] vs. 736 of 1,227 species [60.0%]). If endemism can be considered an important criterion for listing a species as threatened under the IUCN system (which it is not, as this system exists), then a substantial number of other candidates are available for choosing (Table 10), a significant issue that needs to be addressed.

A similar issue is the number of species judged as Data Deficient (Table 9). Of these 26 species, 17 are country and nine are state level endemics. Assignment of the DD status leaves these species in limbo, and requires additional fieldwork before applying for a change in a species' status. Other papers in this special Mexico issue have criticized the use of the DD category, with Wilson et al. (2013b) labeling these species as "threat species in disguise." The significance of such species can be ignored in the "rush to judgment" that sometimes accompanies assessments conducted using the IUCN system (NatureServe Press Release 2007).

Another problem with the use of the IUCN system is discussed in the lead-in paragraph to this section, i.e., that some species have not been evaluated

(the NE species). Given the average cost of producing an IUCN threat assessment for a single species (\$534.12, according to the figures in Stuart et al. 2010b), it takes a considerable investment to assign a species to a category other than NE. Nonetheless, one is left with relegating such species to a “wastebasket of neglect.” In the case of the Michoacán herpetofauna, 28 species fall into this category, including nine lizards and 19 snakes (Table 9). To be fair, the distributions of most of these species (21) extends outside of Mexico and thus were assessed in a Central American Workshop held in May of 2012 in Costa Rica (Rodríguez et al. 2013). At that workshop, most of these species were assigned an LC status.

Adding more species to the LC category is not necessarily a beneficial step, inasmuch as this category

was described as a “dumping ground” by Wilson et al. (2013b), who opined that “a more discerning look would demonstrate that many of these species should be partitioned into IUCN categories other than LC,” e.g., the threat categories and NT. Currently, 127 of the 212 native species of amphibians and reptiles (59.9%) are placed in the LC category (Table 9), which includes 31 anurans, one salamander, two turtles, 39 lizards, and 54 snakes. We question these assignments on the basis that 83 of these species are country-level endemics, and three (*Phyllodactylus duellmani*, *Aspidoscelis calidipes*, and *Thamnophis postremus*) also are state-level endemics (Table 7).

Table 10. Summary of the distributional status of amphibian and reptile families in Michoacán.

Families	Number of Species	Distributional Status			
		Non-endemic (NE)	Country Endemic (CE)	State Endemic (SE)	Non-native (NN)
Bufo	6	1	4	1	—
Craugastor	5	2	3	—	—
Eleutherodactyl	5	—	3	2	—
Hyla	11	5	6	—	—
Leptodactyl	2	2	—	—	—
Microhyla	2	2	—	—	—
Rana	11	2	7	1	1
Rhinophryn	1	1	—	—	—
Scaphiopod	1	1	—	—	—
Subtotals	44	16	23	4	1
Ambystoma	6	—	3	3	—
Plethodon	3	—	3	—	—
Subtotals	9	—	6	3	—
Caecilia	1	—	1	—	—
Subtotals	1	—	1	—	—
Totals	54	16	30	7	1
Crocodyl	1	1	—	—	—
Subtotals	1	1	—	—	—
Cheloni	2	2	—	—	—
Dermochely	1	1	—	—	—
Geoemyd	2	1	1	—	—
Kinostern	2	1	1	—	—
Subtotals	7	5	2	—	—
Biped	1	—	1	—	—
Angu	6	2	3	1	—
Corytophan	1	1	—	—	—
Dactyl	2	—	2	—	—

Gekkonidae	1	—	—	—	1
Helodermatidae	1	1	—	—	—
Iguanidae	3	1	2	—	—
Mabuyidae	1	1	—	—	—
Phrynosomatidae	20	5	15	—	—
Phyllodactylidae	5	—	3	2	—
Scincidae	6	—	6	—	—
Sphenomorphidae	1	1	—	—	—
Teiidae	8	3	4	1	—
Xantusiidae	1	—	1	—	—
Subtotals	58	16	37	4	1
Boidae	1	1	—	—	—
Colubridae	28	12	15	1	—
Dipsadidae	33	9	19	5	—
Elapidae	4	2	2	—	—
Leptotyphlopidae	4	2	1	1	—
Loxocemidae	1	1	—	—	—
Natricidae	11	3	7	1	—
Typhlopidae	1	—	—	—	1
Viperidae	10	2	7	1	—
Xenodontidae	2	—	2	—	—
Subtotals	95	32	53	9	1
Totals	161	54	92	13	2
Sum Totals	215	70	122	20	3

3. The EVS system



Rena bressoni. The Michoacán slender blindsnake is a state endemic, and its distribution is limited to the Balsas-Tepalcatepec Depression. Its EVS has been estimated as 14, placing it at the lower end of the high vulnerability category, it has been judged as Data Deficient by IUCN, and SEMARNAT considers it a Special Protection species. This individual was found in the municipality of Tacámbaro in Michoacán. *Photo by Oscar Medina-Aguilar.*



Crotalus basiliscus. The west coast Mexican rattlesnake is distributed from southern Sonora to northwestern Michoacán. In Michoacán, it is found in the Coastal Plain, Sierra Madre del Sur, and the Balsas-Tepalcatepec Depression physiographic provinces. Its EVS has been reported as 16, placing it in the middle of the high vulnerability category, it has been assessed as Least Concern by IUCN, and it is regarded as a Special Protection species by SEMARNAT. This individual is from San Mateo, on the coast of Jalisco.
Photo by Oscar Medina-Aguilar.



Crotalus pusillus. The Tancitaran dusky rattlesnake is found in the Sierra de Coalcomán region of the Sierra Madre del Sur and the western portion of the Transverse Volcanic Axis. Its EVS has been estimated as 18, placing it in the upper portion of the high vulnerability category, it has been assessed as Endangered by IUCN, and it is considered as Threatened by SEMARNAT. This individual came from Cerro Tancítaro, the highest mountain in Michoacán, located in the west-central portion of the state. Photo by Javier Alvarado-Díaz.

The EVS (Environmental Vulnerability Score) system of conservation assessment first was applied to the herpetofauna of Honduras by Wilson and McCranie (2004). Since that time, this system has been applied to the herpetofaunas of Belize (Stafford et al. 2010), Guatemala (Acevedo et al. 2010), Nicaragua (Sunyer and Köhler 2010), Costa Rica (Sasa et al. 2010), and Panama (Jaramillo et al. 2010). In this special Mexico issue, the EVS measure also has been applied to the herpetofauna of Mexico (Wilson et al. 2013a,b).

In this paper, we utilized the scores computed by Wilson et al (2013a,b), which are indicated in Table 7 and summarized in Table 11 for the 208 species for which the scores are calculable. We arranged the resultant scores into three categories (low, medium, and high vulnerability), which were established by Wilson and McCranie (2004).

The EVS for members of the Michoacán herpetofauna range from 3 to 19 (Table 11). The lowest score of 3 was calculated for three anurans (the bufonid *Rhinella marina*, the hylid *Smilisca baudinii*, and the ranid *Lithobates forreri*) and one snake (the leptotyphlopoid *Epicratis goudotii*). The highest value of 19 was assigned to the viperid *Crotalus tancitarensis*.

The summed scores for the entire herpetofauna vascillate over the range, but still generally rise from the lower scores of 3 through 5 to peak at 14 and decline thereafter (Table 11). Similar patterns are seen for amphibians and reptiles separately, although the species numbers for amphibians peak at an EVS of 13 instead of 14, as is the case for reptiles.

Table 11. Environmental Vulnerability Scores (EVS) for amphibian and reptile species in Michoacán, arranged by family. Shaded area to the left encompasses low vulnerability scores, and to the right high vulnerability scores.

Families	Number of Species	Environmental Vulnerability Scores																	
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Bufonidae	6	1	—	—	—	—	—	—	—	3	—	—	1	1	—	—	—	—	
Craugastoridae	5	—	—	—	—	—	1	1	—	—	—	2	—	1	—	—	—	—	
Eleutherodactylidae	5	—	—	—	—	—	—	—	—	—	1	—	—	—	1	3	—	—	
Hylidae	11	1	1	—	—	1	1	1	1	2	1	2	—	—	—	—	—	—	
Leptodactylidae	2	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	
Microhylidae	2	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	
Ranidae	10	1	—	—	—	1	—	1	—	1	2	2	2	—	—	—	—	—	
Rhinophrynidae	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	
Scaphiopodidae	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	
Subtotals	43	3	2	1	2	3	3	3	1	6	4	6	3	2	1	3	—	—	
Subtotals %	—	7.0	4.6	2.3	4.6	7.0	7.0	7.0	2.3	14.0	9.3	14.0	7.0	4.6	2.3	7.0	—	—	
Ambystomatidae	6	—	—	—	—	—	—	—	1	—	—	3	—	2	—	—	—	—	
Plethodontidae	3	—	—	—	—	—	—	—	—	—	1	—	—	—	1	1	—	—	
Subtotals	9	—	—	—	—	—	—	—	1	—	1	3	—	2	1	1	—	—	
Subtotals %	—	—	—	—	—	—	—	—	11.1	—	11.1	33.3	—	22.2	11.1	11.1	—	—	
Caeciliidae	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	
Subtotals	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	
Subtotals %	—	—	—	—	—	—	—	—	—	—	100	—	—	—	—	—	—	—	
Totals	53	3	2	1	2	3	3	3	2	6	6	9	3	4	2	4	—	—	
Totals %	—	5.7	3.8	1.9	3.8	5.7	5.7	5.7	3.8	11.3	11.3	16.8	5.7	7.5	3.8	7.5	—	—	
Crocodylidae	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	
Subtotals		—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	
Subtotal %	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	—	—	—	
Geoemydidae	2	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	
Kinosternidae	2	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	
Subtotals	4	—	—	—	—	—	1	—	1	1	—	—	1	—	—	—	—	—	
Subtotal %	—	—	—	—	—	—	25.0	—	25.0	25.0	—	—	25.0	—	—	—	—	—	
Bipedidae	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	
Anguidae	6	—	—	—	1	—	—	—	1	—	—	—	1	1	2	—	—	—	
Corytophanidae	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	
Dactyloidae	2	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	
Eublepharidae	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	
Helodermatidae	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	
Iguanidae	3	—	—	—	—	—	—	—	—	—	1	—	—	2	—	—	—	—	
Mabuyidae	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	
Phrynosomatidae	20	—	—	—	—	—	—	2	—	5	6	2	2	2	1	—	—	—	
Phyllodactylidae	5	—	—	—	—	—	—	—	—	—	—	—	—	2	3	—	—	—	
Scincidae	6	—	—	—	—	—	—	—	—	—	—	—	3	2	1	—	—	—	
Sphenomorphidae	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	
Teiidae	8	—	—	—	—	1	1	1	—	1	—	—	4	—	—	—	—	—	
Xantusiidae	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	
Subtotals	57	—	—	—	2	3	1	4	1	7	8	3	11	9	8	—	—	—	
Subtotal %	—	—	—	—	3.5	5.3	1.8	7.0	1.8	12.3	14.0	5.3	19.3	15.7	14.0	—	—	—	
Boidae	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	
Colubridae	28	—	—	1	5	2	2	2	1	1	1	4	5	2	2	—	—	—	
Dipsadidae	33	—	1	2	1	3	3	—	1	—	1	6	3	5	4	3	—	—	
Elapidae	3	—	—	—	—	—	—	—	—	1	—	—	2	—	—	—	—	—	
Leptotyphlopidae	4	1	—	—	—	—	1	—	—	1	—	—	1	—	—	—	—	—	
Loxocemidae	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	
Natricidae	11	—	—	—	—	2	1	—	—	1	1	—	1	5	—	—	—	—	
Viperidae	10	—	—	—	—	—	1	—	—	1	—	—	—	1	4	—	2	1	

Xenodontidae	2	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
Subtotals	93	1	1	3	6	7	8	2	4	6	3	11	12	13	10	3	2	1
Subtotal %	—	1.1	1.1	3.2	6.4	7.5	8.6	2.2	4.3	6.4	3.2	11.8	12.9	14.0	10.8	3.2	2.2	1.1
Totals	155	1	1	3	8	10	10	6	6	14	11	14	25	22	18	3	2	1
Total %	—	0.6	0.6	1.9	5.2	6.5	6.5	3.9	3.9	9.0	7.1	9.0	16.1	14.2	11.6	1.9	1.3	0.6
Sum Totals	208	4	3	4	10	13	13	9	8	20	17	23	28	26	20	7	2	1
Sum Totals %	—	1.9	1.4	1.9	4.8	6.3	6.3	4.3	3.8	9.6	8.2	11.1	13.5	12.5	9.6	3.3	1.0	0.5

After organizing the EVS into low, medium, and high categories, a number of conclusions of conservation significance are apparent. The absolute and relative numbers for each of these categories, from low to high arranged

by major herpetofaunal group, are as follows: anurans = 17 (39.5%), 17 (39.5%), 9 (21.0%); salamanders = 0 (0.0%), 5 (55.6%), 4 (44.4%); caecilians = 0 (0.0%), 1 (100%), 0 (0.0%); crocodylians = 0 (0.0%), 0 (0.0%), 1 (100%); turtles = 1 (25.0%), 2 (50.0%), 1 (25.0%); lizards = 10 (17.6%), 19 (33.3%), 28 (49.1%); and snakes = 28 (30.1%), 25 (26.9%), 40 (43.0%). The highest absolute and relative numbers for each of the amphibian groups fall into the medium range, evident when these numbers are added, as follows: 17 (32.1); 23 (43.4); and 13 (24.5). For the reptile groups, the pattern is different in that the largest absolute and relative numbers for all groups, except for turtles, fall into the high range. Summing these numbers illustrates the general trend for reptiles, in which numbers increase from low to high: 39 (25.2); 46 (29.7); and 70 (45.1).

The trend seen for reptiles also applies to the herpetofauna as a whole. Of the 208 total species, 56 (26.9%) are assigned to the low category, 69 (33.2%) to the medium category, and 83 (39.9%) to the high category.

In summary, application of the EVS measure to the members of the herpetofauna of Michoacán demonstrates starkly that the absolute and relative numbers increase dramatically from the low category of scores through the medium category to the high category.

4. Comparing the results of the three systems

When we compared the results of the three conservation assessment systems, it was obvious that the EVS is the only one for which the entire land herpetofauna of Michoacán can be assessed. The EVS also is the only system that provides a fair accounting of the distributional status of species (state-level endemic, country-level endemic, and non-endemic). Furthermore, this system is cost-effective, as the authors of this paper and those of the two on the Mexican herpetofauna in this special Mexico issue assembled these contributions from their homes, simply by using the communicative ability of the Internet. The only disadvantage of the EVS is that it does not apply to marine species; today, however, a sizable number of conservation champions at least are working with marine turtles. Thus, as noted by Wilson

et al. (2013b), “given the geometric pace at which environmental threats worsen, since they are commensurate with the rate of human population growth, it is important to have a conservation assessment measure that can be applied simply, quickly, and economically to the species under consideration.” The EVS is the only one of the three systems we examined with this capacity.

Conclusions and Recommendations

1. Conclusions

A broad array of habitat types are found in Michoacán, ranging from those at relatively lower elevations along the Pacific coastal plain and in the Balsas-Tepalcatepec Depression to those at higher elevations in the Sierra Madre del Sur, the Transverse Volcanic Axis, and the Central Plateau. In total, 215 species of amphibians and reptiles are recorded from the state, including 212 native and three non-native species (*Lithobates catesbeianus*, *Hemidactylus frenatus*, and *Ramphotyphlops braminus*). The native amphibians comprise 43 anurans, nine salamanders, and one caecilian. The native reptiles constitute 151 squamates (including the marine *Pelamis platura*), seven turtles (including the marine *Chelonia mydas*, *Dermochelys coriacea*, and *Lepidochelys olivacea*), and one crocodylian.

With respect to the number of physiographic provinces inhabited, the numbers drop consistently from the lowest to the highest occupancy figures (i.e., one through five). The number of taxa in each of the provinces, in decreasing order, is as follows: Sierra Madre del Sur (103 species); Balsas-Tepalcatepec Depression (98); Transverse Volcanic Axis (97); Coastal Plain (71); and Central Plateau (29). Among the five provinces, the representation of the major herpetofaunal groups is as follows: anurans = Balsas-Tepalcatepec Depression; salamanders = Transverse Volcanic Axis (all species limited here); caecilians = Sierra Madre del Sur and Transverse Volcanic Axis (single species limited to these two provinces); lizards = Sierra Madre del Sur; snakes = Sierra Madre del Sur; turtles = Coastal Plain; and crocodylians = Coastal Plain (single species limited here). The degree of herpetofaunal resemblance is greatest between the Balsas-Te-

palcatepec Depression and the Sierra Madre del Sur. The greatest resemblance of the Coastal Plain herpetofauna also is to that of the Balsas-Tepalcatepec Depression. Finally, the greatest resemblance of the herpetofauna of the Transverse Volcanic Axis is to that of the Central Plateau, and vice versa. Within Michoacán, close to one-half of the native herpetofauna is limited in distribution to a single physiographic province, in the following decreasing order: Transverse Volcanic Axis, Coastal Plain, Balsas-Tepalcatepec Depression, Sierra Madre del Sur, and Central Plateau. Most of these single-province species also are country-level endemics.

We employed three systems for assessing the conservation status of members of the Michoacán herpetofauna (SEMARNAT, IUCN, and EVS). The SEMARNAT system was developed for use in Mexico by the Secretaría de Medio Ambiente y Recursos Naturales. Although widely used in Mexico, when this system is applied to the herpetofauna of Michoacán it leaves almost one-half of the species unassessed (i.e., having “no status”). Nevertheless, we documented and analyzed the results applying this system to the herpetofauna of Michoacán. Given the significantly incomplete coverage of the SEMARNAT system, we found it insufficiently useful for our purposes.

The IUCN system is applied and used globally. Its categories are broadly recognized (e.g., Critically Endangered, Endangered, and Vulnerable, the three so-called threat categories). Although this system presently

has been applied to a greater proportion of the herpetofauna of Michoacán (compared to the SEMARNAT system), it has not been applied to about 13% of the species. Furthermore, we question the applicability of some aspects of this system, especially with regard to the significant use of the Data Deficient category and the overuse of the Least Concern category. In addition, the expense of creating IUCN threat assessments and the manner in which they are created (e.g., workshops that bring together workers from far-flung areas of the world to a single location within the area of evaluation for several days) often is cost-prohibitive. We also found this system deficient in presenting a useful appraisal of the conservation status of Michoacán’s herpetofauna.

The EVS system originally was developed for use with amphibians and reptiles in Honduras, but later was expanded for use elsewhere in Central America. In this Special Mexico Issue of *Amphibian & Reptile Conservation*, it was applied to all of the native amphibians and non-marine reptiles of Mexico (Wilson et al. 2013a,b). We adopted the scores developed in these two papers for use with the Michoacán herpetofauna, and analyzed the results. We discovered that once all of the species were evaluated using the EVS system and allocated to low, medium, and high score categories, the number of species increases strikingly from the low through the medium to the high category.

2. Recommendations

Based on our conclusions, a number of recommendations follow:

1. Given that the degree of herpetofaunal endemism in Michoacán is greater than that for the country of Mexico, and that a substantial number of those endemic species are known only from the state, the level of protection afforded to the state’s herpetofauna is of major conservation interest. One hundred and twenty-one species are endemic at the country level and an additional 20 are endemic at the state level. Thus, the total for these two groups is 141 (66.5% of the total native herpetofauna), a figure 6.5% higher than that for the country (Wilson et al. 2013a,b). The species with the most conservation significance are the 20 state endemics, and we recommend a conservation assessment



Porthidium hespere. The western hog-nosed viper inhabits the coastal plain of western Mexico, from southeastern Colima to central Michoacán. Its EVS has been reported as 18, placing it in the upper portion of the high vulnerability category, it has been judged as Data Deficient by IUCN, and assigned a Special Protection status by SEMARNAT. This individual is from Coahuayana on the coast of Michoacán. Photo by Oscar Medina-Aguilar.

of the state's herpetofauna that focuses on the state- and country-level endemic species.

2. Michoacán contains a sizable number of protected areas at the global, national, state, and local levels. Because the distribution of the herpetofauna in these areas only is being determined, we recommend that this work be accelerated to form a database for creating a state-level conservation plan.
3. An evaluation of the level of protection afforded to the state's herpetofauna in protected areas is critical for determining areas with high species richness, a high number of endemic species, or species at risk, as well as the degree of overlap within the various protected areas.
4. We recommend an evaluation of all the protected areas in the state, based on their ability to support viable populations of the resident herpetofauna.
5. Once a distributional database is assembled for the state's herpetofauna in protected areas, and a capacity analysis completed, a robust conservation plan needs to be developed and implemented.
6. Considering that agriculture, logging, and cattle ranching are the leading factors in the local extirpation and extinction of ecosystems and their resident species, and that human-modified environments now are the dominant landscapes in the state, the potential for the conservation of the herpetofauna in these environments needs to be evaluated. Management strategies that allow for the maximal numbers of herpetofaunal species to survive and thrive in these altered landscapes also need to be defined.
7. Ultimately, humans protect only what they appreciate, and thus a conservation management plan must encompass environmental education programs for all groups of people, especially the young, as well as the involvement of local people in implementing these programs.

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Addendum

After this paper was placed in proof, we discovered a report of a new Michoacán record for *Coniophanes melanocephalus* (Carbajal-Márquez RA, Quintero-Díaz GE, and Domínguez-De La Riva MA. 2011. Geographic distribution. *Coniophanes melanocephalus* [Black-headed Stripeless Snake] *Herpetological Review* 42: 242). The specimen was found in “subtropical dry forest” at Hoyo del Aire, Municipality of Taretan, at an elevation of 887 m. This locality lies within the northernmost finger of the Balsas-Tepalcatepec Depression in central Michoacán. The EVS of *Coniophanes melanocephalus* has been assessed as 14, placing it in the high vulnerability category, its IUCN status reported as DD (Wilson et al. 2013), and no status is available in the SEMARNAT system (www.semarnat.gob.mx).

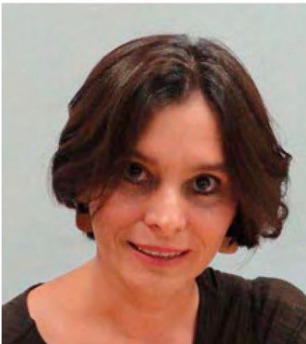
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Javier Alvarado-Díaz is a herpetologist and professor of vertebrate zoology and herpetology at the Universidad de Michoacán, México. His main interest in herpetology is the conservation of Mexican amphibians and reptiles, from sea turtles to montane snakes. He is a member of the Sistema Nacional de Investigadores and has published a number of peer-reviewed papers and books on conservation and ecology of the Mexican herpetofauna.



Irerí Suazo Ortuño is a herpetologist and professor of zoology and herpetology at the Universidad de Michoacán, México. Her principal interest in herpetology is the conservation of amphibians and reptiles in human modified landscapes. She is a member of the Sistema Nacional de Investigadores, and has published peer-reviewed papers on the ecology of tropical herpetofaunal assemblages. She is also the director of the Instituto de Investigaciones sobre los Recursos Naturales de la Universidad Michoacana de San Nicolás de Hidalgo.



Larry David Wilson is a herpetologist with lengthy experience in Mesoamerica, totaling six collective years (combined over the past 47). Larry is the senior editor of the recently published *Conservation of Mesoamerican Amphibians and Reptiles* and a co-author of seven of its chapters. He retired after 35 years of service as Professor of Biology at Miami-Dade College in Miami, Florida. Larry is the author or co-author of more than 290 peer-reviewed papers and books primarily on herpetology, including the 2004 *Amphibian & Reptile Conservation* paper entitled “The conservation status of the herpetofauna of Honduras.” His other books include *The Snakes of Honduras*, *Middle American Herpetology*, *The Amphibians of Honduras*, *Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras*, *The Amphibians and Reptiles of the Honduran Mosquitia*, and *Guide to the Amphibians & Reptiles of Cusuco National Park, Honduras*. He also served as the Snake Section Editor for the *Catalogue of American Amphibians and Reptiles* for 33 years. Over his career, Larry has authored or co-authored the description of 69 currently recognized herpetofaunal species and six species have been named in his honor, including the anuran *Craugastor lauraster* and the snakes *Cerrophidion wilsoni*, *Myriopholis wilsoni*, and *Oxybelis wilsoni*.



Oscar Medina-Aguilar graduated from the Facultad de Biología of the Universidad Michoacana de San Nicolás de Hidalgo in 2011. He studied the herpetofauna of Tacámbaro, Michoacán, as part of his degree requirements. His interests include the systematics and distribution of the amphibians and reptiles of México. In 2011, the results of his study of the herpetofauna of Tacámbaro were published in the *Revista Mexicana de Biodiversidad*.



Alvarado-Díaz, Javier et al. 2013. "Patterns of physiographic distribution and conservation status of the herpetofauna of Michoacan, Mexico." *Amphibian & reptile conservation* 7, 128–170.

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