Ctenosaura defensor (Cope, 1866). The Yucatecan Spiny-tailed Iguana, a regional endemic in the Mexican Yucatan Peninsula, is distributed in the Tabascan Plains and Marshes, Karstic Hills and Plains of Campeche, and Yucatecan Karstic Plains regions in the states of Campeche, Quintana Roo, and Yucatán (Lee, 1996; Calderón-Mandujano and Mora-Tembre, 2004), at elevations from near "sea level to 100 m" (Köhler, 2008). In the original description by Cope (1866), the type locality was given as "Yucatán," but Smith and Taylor (1950: 352) restricted it to "Chichén Itzá, Yucatán, Mexico." This lizard has been reported to live on trees with hollow limbs, into which they retreat when approached (Lee, 1996), and individuals also can be found in holes in limestone rocks (Köhler, 2002). Lee (1996: 204) indicated that this species lives "mainly in the xeric thorn forests of the northwestern portion of the Yucatán Peninsula, although they are also found in the tropical evergreen forests of northern Campeche." This colorful individual was found in low thorn forest 5 km N of Sinanché, in the municipality of Sinanché, in northern coastal Yucatán. Wilson et al. (2013a) determined its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has been assessed as Vulnerable by the IUCN, and as endangered (P) by SEMARNAT. © Javier A. Ortiz-Medina

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The Herpetofauna of the Mexican Yucatan Peninsula: composition, distribution, and conservation status

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Abstract: The herpetofauna of the Mexican Yucatan Peninsula is comprised of 145 species, including 22 anurans, three salamanders, two crocodylians, 102 squamates, and 16 turtles. We examined the state-level distribution of the herpetofauna of this region, which revealed that the largest number of amphibian species (24 of 25) is recorded for Campeche, followed by Quintana Roo (22), and then by Yucatán (17). The largest number of crocodylians, squamates, and turtles is reported for Quintana Roo (107 of 120), with the next highest number in Campeche (104) and then in Yucatán (88). We documented the distribution of the herpetofauna among the six physiographic regions recognized herein, including four mainland regions and two insular ones. The total number of species in these six regions ranges from 43 in the Gulf Islands region to 120 in the Karstic Hills and Plains of Campeche. The individual species inhabit from one to six regions ($\bar{x} = 3.7$). The largest number of single-region species (five) is restricted to the Yucatecan Karstic Plains. We constructed a Coefficient of Biogeographic Resemblance (CBR) matrix that demonstrates the number of shared species ranging from 26 between the Caribbean Islands and Gulf Islands to 104 between the Karstic Hills and Plains of Campeche and the Yucatecan Karstic Plains. The CBR values range from 0.44 between the Karstic Hills and Plains of Campeche and the Caribbean Islands to 0.88 between the Gulf Islands and the Karstic Hills and Plains of Campeche. Based on the CBR data we constructed an Unweighted Pair Group Method with Arithmetic mean (UPGMA) dendrogram, which indicates that the four mainland physiographic regions are fairly closely related to one another because they share a sizable number of broadly distributed species, and are fairly distantly related to the two insular groupings perhaps because of the dispersal ability bias seen among members of the mainland herpetofauna. Only about 24% of the herpetofauna is distributed in one or two of the six regions, demonstrating the relatively broad distribution of many species on the peninsula. We placed the members of the herpetofauna into four distributional categories, of which the largest number (127 of 145) is allocated to the non-endemic category; relatively small numbers are placed in the regional endemic category (11), followed by the non-native species (six) and the country endemic category (one). We identified the principal environmental threats as agriculture and deforestation, hurricanes and other tropical storms, forest fires, tourist development, infectious diseases, invasive species, climate change, illegal collecting, oil mining, killing on roads, and other forms of direct and incidental killing. We assessed the conservation status of the native species by employing the SEMARNAT (NOM-059), IUCN, and Environmental Vulnerability Score (EVS) systems, of which the EVS proved to be the most useful. The number of species in the three EVS categories decreased from low (57) through medium (51) to high (26). We also used the EVS rankings to determine how species in the IUCN Not Evaluated (NE) and Least Concern (LC) categories might be evaluated more informatively. In addition, we used a means of determining Relative Herpetofaunal Priority (RHP), a simple method for ascertaining the rank order of a physiographic regional herpetofauna based on the number of peninsular and national endemic species, as well as the number of high vulnerability EVS species. Using these measures, we concluded that the Yucatecan Karstic Plains ranked as the highest priority region, in both cases. Moreover, we discuss the capability of the protected areas of the Mexican Yucatan Peninsula to provide protection for members of the herpetofauna. Based on our analysis, we erected a set of conclusions and recommendation for the perpetual protection of the peninsular herpetofauna.

Key Words: Anurans, caudates, physiographic regions, protected areas, protection recommendations, squamates, turtles

Resumen: La herpetofauna de la Península de Yucatán mexicana consiste de 145 especies, incluyendo 22 anuros, tres salamandras, dos cocodrílidos, 102 escamosos y 16 tortugas. Examinamos la distribución de la herpetofauna a nivel estatal, la cual reveló que el mayor número de anfibios (24 de 25) se encuentra en Campeche, seguido por Quintana Roo (22) y Yucatán (17). El mayor número de cocodrílidos, escamosos y tortugas está reportado en Quintana Roo (107 de 120), seguido por Campeche (104) y después por Yucatán (88). Documentamos la distribución de la herpetofauna entre las seis regiones fisiográficas aquí reconocidas, incluyendo cuatro regiones continentales y dos insulares. El número total de especies en estas seis regiones va de 43 en la región de las Islas del Golfo, a 120 en Carso y Lomeríos de Campeche. Las especies ocupan de una a seis regiones ($\bar{x}$ = 3.7). El número más grande de especies que se encuentran en una sola región (cinco) está restringido a la región Carso Yucateco. Construimos una matriz de Coeficientes de Similitud Biogeográfica (CBR) que demuestra que el número de especies compartidas va de 26 entre las Islas del Caribe y las Islas del Golfo a 104 entre Carso y Lomeríos de Campeche y Carso Yucateco. Los valores de CBR van de 0.44 entre Carso y Lomeríos de Campeche y las Islas del Caribe a 0.88 entre las Islas del Golfo y Carso y Lomeríos de Campeche. De acuerdo con los datos del CBR, construimos un dendrograma basado en el método de UPGMA, el cual indica que las cuatro regiones fisiográficas en tierra firme están estrechamente relacionadas porque comparten un número significativo de especies con amplia distribución, y están distantemente relacionadas con los dos grupos insulares, probablemente debido a la capacidad sesgada de dispersión entre miembros de la herpetofauna en tierra firme. Solamente alrededor del 24% están distribuidas en una o dos de las seis regiones, demostrando la relativamente amplia distribución de muchas especies en la península. Ubicamos a los miembros de la herpetofauna en cuatro categorías de distribución, de los cuales el número más grande (127 de 145) está asignado a la categoría de especies no endémicas; números relativamente menores están ubicados en la categoría de endémicas a nivel regional (11), seguidos por las especies no nativas (seis) y las endémicas al país (una). Identificamos las amenazas ambientales principales como la agricultura y deforestación, huracanes y tormentas tropicales, incendios forestales, desarrollo turístico, enfermedades infecciosas, especies invasoras, cambio climático global, colección ilegal, actividad petrolera, muerte por atropellamiento, y otras formas de eliminación directa o indirecta. Estimamos el estatus de conservación de las especies nativas empleando los sistemas de SEMARNAT (NOM-059), IUCN, y Valor de Vulnerabilidad Ambiental (EVS), de los cuales el sistema de EVS mostro ser más útil. El número de especies en las tres categorías de EVS disminuyó de la baja (57), media (51) a la alta categoría (26). También usamos los rangos del sistema de EVS para determinar cómo las especies en las categorías de No Evaluadas (NE) y de Preocupación Menor (Least Concern [LC]) de la UICN podrían ser evaluadas de una forma más precisa. Adicionalmente, determinamos la Prioridad

Herpetofaunística Relativa (PHR), un método simple para establecer el rango de relevancia de una región fisiográfica en función del número de especies endémicas a la península y al país, aunado al número de especies con un valor de EVS de alta vulnerabilidad. Utilizando estas medidas, concluimos que el Carso Yucateco ocupa el rango uno en ambos casos. Adicionalmente, discutimos la capacidad de las áreas protegidas de la parte mexicana de la Península de Yucatán para proporcionar protección a los miembros de la herpetofauna. Basado en nuestro análisis, desarrollamos un conjunto de conclusiones y recomendaciones para la protección perpetua de la herpetofauna de la península.

Palabras Claves: Anuros, áreas protegidas, caudados, escamosos, recomendaciones para protección, regiones fisiográficas, tortugas

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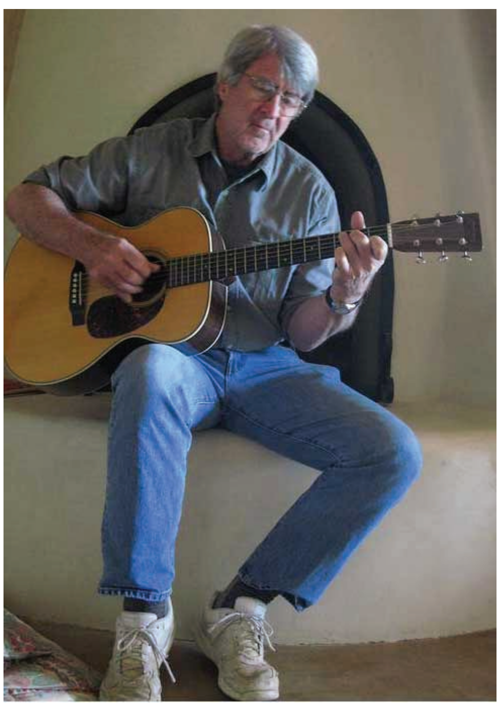
DEDICATION



We are pleased to dedicate this work to Dr. Julian C. Lee, the individual whose name is most closely associated with herpetofaunal research on the Yucatan Peninsula. Julian spent much of his scientific career documenting the composition and distribution of these creatures in this biologically and culturally important region of Mexico. Three pieces of substantial work epitomize his reputation: a 1980 study entitled *An ecogeographic analysis of the herpetofauna of the Yucatan Peninsula*; his *magnum opus—The Amphibians and Reptiles of the Yucatán Peninsula*; and *A Field Guide to the Amphibians and Reptiles of the Maya World: The Lowlands of Mexico, Northern Guatemala, and Belize.* In addition to being an experienced tropical biologist, Julian also is a talented scientific illustrator. Stunning black-and-white pen-and-ink drawings of the regional herpetofauna, as well as of Mayan archaeology, graced his 1996 book and subsequent field guide. His interest in ethnoherpetology led him to provide a closing essay in his 1996 book, which he decorated with numerous drawings exemplifying the Mayan use of herpetofaunal motifs in their art. After 31 years of tenure (1977–2008) at the University of Miami (in Florida), Julian is recognized as Professor Emeritus; he now lives in Silver City, New Mexico.

Lithobates juliani (Hillis and de Sá, 1988). The Maya Mountain Frog, named in honor of our dedicatee, Julian C. Lee, is endemic to the the streams of Little Quartz Ridge and Mountain Pine Ridge of the Maya Mountains, Belize, at elevations from 100 to 915 m (Frost, 2016). This frog is a "common inhabitant of streams in montane and premontane habitats" (Lee, 2000) in western Belize. Johnson et al. (2015b) assessed its EVS as 12, placing it in the upper portion of the medium vulnerability category, and its IUCN status is Near Threatened. This individual is from "a stream in lowland primary forest" in the Maya Mountains of Stann Creek District, Belize (CalPhotos). © Michael Starkey

... As we extinguish a large portion of our planet's biological biodiversity, we will lose also a large portion of our world's beauty, complexity, intellectual interest, spiritual depth, and ecological health.

—David Quammen (1996)

INTRODUCTION

The Yucatan Peninsula is one of the most recognizable parts of Mexico. This area protrudes in a northerly direction from the southern end of the country to separate the western portions of the Gulf of Mexico and the Caribbean Sea, and also disrupts the flow of the Atlantic versant in Mesoamerica. The Mexican portion of this peninsula is comprised by three states: Campeche, Yucatán, and Quintana Roo. This region is well known as one of the significant areas in Mesoamerica that supported the Maya civilization, as evidenced today by several important ruins located in such places as Chichén Itzá, Uxmal, Calakmul, Cobá, and Tulum (Sharer, 1998). Today, descendants of these peoples remain broadly distributed in the Mexican Yucatan Peninsula and in the states of Tabasco and Chiapas, as well as in Guatemala, Belize, and western Honduras (Ruz, 2006). The traditions of these people contribute significantly to the amazing cultural diversity found in Mexico (Wauchope, 1964–1975).

The state of Yucatán, which occupies the north-central portion of the Mexican Yucatan Peninsula, is roughly triangular in shape and lies wedged between the northern portions of Campeche to the west and Quintana Roo to the east. With a surface area of 39,524 km^2, Yucatán is the 20th largest state in Mexico; its population is 2,097,175 (INEGI 2015a; figure 1) and ranks 21st, and its density is 53 people/km^2 and ranks 17th (INEGI, 2015a). The capital and largest city is Mérida, which is located inland about 35 km south of the coastal town of Progreso, in the northwestern portion of the state (www.wikipedia.org; accessed 2 October 2016). The origin and etymology of the name "Yucatán" is a topic of wide discussion, which varies from source to source. Without pretending to give the "correct" version, we only mention that one of the most plausible explanations comes from the travel reports of Bartholomew Columbus (brother of Christopher Columbus), in which he indicated that during a voyage across an undetermined area of the Caribbean (perhaps Honduras), he found a group of Mayan navigators. After trading with them, he asked the name of their nation and received the answer "*Yuk'al-tan mayab*," which means "All who speak the Maya language," and thus Columbus used this phrase to designate the Caribbean shoreline extending from northern Honduras to the eastern coast of the peninsula as the "Yucathan maian" (Cásares et al., 1998).

The state of Campeche is located in the southwestern part of the peninsula and shares borders with the country of Guatemala to the south, and the states of Tabasco to the southwest, Yucatán to the northeast, Quintana Roo to the east, and the country of Belize to the southeast. With an area of 57,507 km^2, Campeche is the 17th largest state in Mexico; its population is 899,931, which ranks 30th, and its density is 16 people/km^2, which ranks 29th (INEGI, 2015a). The capital and largest city is San Francisco de Campeche (or simply "Campeche"), which lies on the Gulf coast about 120 km south of the point on the coast where the state of Campeche abuts that of Yucatán (www.wikipedia.org; accessed 2 October 2016). The name of the state probably is derived from a sculpture of a snake ("*kaan*") with a tick ("*pech*") on its head (snake-tick), which is found inside a Mayan temple located where the city of Campeche now lies. Another possibility is a derivation from "*Ah-kin*" (priest) and "*pech*" (Peña-Castillo 1999).

The state of Quintana Roo is positioned in the eastern portion of the peninsula and abuts Yucatán to the northwest, Campeche to the southwest, and Belize to the south. Quintana Roo is the 19th most sizeable state in Mexico, with an area of 44,705 km^2; its population is 1,501,562, which ranks 26th, and its density is 34 people/km^2, which ranks 24th (INEGI, 2015a). The capital of the state, Chetumal, lies on the border with Belize, but the largest city, Cancún, is located on Isla Cancún off the northeastern part of the state, near where the Gulf of Mexico and the Caribbean Sea meet (www.wikipedia.org; accessed 2 October 2016). The name of the state is derived from that of an early patriot of the Mexican Republic, Andrés Quintana Roo. Quintana Roo is Mexico's youngest state (Careaga-Viliesid and Higuera-Bonfil, 2011).

Interestingly, each of the states in the Mexican portion of the peninsula shares a border with the other two states. Thus, the states of Campeche and Quintana Roo abut one another south of the southern point of Yucatán. Since these three states comprise only a portion of the physiographic Yucatan Peninsula (Lee, 1996, 2000, Islebe et al., 2015), collectively we refer to them as the "Mexican Yucatan Peninsula" or simply the "Mexican Yucatan." Although in Spanish the word "Yucatán" bears an accent to emphasize the pronunciation on the final vowel, the accent is not used in English and herein we follow this usage when referring to the peninsula, but not the state.

Importantly, a long-standing dispute involving the limits among the three states over the long and complex geopolitical history of the Yucatan Peninsula has existed, which included the independence and later the re-annexation of the peninsula from Mexico, its subsequent division into three states, and the lack of recognition and the reformation of the Quintana Roo territory. As an outcome of this lengthy process, legal controversy remains on the location of the vertex that joins the three states (known as the territorial union point, or simply "PUT"; Romero-Mayo and Rioja-Peregrina, 2012). Consequently, different maps sometimes show different delimitation among the three states. This discrepancy is important when considering the species shared among Campeche, Yucatán, and Quintana Roo, especially in the region of Xpujil, or near Cobá. Consequently, we use the same delimitation used by Lee (1996), because of the relevance of this book to the history of herpetological research in this region.

MATERIALS AND METHODS

Our Taxonomic Position

In this paper, we adopt the same taxonomic position as explained in previous works on other portions of Mesoamerica (Johnson et al., 2015a, b; Mata-Silva et al., 2015). Johnson et al. (2015b) can be consulted for a statement on this position, with special reference to the subspecies concept.

UPDATING THE HERPETOFAUNAL LIST

The herpetofaunal list we adopt here primarily is based on those published in Lee (1996, 2000), with some comments on selected taxa (see below). We updated these lists based on the published literature. The names used for the taxa in our list are based on the Taxonomic List provided on the *Mesoamerican Herpetology* website (www.mesoamericanherpetology.com; accessed 31 January 2017). We prepared tables showing the distribution of the members of the Mexican Yucatan Peninsula herpetofauna both by state and physiographic region.

SYSTEM FOR DETERMINING DISTRIBUTIONAL STATUS

We used the same system developed by Alvarado-Díaz et al. (2013) for the herpetofauna of Michoacán to determine the distributional status of members of the herpetofauna of the Mexican Yucatan Peninsula. Subsequently, Mata-Silva et al. (2015), Johnson et al. (2015a), Terán-Juárez et al. (2016), Woolrich-Piña et al. (2016), and Nevárez-de los Reyes et al. (2016) used this system, which consists of the following four categories: RE = endemic to the Mexican Yucatan Peninsula; CE = endemic to Mexico; NE = not endemic to Mexico; NN = non-native in Mexico.

Systems for Determining Conservation Status

To evaluate the conservation status of the herpetofauna of the Mexican Yucatan Peninsula, we used the same systems (i.e., SEMARNAT [NOM-059], IUCN, and EVS) employed by Alvarado-Díaz et al. (2013), Mata-Silva et al. (2015), Johnson et al. (2015a), Terán-Juárez et al. (2016), Woolrich-Piña et al. (2016), and Nevárez-de los Reyes et al. (2016). Detailed descriptions of these three systems appeared in earlier papers of this series.

THE MEXICAN CONSERVATION SERIES

The Mexican Conservation Series (MCS) was initiated in 2013 with a treatment of the herpetofauna of Michoacán (Alvarado-Díaz et al., 2013), as a part of a set of five papers published in *Amphibian & Reptile Conservation* and designated as the Special Mexico Issue. The basic format of the MCS entries was established in that paper (i.e., to examine the composition, physiographic distribution, and conservation status of a given Mexican state). Two years later, the MCS was resumed with a paper on the herpetofauna of Oaxaca (Mata-Silva et al., 2015), followed by another on the herpetofauna of Chiapas (Johnson et al., 2015a). Three entries were published the following year, on Tamaulipas (Terán-Juárez et al., 2016), Nayarit (Woolrich-Piña et al., 2016), and Nuevo León (Nevárez-de los Reyes et al., 2016), and one on Jalisco appeared earlier this year (Cruz-Sáenz et al., 2017). Thus, this paper on the herpetofauna of the Mexican portion of the Yucatan Peninsula is the eighth in this series.

PHYSIOGRAPHY AND CLIMATE

Physiographic Regions

The region we refer to as the "Mexican Yucatan Peninsula" has a surface area of 126,742 km^2 and comprises all of the states of Quintana Roo and Yucatán, and the majority of Campeche, and occupies 90.8% of the combined area of these three states (Fig. 1). The peninsula, which consists of a high platform of calcareous rocks, is the youngest of the physiographic regions in Mexico, as it emerged from the Caribbean Sea mostly during the Tertiary period and the beginning of the Quaternary (SAGARPA, 2010). The peninsula predominantly is flat, with an average elevation of 50 m above sea level, but elevations of 350 m are found in the south-central portion (Ortíz, 2008). According to INEGI (2001), the mainland portion of the peninsula is divided into four physiographic regions: (1) the Tabascan Plains and Marshes (Llanuras y Pantanos Tabasqueños); (2) the Karstic Hills and Plains of Campeche (Carso y Lomeríos de Campeche); (3) the Yucatecan Karstic Plains (Carso Yucateco); and (4) the Low Coast of Quintana Roo (Costa Baja de Quintana Roo). In the delimitation provided by INEGI (2001), the islands off the peninsula are considered to be part of these physiographic regions. Because of the relevance and uniqueness of the islands in terms of endemism and their vulnerability to extinctions, however, we recognize the islands off the northeastern, northern, and southwestern portions of the peninsula as two separate physiographic areas: (5) the Gulf Islands and (6) the Caribbean Islands. We provide a brief description of these six physiographic regions below.

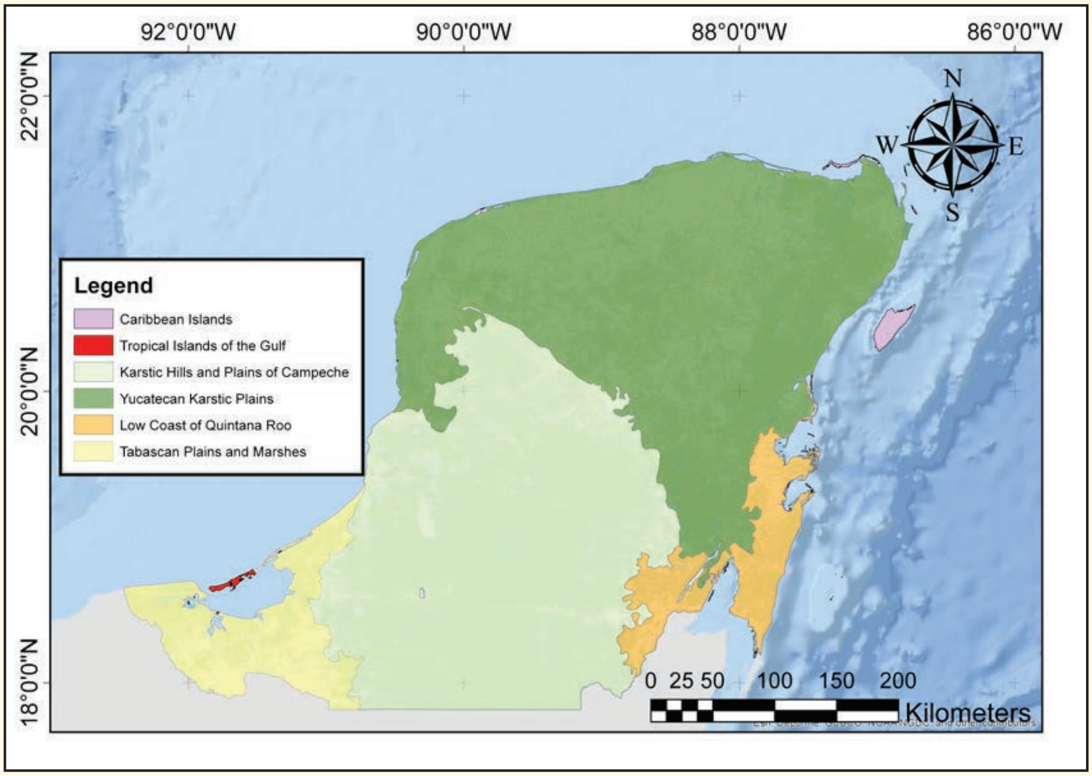


Fig. 1. Physiographic regions of the Mexican Yucatan Peninsula.

Tabascan Plains and Marshes (Llanuras y Pantanos Tabasqueños).—Of all the physiographic regions treated in this study, this one is not considered a part of the Yucatan Peninsula, but instead as part of the Coastal Plains of the Southern Gulf (Llanura Costera del Golfo Sur). Most of the largest rivers in the country, such as the Papaloapan, Coatzacoalcos, Grijalva, and Usumacinta, are found within this region. The Tabascan Plains and Marshes extend from southern Veracruz and cover most of the neighboring state of Tabasco, and then continue into the southwestern portion of the state of Campeche (INEGI, 2001). This region covers about 19% of the area of Campeche. The dominant edaphic features are the deep alluvial soils (Pedrozo-Acuña, 2012), especially arenosols, which practically are absent in other regions of the country. These soils are coarse in texture, with ~65% of sand in the first meter of depth, and are highly permeable and display a low capacity for water and nutrient retention (González-Villarreal et al., 2009).

The southwestern portion of Campeche is part of the deltaic basin of Tabasco, an area highly influenced by such Tabascan rivers as the Grijalva and Usumacinta (Carranza-Edwards et al., 2015). Thus, the appearance of this area of Campeche is determined by the many hydrological systems of this basin, where the dominant habitats are wetlands and marshes. The influence of the Tabascan rivers creates a complex hydrological network, with many rivers and streams flowing near Ciudad del Carmen, which carry sand and mud from the continent. Sea currents favored the accumulation of this material in the area, and over time this action created the island of Carmen and the many coastal lagoons in the region of Laguna de Términos (INE, 1997). This coastal ecosystem is the largest fluvial-lagoon estuarine system in the country (Soto-Galera et al., 2010). Hydrophilic vegetation prevails in this complex network of shallow waters, with a large portion of the surface occupied by species of mangrove (*Rhizophora mangle*, *Avicennia germinans*, *Laguncularia racemose*, and *Conocarpus erecta*), each with different degrees of dominance (INE, 1997; Fig. 2).

A particular habitat of this region is the popales-tulares plant association; these terms do not have an exact equivalent in English, but they refer to a certain kind of plant association that occurs in flooding wetlands; *popal* refers to a plant community of hydrophilic herbaceous species on wetland surfaces or stagnant waters, principally composed of species of the genera *Thalia*, *Calathea*, and *Helicornia* (López-Portillo et al., 2010); and *tular* refers to a community of hydrophilic herbaceous plants dominated by monocotyledons 1–3 m high, with narrow leaves or lacking foliar organs (Moreno-Casasola et al., 2010) known as *tules* (genera *Typha*, *Scirpus*, and *Cyperus*) or *carrizos* (genera *Phragmites* and *Araudo*; López-Portillo et al., 2010). These communities often are found together, but their associations are highly variable in species composition and dominance, and also are referred to by a wide variety of local names. Although these associations can be highly dissimilar among sites, generally they are referred to as tular-popal (Moreno-Casasola et al., 2010). In Campeche, the tular-popal association can be found in the environs of Laguna de Términos and also is particularly relevant in the surroundings of Río Palizada, where there are associations of *Typha domingensis–Eleocharis cellulosa*, *Leersia exandra*, and *Sagittaria lancifolia*, sites of carrizal *Phragmites australis*, communities of *Typha–Phragmites*, and popales of *Thalia–Pontederia–Sagittaria* (Ocaña and Lot, 1996).

The mangrove wetlands (Fig. 2) and popal-tular associations in Laguna de Términos occupy 259,000 ha along the Gulf shore; they also join with the similar associations in Pantanos de Centla, Tabasco, which extend into southern Veracruz and constitute one of the most important and extensive ecological units in Mesoamerica (INE, 1997). The rest of the region in Campeche is occupied by induced grasslands and a few remnants of tropical forest, primarily in the municipalities of Candelaria and Escárcega (INEGI, 2015b).

Fig. 2. *Tabascan Plains and Marshes.* Mangrove (*Rhizophora mangle*) in Río Candelaria, near the Laguna de Términos region, municipality of Candelaria, Campeche, at an elevation of ca. 35 m. The many fluvial systems in this region favor the presence of different associations of hydrophilic vegetation, which can withstand flooding for several months. Southwestern Campeche is known for its predominance of mangrove associations, which are some of the most extensive in Mexico. © Humberto Bahena-Basave courtesy of HBahena-ECOSUR

Karstic Hills and Plains of Campeche (Carso y Lomeríos de Campeche).—This region comprises the greater part of Campeche (75% of its surface area), except for the northwestern and southwestern portions; it also occupies the southern extreme of Yucatán and the western strip of Quintana Roo. This region is characterized by the presence of hills of tectonic and mostly karstic origins, which alternate with broad extensions of plains and large flooded wetlands. The superficial bodies of water are represented only by the Río Azul, a tributary of the Río Hondo, and many streams that flow into the wetlands or into the phreatic zone (the underground area in which almost all of the porous soil is saturated with water) by filtration through fissures in the limestone substrate (SAGARPA, 2010).

This region contains the highest elevations on the peninsula, and consists of *lomeríos* (a group of small hills with elevations of 20–100 m). Due to the karstic origin of many of these formations, the space between the hills frequently is eroded, which increases the relief, in some cases with abrupt 40° slopes (Hubp et al., 1992). The highest points on the peninsula are located in the Zoh-Laguna plateau and the Edzná valley, with elevations surpassing 300 m (Villalobos-Zapata and Mendoza-Vega, 2010). Away from these sites, on average the elevations decrease to 40–60 m, until they increase again in northeastern Campeche and southern Yucatán. The Sierrita de Ticul is a small system of two parallel ridges with elevations of 120–150 m (at most 200 m) that are separated by a valley. The relief in this region allows for the existence of many superficial and temporal streams that not only erode the surface, but often also flow underground and form caves (*aktun* in the Maya language). In the Bolonchín region, some of these galleries are tens of meters in depth (Hubp et al., 1992). The best known of these formations is the Cenote de Bolonchén (www.wikipedia.org/wiki/Bolonch%C3%A9n).

Historically, the dominant vegetation in this region was semi-evergreen tropical forest (Fig. 3), which now is restricted to a narrow strip in the south-central portion of the peninsula along the border of Campeche and Quintana Roo, most importantly in the municipality of Calakmul (Fig. 3), with some relicts in other parts of the peninsula. Because of the climatic conditions and the soil of this region, these are the driest humid tropical forests in Mexico. The representative trees include Chicle (*Manilkara zapota*), Mahogany (*Swetenia macrophylla*), Pukté (*Bucida buceras*), and Ramón (*Brosimum alicastrum*). The canopy is 30–35 m high, and the trees lose 25% of their foliage during the dry season (Villalobos-Zapata and Mendoza-Vega, 2010).

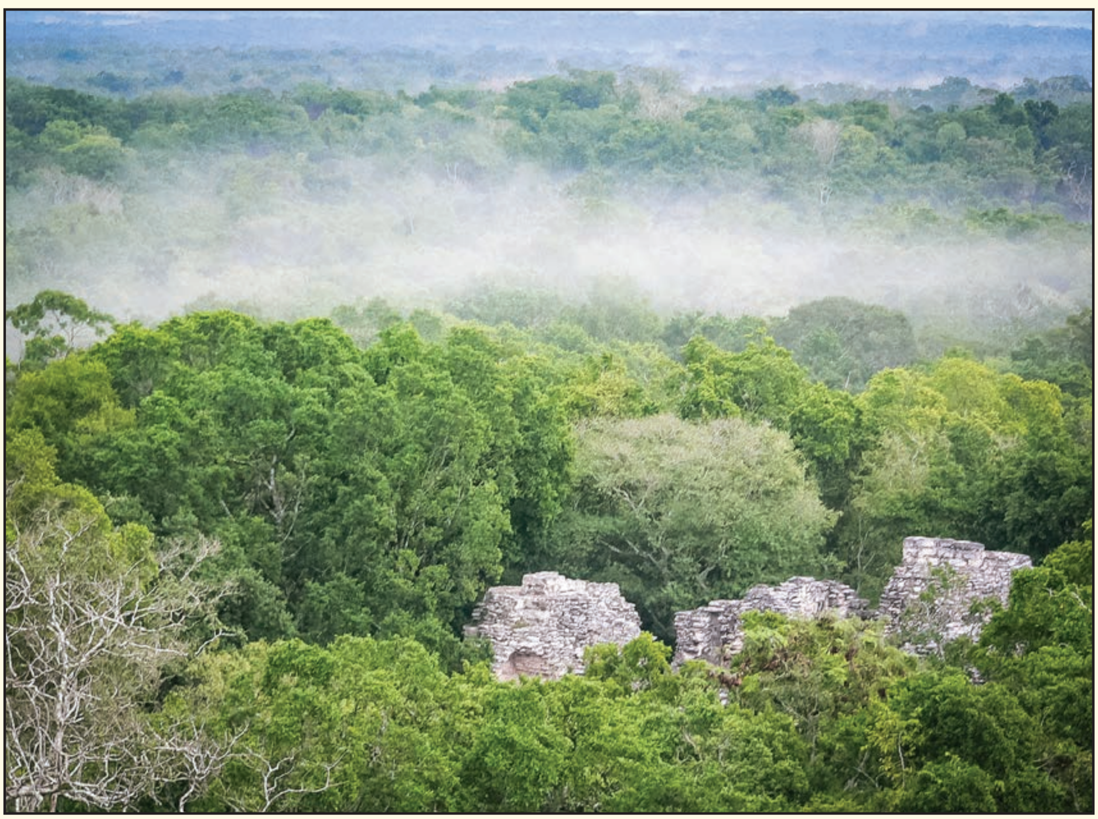


Fig. 3. *Karstic Hills and Plains of Campeche.* A view of tropical evergreen forest in the vicinity of the Calakmul archeological site, in the municipality of Calakmul, in southeastern Campeche, at an elevation of 260 m. The topography of this region is characterized by the predominance of small hills. © Victor Hugo González-Sánchez

Craugastor yucatanensis (Lynch, 1965). The Yucatecan Rainfrog is a regional endemic in the Mexican Yucatan Peninsula, distributed in the Yucatecan Karstic Plains region in the states of Quintana Roo and Yucatán. This individual was found 5.8 km WSW of Puerto Morelos in the municipality of Puerto Morelos, in the state of Quintana Roo. Wilson et al. (2013b) determined its EVS as 17, placing it in the middle portion of the high vulnerability category. Its conservation status has been evaluated as Near Threatened by the IUCN, and as a species of special protection (Pr) by SEMARNAT. © Javier A. Ortiz-Medina

Eleutherodactylus planirostris (Cope, 1862). The Greenhouse Frog is a non-native species in the Mexican Yucatan Peninsula, distributed in the Yucatecan Karstic Plains region in Yucatán and Quintana Roo, as well as on the Caribbean island of Cozumel. This frog is native to Cuba (including Isla de Juventud), the Cayman Islands, and the Caicos Islands, and has been introduced into Florida, southern Louisiana, southern Mississippi, southern Alabama, southern Georgia to southeastern South Carolina, as well as Oahu and the island of Hawaii, in the United States; it also has been introduced into Hong Kong (China), Guam, the Philippines, Jamaica, Honduras (including Isla de Guanaja), Surinam, and Veracruz (Frost, 2016). This individual was found in Isla Cozumel, Quintana Roo. As a non-native in the Mexican Yucatan Peninsula, we do not consider its conservation status. © Claudio Contreras-Koob

Deciduous and semi-deciduous tropical forests extend along the southern portion of Campeche, from the Zoh-Laguna plateau to the northwestern portion of this state, and then across the border into Yucatán. The height of the canopy is 10–20 m and the trees lose 50–75% of their foliage during the dry season, which creates a layer of organic litter that covers the rocky soil and facilitates the establishment of vegetation. The representative trees of these forests are Pich (*Enterolobium cyclocarpun*), Chechem Negro (*Metopium brownei*), Ceiba (*Ceiba pentandra*), and Ya'axnik (*Vitex gaumeri*). Other types of tropical forests are found in this region, but they are not as representative as those mentioned here; also, they constitute an ecological unit known as Selva Maya, one of the most extensive remnants of tropical vegetation in North- and Central America (Villalobos-Zapata and Mendoza-Vega, 2010).

Yucatecan Karstic Plains (Carso Yucateco).—This region (Fig. 1) occupies the northern and northeastern portions of the peninsula, and is the only one that extends from the coastal region of the Gulf of Mexico on the west, to the Caribbean Sea on the east. This region encompasses almost all of the state of Yucatán, the northern half of Quintana Roo, and a small portion in northwestern Campeche. Except for the beaches along the northern coast of Yucatán and the northeastern coast of Quintana Roo, the only other topoform in this region is the rocky calcareous plain, with an average elevation of 5 m (SEMARNAT, 2014a).

Little relief is present on the karstic formations in the northwestern part of the peninsula, on account of the limited amount of precipitation in this area, the fact that the relief is geologically recent (Quaternary), and the disposition of the geological structure in thin strata of limestone (Hubp et al., 1992). This topography and the permeability of the ground forestall the formation of superficial rivers and streams, the reason why almost all of the hydrology in this region is subterranean. Some superficial bodies are present, however, such as Laguna Flamingos and Laguna Rosada, as well as the marshes of Celestún, Yucalpetén, Ría Lagartos, El Islote, and Yolvé (SEMARNAT, 2014a). The north-central portion of this region in Quintana Roo also is distinctive, because of the presence of tectonic faults that result in longitudinal depressions and permanent lagoons, such as Cobá and Chichankanab, as well as the many flooded wetlands (SAGARPA, 2010).

Phreatic aquifers are continuous in most of the region. The infiltration of rain occurs throughout a cavernous system that creates underground water deposits whose depths can vary from 80 to 120 m in southern Yucatán, or only from 2 to 3 m in areas near the northern coast (SEMARNAT, 2014b). In the northeastern portion of the peninsula, the erosion of limestone rocks has created thousands of subterranean caves, *dolines* (sinkholes or depressions in the ground created by the dissolution of the karst by the water, known locally as *cenotes*) and *aguadas* (water ponds created by erosion of the rocks, which are not very deep and have a plain bottom due to filling with soil). In some instances, the combination of erosion and past changes in the phreatic aquifer and sea levels (much of this region was underwater in the past, and many inundated caves also were located above surface, as evidenced by the many fossils of shellfish and archeological vestiges), has led to the collapse of the roofs in these galleries. This process creates exposed sinkholes that sometimes are several meters deep, such as the Cenote of Valladolid (Hubp et al., 1992).

Almost one-half of the soils in this region are rendzinas, which are rocky and thin soils with a fertile superficial layer rich in organic material lying over the limestone. These soils are shallow, no more than 25 cm deep, and support tropical forests. Lithosols comprise almost one-fourth of the surface of the state of Yucatán; these soils are less than 10 cm deep, and limited by the presence of rock or hardened caliche. They also are abundant in the central and northern parts of the state of Yucatán, where they represent the substrate for low deciduous forest, medium-height semi-deciduous rainforest, and medium-height semi-evergreen rainforest. Luvisols, which are soils with accumulations of red or yellowish clay, occur in about 16% of the state's surface; these soils support natural forest and grassland associations. The solonchack are another type of soil that is restricted largely to the northern and northwestern portions of the Yucatan Peninsula. These salty soils often are found in areas where saltpeter accumulates, such as in coastal lagoons and lake beds; they also support mangroves, savannas, low deciduous forest, and coastal dune vegetation (SEMARNAT, 2014a).

The vegetation of this region once was characterized by high and medium-height semi-evergreen tropical forests, of which the dominant tree is *Manilkara zapota*. Characteristic and commercially valuable canopy species include *Swietenia macrophylla*, *Swartzia cubensis*, *Pimenta dioica*, *Aspidosperma megalocarpon*, and *Caesalpinia gaumeri*. The high forest consists of different plant communities, in which *Manilkara zapota–Coccothrinax readii* is the dominant association. In the central Yucatan Peninsula, the association containing *Hampea trilobata–Metopium* *brownei–Bursera simaruba* is widely distributed, and includes many characteristic taxa of secondary forests like *Nectandra coriacea*, *Sabal yapa*, *Bauhinia divaricata*, *Lysiloma latisiliquum*, and *Bauhinia jenningsii*. Actually, most of the high and medium-height semi-evergreen forests on the Yucatecan Central Plateau have been replaced by induced grasslands and crops (Islebe et al., 2015), but a plateau of high and medium tropical forests can be found in the municipalities of Tizimín and Chemax (SEMARNAT, 2014a).

Low seasonally deciduous dry forest extends throughout the peninsula, but is most prevalent in its center (Fig. 4). This forest type has canopy heights of less than 15 m, and nearly 100% of the tree species drop their leaves during the dry season. Characteristic species are *Lysiloma bahamensis*, *Baeucarnea pliabilis*, *Gymnopodium floribundum*, *Cassia alata*, *Acacia milleriana*, *Mimosa bahamensis*, *Diospyros anisandra*, *Pseudophoenix sargentii*, and *Piscidia piscipula*, all of which can grow directly on eroded limestone. On a community level, *Sebastiania adenophora–Plumeria obtusa* var. *cericifolia–Agave angustifolia* is the dominant association in the eastern portion of the Yucatan Peninsula. Dry tropical forest is the most altered vegetation type in the peninsula, with 3,907,388 ha of disturbed area, in comparison to 92,221 ha of conserved surface (Islebe et al., 2015).

Fig. 4. *Yucatecan Karstic Plains.* A view of tropical deciduous forest in the Zona Arqueológica de Yaxuná, in the municipality of Yaxcabá, in central Yucatán, at an elevation of ca. 28 m. © Jorge Armín Escalante-Pasos

A peculiarity of the seasonally dry tropical forest in the northwestern part of the peninsula is the occurrence of columnar cacti, including some endemic species of this vegetation type, such as *Mammillaria gaumeri*, *Beaucarnea pliabilis*, *Guaiacum sanctum*, *Pilosocereus gaumeri*, *Nopalea gaumeri*, *Nopalea inaperta*, and *Pterocereus gaumeri* (Islebe et al., 2015).

On the northern shore of the peninsula is a strip consisting of approximately 2,016.90 km^2 known as the Northern Yucatán Wetlands. About 38% of its surface is covered by mangroves, with an important fraction of low, thorny, semi-evergreen tropical forest and tulares (SEMARNAT, 2014a), which are flooded wetlands with plant associations of *Typha* spp., *Scirpus* spp., *Cyperus giganteus*, and *Cyperus* spp. Portions of the Northern Yucatán Wetlands are protected by the Ría Celestún and Ría Lagartos Biosphere Reserves.

Finally, the majority of the islands on the peninsula (Cozumel, Isla Mujeres, Contoy, and Holbox) are included as part of this region, but we discuss these in detail below in the section on offshore islands.

Low Coast of Quintana Roo (Costa Baja de Quintana Roo). —This region, located along the southeastern portion of Quintana Roo and bordered by the Río Hondo to the south, and the Caribbean Sea to the east, is the smallest of the three physiographic regions of the mainland portion of the Mexican Yucatan Peninsula. Its width is variable and borders the Caribbean Sea, and it occupies an area of 8,925 km^2, which comprises 21% of the surface of Quintana Roo. The topography of this region is predominately flat with occasional outcroppings. Much of this area is prone to frequent flooding, primarily during the rainy and "nortes" seasons (SAGARPA, 2010). The principal topoforms are the rocky plains, which occupy most of this region. The beaches extend along the shoreline from Bahía del Espiritu Santo to Xcalak; beaches are scattered along the remainder of the shoreline, but are interrupted by reef formations in the vicinity of Cayo Culebras (SEMARNAT, 2014b).

As in much of the Peninsula, the dominant soils are the litosols; in most cases these are rocky soils less than 10 cm deep. Another important soil type is the gleysoles (known locally as *Ak'alches*). These soils have a depth of 50 cm and are gray, blue, or green in coloration, and take on a red tone when dry. They also tend to accumulate and hold water, and the vegetation communities supported include natural grasslands and mangroves (SEMARNAT, 2014b).

The hydrography of this region is noteworthy, because the Río Hondo is the only permanent river in Quintana Roo. Cenotes are common (Fig. 5), the most notable being Cenote Azul, the deepest water-filled sinkhole in Mexico (Tello-Taracena and Castellanos-Martínez, 2011). The eastern part of Quintana Roo is near the active tectonic margin of the Yucatan Peninsula; this activity has led to the creation of terraces of different elevations in the region; the hydrological systems sometimes flow into these depressions, and in many cases constitute elongated basins without external flow (Hubp et al., 1992). This process has created many wetlands and permanent lagoons in this region, such as Bacalar, San Felipe, La Virtud, Chile Verde, and Laguna Guerrero (Tello-Taracena and Castellanos-Martínez, 2011).

Fig. 5. *Low Coast of Quintana Roo.* An aerial view of medium sub-evergreen tropical forest in Chetumal Bay, municipality of Othón P. Blanco, Quintana Roo, at an elevation of ca. 20 m. Water-filled sinkholes (locally known as *cenotes*) are common in this region, and many are exposed. © Humberto Bahena-Basave, courtesy of HBahena-ECOSUR

Triprion petasatus (Cope, 1865). The Yucatecan Casque-headed Frog is "widely distributed in the Yucatan Peninsula, Mexico, through Belize, and throughout El Petén, Guatemala" (Frost, 2016). An isolated record was reported from northwestern Honduras (Wilson et al., 1986; McCranie and Wilson, 2002), which was discounted by McCranie (2015). These amplexing individuals were encountered at Reserva Estatal Biocultural del Puuc, in the municipality of Oxkutzcab, in southwestern Yucatán. Wilson et al. (2013b) determined its EVS as 10, placing it at the lower limit of the medium vulnerability category. Its conservation status has been indicated as Least Concern by the IUCN, and this hylid is considered as a species of special protection (Pr) by SEMARNAT. © Javier A. Ortiz-Medina

Bolitoglossa yucatana (Peters, 1862). The Yucatecan Salamander occurs in the "Yucatan Peninsula in Mexico, extreme northern Belize, and possibly northern Guatemala" (Frost, 2016). This individual was found at Reserva Estatal Biocultural del Puuc, Municipio de Oxkutzcab, Yucatán. Wilson et al. (2013b) calculated its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has been evaluated as Least Concern by the IUCN, and this salamander is listed as a species of special protection (Pr) by SEMARNAT.
© Javier A. Ortiz-Medina

The predominant vegetation consists of mangroves and tulares, mainly concentrated in the environs of Bahía de la Ascensión and Bahía del Espiritu Santo located in the Sian Ka'an Biosphere Reserve. The tular (see section on *Tabascan Plains and Marshes*) in Quintana Roo is more associated with the saibal than the popal, which is not as common as in Campeche (Ek-Díaz, 2011). The saibal is a vegetation typical of wetlands, defined by the dominance of sedges or sawgrasses of the genus *Claudium* (poales; Cyperaceae) known as "saiba" or "cortadera." These plants are characterized by their long and narrow leaves (which resembles grass), with sharp or serrated margins. This vegetation also is dominant in wetlands that were affected by wildfires or cleared for agriculture and then abandoned (such as the former cane field on the Río Hondo basin).

The tular grows in shallow water and flooded areas that retain high humidity during the dry season, and is composed of tule (*Typha* spp.) and tulillo (*Scirpus* spp.), along with the saibales of Cortadera Grass (*Cladium jamaice*) (SEMARNAT, 2014a). The tular and saibal are closely associated with mangroves, of which some reach heights of 6–10 m, while others, mostly in the area of Mahahual and the Estero de Chaac, attain average heights of 1 m (manglar chaparro). Although four species of mangrove occur in the region, Red Mangrove (*Rhizophora mangle*) is dominant in most of these associations (Ek-Díaz, 2011).

As in most of the peninsula, medium semi-evergreen tropical forest is widely distributed. The canopy reaches heights from 15 to 25 m, and the most common species of trees are Ramón or Ox (*Brosimum alicastrum*), Chakáh (*Bursera simaruba*), Sakpah (*Byrsonima bucidaefolia*), Kitam Che (*Caesalpinia gaumeri*), Chechen Negro (*Metopium brownei*), Xtojyuub (*Coccoloba acapulcensis*), Tzalam (*Lysiloma latisiliquum*), Yaaxnik (*Vitex gaumeri*), Zapote or Ya' (*Manilkara zapota*), Mahogany (*Swietenia macrophylla*), among others; additionally, ferns, mosses, bromeliads, aroids, and orchids are abundant (Ek-Díaz, 2011; SEMARNAT, 2014b).

The *petenes*, islands of vegetation frequently found in the middle of manglar chaparro, saibales, or marshes, are another distinctive vegetation type on the peninsula. The petenes are characterized by the presence of medium-height evergreen and semi-evergreen tropical forests, and are abundant in Sian Ka'an and near important bodies of water such as Bacalar Lagoon and Chetumal Bay (Ek-Díaz, 2011). Banco Chinchorro, a semicircular atoll, is located within this physiographic region.

Gulf Islands (Islas del Golfo de México).—As mentioned above, the region of Laguna de Términos is highly influenced by the Tabascan rivers, as this complex's hydrological network is composed of many rivers and streams that flow near Ciudad del Carmen and transport sand and mud to the coast. The sea currents favored the accumulation of this material in the area, and over time this action has created many islands and coastal lagoons in the region of Laguna de Términos, of which the most important is Isla del Carmen (INE, 1997).

Isla del Carmen is a barrier island located along the mouth of Laguna de Términos, Campeche, which is delimited by two natural inlets of the lagoon: Carmen on the southwest and Puerto Real on the northeast. Because of its location, the island is composed of such sediments as sand, silt, and fine clays coming from marine, fluvial, and lagunar sources. A small dune system (3–4 m high) extends along the 37 km of the island. Topographically, the island generally lies near sea level, except for some dunes that reach an elevation of 3–4 m (Escudero et al., 2014).

The island used to be covered extensively by mangroves (*Rhizophora mangle*, *Avicennia germinans*, *Laguncularia racemosa*, and in a much lesser proportion by *Conocarpus erecta*), with beds of sea grasses (*Thalassia testudinum*, *Halodule wrightii*, and *Siringodium filiforme*; Day et al., 1987) dominating the shallow waters on the lagunar side. Most of this vegetation, however, has been replaced by coconut and rice plantations, as well as by the expansion of Ciudad del Carmen (INE, 1997), an urban area of about 2,700 ha that supports 170,000 inhabitants; this city has been an important hub of the Mexican petroleum industry since 1971 (Escudero et al., 2014). Even so, Isla del Carmen, along with the entire Laguna de Términos system, remains one of the most important areas of biodiversity in Mesoamerica (INE, 1997).

Arrecife Alacranes (Fig. 6), although often erroneously considered as an atoll, actually is a reef platform formation created by the accumulation of calcareous material of coralline origin, with several well differentiated physiographic elements, such as reef margins, an interior lagoon, and five clearly distinguishable sandy islands. The entire reef system comprises an area of ~300 km^2, but the total area of the five islands is 530407.78 m^2 (0.53040778 km^2), which represents 1.7% of the entire reef system area. The largest island is Desterrada, with a surface area of 232,291.66 m^2; the maximum elevation in the chain is 4 m on Isla Muertos. The geographic center of Arrecife Alacranes is 132 km north of Puerto Progreso, Yucatán (CONANP, 2006).

Fig. 6. *Gulf Islands.* A coastal view of Isla Pérez, Arrecife Alacranes, Yucatán. As can be seen at the bottom, these islands are composed of coralline material. The dominant vegetation on this island is characteristic of coastal dunes and contains herbaceous and succulent plants, as well as coastal scrubs. © Alberto de Jesús Navarrete

The vegetation on these islands is composed of several plant associations that can be considered as different successional stages, from the sea grasses (*Thalassia* and *Halodule*) in the shallow waters near the coast, to the herbaceous and succulent plants dominating the coastal dunes (*Sesuvium*, *Portulaca*, *Sporobolus*, *Cenchrus*, *Chamaesyce*, and *Batis*), and to the coastal scrubs dominated by species of the genera *Tournefortia* and *Suriana*. Some introduced plants can be found there, such as species of *Opuntia* and *Casuarina*. With regard to its fauna, this site is well recognized for its diversity of reef fishes, and is an important nesting site for marine birds and sea turtles (CONANP, 2006).

In summary, Campeche contains seven islands (Aguada, Cayos Arcas, Arena, del Carmen, de Jaina, de Piedras, and Uaymil), and eight islands are present in Yucatán, of which the most prominent form the Arrecife Alacranes Archipiélago, including Isla Pérez, Isla Desertora (= Isla Muertos), Oeste (= Desaparecida), Isla Pájaros (= Isla Larga), Isla Chica (= Cornezuelos or Blanca), and Isla Desterrada.

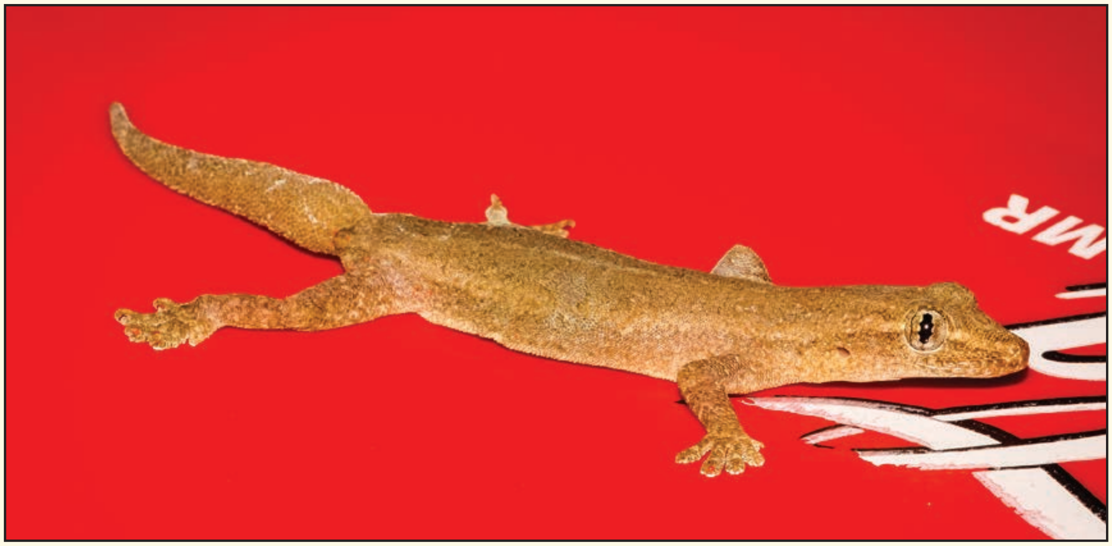
Caribbean Islands (Islas del Caribe Mexicano).—The Caribbean Sea in the Mexican portion of the Yucatan Peninsula extends from the Yucatan Channel (the strait between Mexico and Cuba) in northern Quintana Roo, to the Xcalak Peninsula in the southern portion of the state, bordering Belize. Thus, the Caribbean Islands physiographic region includes all the islands off the coast of Quintana Roo. Fifteen islands and cays are found in this state (excluding Cancún and Tamalcab), of which the most relevant are Cozumel, Isla Mujeres, Holbox, Contoy, and the Banco Chinchorro system (Fig. 7).

Fig. 7. *Caribbean Islands.* An aerial view of Cayo Centro, a low island in the atoll reef of Banco Chinchorro located 42 km off the town of Mahahual on the mainland of Quintana Roo. Banco Chinchorro, in the municipality of Othón P. Blanco, is the largest coralline atoll in Mexico (43 km long × 28 km wide), and also is the second largest in the world (www.es.wikipedia.org/wiki/Banco_Chinchorro; accessed 8 April 2017). © Lizbeth Lara-Sánchez

The characteristics and origins of these islands are contrasting and diverse; for example, most of the coastal islands in the northeastern portion of the peninsula originated as a result of the accumulation of carbonated sand on eolian ridges or dunes during the Pleistocene, and later they became partially eroded during the rise of the sea in the Holocene. The islands of Contoy, Isla Mujeres, and Cancún are the remnants of these Pleistocene dune ridges. Conversely, Cozumel is the emergent portion of a horst block, a mass of land pushed upward between two normal fault lines (the most accurate translation in Spanish is "macizo tectónico"), and after periods of submergence and exposure, and the final Holocene sea-level rise, only the crest of the carbonate platform was exposed (Ward, 1997).

Banco Chinchorro is an exceptional and distinctive example of an insular system originating from coral reef formations; this semicircular atoll (or false atoll, according to Charles Darwin) contains four emergent cays (sandy islands on top of a coral reef): Cayo Centro (Fig. 7), Cayo Norte Mayor, Cayo Norte Menor, and Cayo Lobos. No clear explanation of how this system originated is available, but perhaps its foundation emerged from a submarine ridge created during the formation of the Yucatan basin, which later was modified by considerable coral reef accretion (Jordan and Martin, 1987).

In terms of biodiversity, the most relevant island is Cozumel—the largest island in the Yucatan Peninsula region and the third largest in the country (INEGI 2015c). Cozumel hosts 31 endemic species of several groups (Nuttall, 2013), and perhaps is the most biodiverse island in Mexico. Unfortunately, it has been subjected to human settlements since pre-Columbian times and currently is one of the most popular tourist destinations in the Caribbean, so the island faces enormous pressure from tourism and its effects, as well as from disturbance of the local environment by developers.



Hemidactylus frenatus Duméril & Bibron, 1836. The Common House Gecko is a non-native species in the Mexican Yucatan Peninsula, where it has been recorded in the three states and in all six physiographic regions. Beyond its distribution in this area, this species occurs broadly in tropical and subtropical regions in "Taiwan, Hong Kong, Guangdong, Hainan, and southern Yunnan, China, southern and eastern Africa, Madagascar, Mauritius, south and southeastern Asia, Philippines, Japan (Ryukyu and Bonin islands), Indoaustralian Archipelago east to New Guinea and northern Australia; Oceania and Mexico" (Zhao and Adler, 1993: 184). "Also widely introduced in Central America, and introduced populations have also been reported from Florida and Texas, [as well as the Hawaiian Islands] USA" (McCranie et al., 2005: 77). This individual was photographed in Tulum, Quintana Roo. Given that this gecko has been introduced into the Mexican Yucatan Peninsula, we did not determine its conservation status.

© Elí García-Padilla

Ctenosaura alfredschmidti Köhler, 1995. The Campeche Spiny-tailed Iguana is distributed in "southern Campeche and Quintana Roo, Mexico, and adjacent regions in Petén, Guatemala" (Köhler, 2003: 140). This individual was photographed in the vicinity of the Reserva de la Biósfera Calakmul, Campeche. Wilson et al. (2013a) estimated its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has been evaluated as Near Threatened by the IUCN, but this species is not listed by SEMARNAT.

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Climate

Temperature.—We constructed a table containing the minimum, mean, and maximum temperatures for one locality in each of the six physiographic regions in the Mexican Yucatan Peninsula (Table 1). The elevations for these six localities range from 4 m in the Tabascan Plains and Marshes to 275 m in the Karstic Hills and Plains of Campeche.

Table 1. Monthly minimum, mean (in parentheses), maximum, and annual temperature data (in °C) for the physiographic regions of the Mexican Yucatan Peninsula. Localities and their elevation for each of the regions are as follows: Low Coast of Quintana Roo–Chetumal (5 m); Karstic Hills and Plains of Campeche–Zoh-Laguna (275 m); Yucatecan Karstic Plains–Tizimín (22 m); Tabascan Plains and Marshes–Palizada (4 m); Caribbean Islands of the Yucatán Península–Isla Holbox (10 m); Tropical Islands of the Gulf–Isla del Carmen (5 m). Data taken from www.smn.cna.gob.mx; accessed 1 February 2017.

Physiographic Region	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Low Coast of Quintana Roo	18.9 (23.6) 28.3	19.2 (24.1) 29.1	20.5 (25.4) 30.4	21.8 (26.7) 31.7	22.8 (27.5) 32.3	23.5 (27.6) 31.8	23.5 (27.6) 31.8	22.9 (27.3) 31.8	23.2 (27.4) 31.7	22.1 (26.4) 30.8	19.9 (24.3) 28.8	19.0 (23.7) 28.5	18.9 (26.0) 32.3
Karstic Hills and Plains of Campeche	14.9 (20.8) 26.7	15.7 (22.0) 28.4	17.5 (24.0) 30.6	20.0 (26.5) 33.1	20.7 (27.1) 33.6	21.3 (26.8) 32.4	20.9 (26.2) 31.5	20.7 (26.3) 32.0	20.8 (26.2) 31.7	19.5 (24.8) 30.1	17.0 (22.4) 27.9	15.8 (21.3) 26.9	14.9 (24.5) 33.6
Yucatecan Karstic Plains	15.8 (22.2) 28.7	16.1 (22.8) 29.5	24.8 (17.9) 31.7	19.6 (26.8) 34.0	20.9 (27.6) 34.3	21.8 (27.6) 33.4	21.4 (27.2) 33.1	21.4 (27.4) 33.5	21.7 (27.1) 32.5	20.1 (25.4) 30.8	17.6 (23.5) 29.5	17.6 (23.5) 29.5	15.8 (25.4) 34.3
Tabascan Plains and Marshes	18.7 (23.2) 27.7	19.4 (24.6) 29.8	21.0 (26.4) 31.8	22.4 (28.2) 34.0	23.4 (29.1) 34.8	23.7 (28.7) 33.8	23.1 (28.0) 33.0	23.6 (28.6) 33.6	23.3 (27.8) 32.4	22.7 (26.8) 31.0	21.0 (25.3) 29.6	19.6 (23.9) 28.3	18.7 (26.7) 34.8
Caribbean Islands of the Yucatan Peninsula	20.2 (24.8) 29.4	20.1 (24.8) 29.5	20.7 (25.8) 30.8	21.2 (26.4) 31.6	22.0 (27.0) 32.0	22.2 (27.1) 32.0	22.5 (27.3) 32.1	22.9 (27.4) 31.9	23.0 (27.4) 31.9	22.3 (26.8) 31.2	21.9 (26.2) 30.5	21.0 (25.3) 29.7	20.1 (26.4) 32.1
Tropical Islands of the Gulf	16.6 (23.9) 35.7	17.8 (24.8) 32.4	18.6 (26.3) 34.2	19.5 (28.7) 37.2	22.4 (29.8) 37.8	22.3 (29.2) 37.8	20.4 (28.6) 35.4	22.4 (28.5) 34.9	21.5 (28.2) 34.7	19.8 (27.0) 34.9	19.0 (25.5) 31.8	17.5 (24.1) 30.2	16.6 (27.1) 37.8

The range of elevations in the largely lowland Mexican Yucatan Peninsula is limited, and thus evidence for the normal lapse rate also will be restricted. Nonetheless, the mean annual temperature (MAT) generally decreases from the lowest to the highest elevations, as follows (temperatures refer to the monthly minimums): Tabascan Plains and Marshes (elev. 4 m) = 26.7°C; Low Coast of Quintana Roo (5 m) = 26.0°C; Offshore Islands (10 m) = 26.4°C; Yucatecan Karstic Plains (22 m) = 25.4°C; and Karstic Hills and Plains of Campeche (275 m) = 24.5°C. The annual monthly minimum temperature ranges from 14.9°C in the Karstic Hills and Plains of Campeche to 20.1°C in the Offshore Islands. This temperature also is 6.3 to 9.6°C below the MAT, and the mean maximum temperature is 5.7 to 9.1°C above the MAT. During the year, the MATs peak at some point between May and September, usually May or June, and the lowest occur sometime between January and March, usually in January (Table 1).

Precipitation.—Precipitation in the Mexican Yucatan Peninsula cumulatively is highest during the months of May to October, which comprise the rainy season, and cumulatively lowest from November to April, the dry season (Table 2). The data in Table 2 indicate that the annual precipitation ranges from 877 mm on the offshore Islands (Isla Holbox) to 1,856 mm in the Tabascan Plains and Marshes. The proportion of the precipitation falling during the rainy season ranges from 65.3% in the offshore Islands to 80.5% in the Yucatecan Karstic Plains. The greatest amount of precipitation falls in September, and the least amount in March or April. Generally speaking, the annual precipitation decreases from the Tabascan Plains and Marshes (1,856 mm) in the southwestern portion of the peninsula to the Offshore Islands (877 mm) in the northeastern portion of the peninsula; in the central parts of the peninsula, the precipitation can reach slightly above 1,100 mm.

Table 2. Monthly and annual precipitation data (in mm.) for the physiographic regions of the Mexican Yucatan Peninsula. Localities and their elevation for each of the regions are as follows: Low Coast of Quintana Roo–Chetumal (5 m); Karstic Hills and Plains of Campeche–Zoh-Laguna (275 m); Yucatecan Karstic Plains–Tizimín (22 m); Tabascan Plains and Marshes–Palizada (4 m); Caribbean islands of the Yucatan Peninsula–Isla Holbox (10 m); and Tropical Islands of the Gulf–Isla del Carmen (5 m). Data taken from www.smn.cna.gob.mx; accessed 1 February 2017. Darker shading represents the rainy season.

Physiographic Region	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Low Coast of Quintana Roo	61	37	23	35	75	179	143	139	185	149	90	64	1180
Karstic Hills and Plains of Campeche	57	31	24	41	110	167	134	124	191	138	59	45	1121
Yucatecan Karstic Plains	44	40	35	31	108	177	178	157	195	124	43	35	1167
Tabascan Plains and Marshes	96	55	47	46	91	208	206	209	340	276	160	122	1856
Caribbean Islands of the Yucatan Peninsula	46	49	28	32	58	108	97	85	119	106	76	69	877
Tropical Islands of the Gulf	55	45	51	25	67	211	177	210	295	270	115	84	1610

COMPOSITION OF THE HERPETOFAUNA

Families

The herpetofauna of the Mexican Yucatan Peninsula comprises representatives of 40 families (Table 3), including nine of amphibians (eight of anurans and one of salamanders) and 31 of the remainder of the herpetofauna (one of crocodylians, 22 of squamates, and eight of turtles). The total number of families is 70.2% of the total number of families with representatives in Mexico (57; J. Johnson, unpublished). Caecilians are not recorded from the Mexican Yucatan Peninsula, although Lee (1996: 36) indicated that *Dermophis mexicanus* "is definitely known to approach the westernmost limits of the Yucatan Peninsula in eastern Tabasco and may very well occur in the Río Grijalva-Usumacinta floodplain in westernmost Campeche." Slightly more than one-half of the species of amphibians (56.0%) are allocated to the families Hylidae, Leptodactylidae, and Plethodontidae, and 76.7% of the remainder of the herpetofauna are in the families Corytophanidae, Dactyloidae, Iguanidae, Phrynosomatidae, Sphaerodactylidae, Teiidae, Colubridae, Dipsadidae, Natricidae, Viperidae, Cheloniidae, and Kinosternidae (Tables 4, 5).

Genera

The amphibians of the Mexican Yucatan Peninsula are represented by 17 genera, of which 16 include anurans and one a salamander. The remainder of the herpetofauna is allocated to 73 genera, including one crocodylian, 59 squamates, and 13 turtles. The total number of genera in the Mexican Yucatan Peninsula is 90 (Table 3), which is 42.9% of the total number of 210 in the all of Mexico (J. Johnson, unpublished). The most speciose amphibian genus is *Bolitoglossa* (with 3 species), and *Norops* (seven), *Ctenosaura* (three), *Sceloporus* (five), *Sphaerodactylus* (three), *Aspidoscelis* (five), *Holcosus* (three), *Tantilla* (three), *Coniophanes* (five), *Imantodes* (three), and *Kinosternon* (four) among the rest of the herpetofauna.

Ctenosaura similis (Gray, 1831). The Black Spiny-tailed Iguana ranges from "central Tabasco and the Yucatan Peninsula, Mexico, to northeastern Honduras and in western Nicaragua, eastern Costa Rica, and central Panamá (including numerous islands in the Caribbean Sea) and from southeastern Oaxaca, Mexico, to west-central Panamá on the Pacific versant (including several islands near the coast). It has also been introduced into southern Florida, USA" (McCranie et al., 2005). This spectacular male was photographed at the Zona Arqueológica de Tulum, in the municipality of Tulum, in central coastal Quintana Roo. Wilson et al. (2013a) estimated its EVS as 8, placing it in the upper portion of the low vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, and as threatened (A) by SEMARNAT.

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Sceloporus cozumelae Jones, 1927. The Cozumel Spiny Lizard is a regional endemic in the Mexican Yucatan Peninsula, occurring in all physiographic regions in the states of Campeche, Quintana Roo, and Yucatán. This individual was found at 4 km W of Dzilam de Bravo, in the municipality of Dzilam de Bravo, in the state of Yucatán. Wilson et al. (2013a) determined its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has been evaluated as Least Concern by the IUCN, and as a species of special protection (Pr) by SEMARNAT.

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Table 3. Composition of the native and non-native herpetofauna of the Mexican Yucatan Peninsula.

Orders	Families	Genera	Species
Anura	8	16	22
Caudata	1	1	3
Subtotals	**9**	**17**	**25**
Crocodylia	1	1	2
Squamata	22	59	102
Testudines	8	13	16
Subtotals	**31**	**73**	**120**
Totals	**40**	**90**	**145**

Species

The herpetofauna of the Mexican Yucatan Peninsula currently is composed of 145 species, including 22 anurans, three salamanders, two crocodylians, 102 squamates, and 16 turtles (Table 3). Wilson et al. (2013a) reported 378 native species of amphibians from Mexico; the current number is 388 (J. Johnson, unpublished). Therefore, the percentage of native amphibians in the Mexican Yucatan Peninsula is 6.4%, which is the same proportion as reported for Nuevo León by Nevárez-de los Reyes et al. (2016). Wilson et al. (2013b) recorded 849 species of crocodylians, squamates, and turtles from Mexico; the current figure is 881 (J. Johnson, unpublished). Six anuran and squamate species are non-native to the Mexican Yucatan Peninsula (Table 4), so the total number of native crocodylians, squamates, and turtles is 114 (12.9% of the Mexican total; J. Johnson, unpublished). In summary, the 139 native herpetofaunal species comprise 11.0% of the total of 1,269 species for all of Mexico (J. Johnson, unpublished). The closest state (geographically) to the Mexican Yucatan Peninsula thus far examined in the MCS is Chiapas, which contains a native herpetofauna of 326 species, 2.3 times the size of the former (Johnson et al., 2015a).

Table 4. Distribution of the herpetofauna of the Mexican Yucatan Peninsula by state. * = country endemic; ** = regional endemic; and *** = non-native.

Taxa	Mexican States in the Yucatan Peninsula			Number of Regions Occupied	Documentation
	Campeche	Yucatán	Quintana Roo		
Anura (22 species)					
Bufonidae (2 species)					
Incilius valliceps	+	+	+	3	Lee, 1996
Rhinella horribilis	+	+	+	3	Lee, 1996
Craugastoridae (2 species)					
Craugastor loki	+		+	2	Köhler, 2011
*Craugastor yucatanensis***		+	+	2	Lee, 1996
Eleutherodactylidae (1 species)					

Table 4 (continued)

Taxa	Mexican States in the Yucatan Peninsula			Number of Regions Occupied	Documentation
	Campeche	Yucatán	Quintana Roo		
*Eleutherodactylus planirostris****		+	+	2	Cedeño-Vázquez et al., 2014; García-Balderas et al., 2016; Pavón-Vázquez et al., 2016; Ortiz-Medina et al., 2017
Hylidae (8 species)					
Dendropsophus ebraccatus	+		+	2	Lee, 1996
Dendropsophus microcephalus	+	+	+	3	Lee, 1996
Scinax staufferi	+	+	+	3	Lee, 1996
Smilisca baudinii	+	+	+	3	Lee, 1996
Tlalocohyla loquax	+	+	+	3	Lee, 1996
Tlalocohyla picta	+	+	+	3	Lee, 1996
Trachycephalus typhonius	+	+	+	3	Lee, 1996
Triprion petasatus	+	+	+	3	Lee, 1996
Leptodactylidae (3 species)					
Engystomops pustulosus	+		+	2	Lee, 1996
Leptodactylus fragilis	+	+	+	3	Lee, 1996
Leptodactylus melanonotus	+	+	+	3	Lee, 1996
Microhylidae (2 species)					
Gastrophyrne elegans	+		+	2	Lee, 1996; Cedeño-Vázquez and Beutelspacher-García, 2016
Hypopachus variolosus	+	+	+	3	Lee, 1996
Phyllomedusidae (1 species)					
Agalychnis callidryas	+	+	+	3	Lee, 1996
Ranidae (2 species)					
Lithobates brownorum	+	+	+	3	Lee, 1996
Lithobates vaillanti	+		?	1	Lee, 1996
Rhinophrynidae (1 species)					
Rhinophrynus dorsalis	+	+	+	3	Lee, 1996
Caudata (3 species)					
Plethodontidae (3 species)					
Bolitoglossa mexicana	+		+	2	Lee, 1996; Colston et al., 2015
Bolitoglossa rufescens	+		+	2	Colston et al, 2015; Calderón-Mandujano and Calmé, 2004
Bolitoglossa yucatana	+	+	+	3	Lee, 1996
Crocodylia (2 species)					
Crocodylus acutus	+	+	+	3	Lee, 1996
Crocodylus moreletii	+	+	+	3	Lee, 1996
Squamata (102 species)					
Anguidae (1 species)					
Celestus rozellae			+	1	Cedeño-Vazquez et al., 2003

Table 4 (continued)

Taxa	Mexican States in the Yucatan Peninsula			Number of Regions Occupied	Documentation
	Campeche	Yucatán	Quintana Roo		
Corytophanidae (5 species)					
Basiliscus vittatus	+	+	+	3	Lee, 1996
Corytophanes cristatus	+		+	2	Lee, 1996
Corytophanes hernandezii	+		+	2	Lee, 1996; Calderón et al., 2003
Laemanctus longipes	+		+	2	Lee, 1996; Calderón-Mandujano et al., 2010
Laemanctus serratus	+	+	+	3	Lee, 1996
Dactyloidae (8 species)					
Anolis allisoni			+	1	Charruau et al., 2015b;
Norops beckeri	+		+	2	Köhler, 2010
Norops biporcatus	+		+	2	Lee, 1996, Calderón-Mandujano and Cedeño-Vázquez, 2011
Norops lemurinus	+	+	+	3	Lee, 1996, 2000
Norops rodriguezii	+	+	+	3	Lee, 1996
*Norops sagrei****	+	+	+	3	Lee, 1996
Norops tropidonotus	+	+	+	3	Lee, 1996
Norops ustus	+	+	+	3	Lee, 1996
Eublepharidae (1 species)					
Coleonyx elegans	+	+	+	3	Lee, 1996
Gekkonidae (2 species)					
*Hemidactylus frenatus****	+	+	+	3	Lee, 1996
*Hemidactylus turcicus****	+	+		2	Lee, 1996
Iguanidae (4 species)					
Ctenosaura alfredschmidti	+	+	+	3	Köhler, 1995, Cedeño-Vázquez et al., 2003a; Morales-Mavil et al., 2016 Buckley et al., 2016
*Ctenosaura defensor***	+	+	+	3	Lee, 1996; Calderón-Mandujano and Mora-Tembre, 2004; Buckley et al., 2016
Ctenosaura similis	+	+	+	3	Lee, 1996; Buckley et al., 2016
Iguana iguana	+		+	2	Lee, 1996; Buckley et al., 2016
Mabuyidae (1 species)					
Marisora brachypoda	+	+	+	3	Lee, 1996
Phrynosomatidae (5 species)					
Sceloporus chrysostictus	+	+	+	3	Lee, 1996
*Sceloporus cozumelae***	+	+	+	3	Lee, 1996; Cedeño-Vázquez et al., 2001
Sceloporus lundelli	+	+	+	3	Lee, 1996
Sceloporus serrifer	+	+	+	3	Lee, 1996; Baldillo-Saldaña et al., 2016
Sceloporus teapensis	+			1	Lee, 1996

Table 4 (continued)

Taxa	**Mexican States in the Yucatan Peninsula**			**Number of Regions Occupied**	**Documentation**
	Campeche	**Yucatán**	**Quintana Roo**		
Phyllodactylidae (2 species)					
Phyllodactylus tuberculosus			+	1	Lee, 1996
Thecadactylus rapicauda	+	+	+	3	Lee, 1996; Calderón et al., 2003
Scincidae (2 species)					
Mesoscincus schwartzei	+	+	+	3	Lee, 1996
Plestiodon sumichrasti	+	+	+	3	Lee, 1996; Calderón et al., 2003
Sphaerodactylidae (4 species)					
Aristelliger georgeensis			+	1	Lee, 1996
*Sphaerodactylus argus****		+		1	Lee, 1996
Sphaerodactylus continentalis			+	1	Lee, 1996
Sphaerodactylus glaucus	+	+	+	3	Lee, 1996
Sphenomorphidae (1 species)					
Scincella cherriei	+	+	+	3	Lee, 1996
Teiidae (8 species)					
Aspidoscelis angusticeps	+	+	+	3	Lee, 1996
*Aspidoscelis cozumela***	+		+	2	Lee, 1996
Aspidoscelis deppii	+			1	Lee, 1996
Aspidoscelis maslini	+		+	2	Lee, 2000; Lee and Calderón Mandujano, 2013
*Aspidoscelis rodecki***			+	1	Lee, 1996
*Holcosus gaigeae***	+		+	2	Meza-Lazaro and Nieto-Montes de Oca, 2015
Holcosus hartwegi	+	+	+	3	Meza-Lazaro and Nieto-Montes de Oca, 2015
*Holcosus stuarti**	+			1	Meza-Lazaro and Nieto-Montes de Oca, 2015
Xantusiidae (1 species)					
Lepidophyma flavimaculatum			+	1	Lee, 1996
Boidae (1 species)					
Boa imperator	+	+	+	3	Lee, 1996
Colubridae (22 species)					
Drymarchon melanurus	+	+	+	3	Lee, 1996
Drymobius margaritiferus	+	+	+	3	Lee, 1996
Ficimia publia	+	+	+	3	Lee, 1996
Lampropeltis abnorma	+	+	+	3	Lee, 1996
Leptophis ahaetulla	+	+	+	2	Lee, 1996; Torres-Solís et al., 2017; Calderón-Mandujano, 2002
Leptophis mexicanus	+	+	+	3	Lee, 1996
Masticophis mentovarius	+	+	+	3	Lee, 1996
Mastigodryas melanolomus	+	+	+	3	Lee, 1996

Table 4 (continued)

Taxa	Mexican States in the Yucatan Peninsula			Number of Regions Occupied	Documentation
	Campeche	Yucatán	Quintana Roo		
Oxybelis aeneus	+	+	+	3	Lee, 1996
Oxybelis fulgidus	+	+	+	3	Lee, 1996
Phrynonax poecilonotus	+	+	+	3	Lee, 1996
Pseudelaphe flavirufa	+	+	+	3	Lee, 1996
*Pseudelaphe phaescens***	+	+	+	3	Heimes, 2016
Senticolis triaspis	+	+	+	3	Lee, 1996
Spilotes pullatus	+	+	+	3	Lee, 1996
Stenorrhina freminvillii	+	+	+	3	Lee, 1996
Symphimus mayae	+	+	+	3	Lee, 1996; Calderón et al., 2003
Tantilla cuniculator		+	+	2	Lee, 1996
Tantilla moesta		+	+	2	Lee, 1996
Tantilla schistosa			+	1	Lee et al., 2013; Wilson and Mata-Silva, 2014
Tantillita canula	+	+	+	3	Lee, 1996
Tantillita lintoni	+	+	+	3	Aguilar-López et al., 2014
Dipsadidae (21 species)					
Coniophanes bipunctatus	+	+	+	3	Lee, 1996
Coniophanes imperialis	+	+	+	3	Lee, 1996
*Coniophanes meridanus***	+	+	+	3	Lee, 1996
Coniophanes quinquevittatus	+	+		2	Lee, 1996
Coniophanes schmidti	+	+	+	3	Lee, 1996
Conophis lineatus	+	+	+	3	Lee, 1996
Dipsas brevifacies	+	+	+	3	Lee, 1996
Imantodes cenchoa	+		+	2	Lee, 1996
Imantodes gemmistratus	+	+	+	3	Lee, 1996
Imantodes tenuissimus	+	+	+	3	Lee, 1996
Leptodeira frenata	+	+	+	3	Lee, 1996
Leptodeira septentrionalis	+	+	+	3	Lee, 1996
Ninia diademata	+			1	Colston et al., 2015
Ninia sebae	+	+	+	3	Lee, 1996
Pliocercus elapoides	+	+	+	3	Lee, 1996
Sibon nebulatus	+	+	+	3	Lee, 1996
Sibon sanniolus	+	+	+	3	Lee, 1996
Tretanorhinus nigroluteus	+		+	2	Lee, 1996
Tropidodipsas fasciata	+	+	+	3	Lee, 1996
Tropidodipsas sartorii	+	+	+	3	Lee, 1996
Xenodon rabdocephalus	+		+	2	Lee, 1996; Calderón et al., 2003
Elapidae (1 species)					

Table 4 (continued)

Taxa	Mexican States in the Yucatan Peninsula			Number of Regions Occupied	Documentation
	Campeche	Yucatán	Quintana Roo		
Micrurus diastema	+	+	+	3	Lee, 1996
Leptotyphlopidae (2 species)					
Epictia magnamaculata			+	1	Wallach, 2016
Epictia vindumi		+	+	2	Wallach, 2016
Natricidae (3 species)					
Nerodia rhombifera	+			1	Lee, 1996
Thamnophis marcianus	+	+	+	3	Lee, 1996; Calderón et al., 2003
Thamnophis proximus	+	+	+	3	Lee, 1996
Sibynophiidae (1 species)					
Scaphiodontophis annulatus		+	+	2	Lee, 1996
Typhlopidae (2 species)					
Amerotyphlops microstomus	+	+	+	3	Lee, 1996
*Indotyphlops braminus*** *	+	+	+	3	Paradiz-Domínguez, 2016; Cedeño-Vázquez et al., 2003a; Solano Zavaleta et al., 2006
Viperidae (4 species)					
Agkistrodon russeolus	+	+	+	3	Lee, 1996
Bothrops asper	+	+	+	3	Lee, 1996
Crotalus tzabcan	+	+	+	3	Lee, 1996
*Porthidium yucatanicum***	+	+	+	3	Lee, 1996
Testudines (16 species)					
Cheloniidae (4 species)					
Caretta caretta	+	+	+	3	Lee, 1996
Chelonia mydas	+	+	+	3	Lee, 1996
Eretmochelys imbricata	+	+	+	3	Lee, 1996
Lepidochelys kempii	+	+		2	Lee, 1996
Chelydridae (1 species)					
Chelydra rossignonii	+			1	Lee, 1996; Legler and Vogt, 2013
Dermatemydidae (1 species)					
Dermatemys mawii	+	+	+	3	Lee, 1996; Legler and Vogt, 2013; Chablé-Santos et al., 2011
Dermochelyidae (1 species)					
Dermochelys coriacea	+		+	2	Lee, 1996
Emydidae (2 species)					
*Terrapene yucatana***	+	+	+	3	Lee, 1996; Legler and Vogt, 2013
Trachemys venusta	+	+	+	3	Lee, 1996
Geoemydidae (1 species)					
Rhinoclemmys areolata	+	+	+	3	Lee, 1996
Kinosternidae (4 species)					

Table 4 (continued)

Taxa	Mexican States in the Yucatan Peninsula			Number of Regions Occupied	Documentation
	Campeche	Yucatán	Quintana Roo		
Kinosternon acutum	+		+	2	Lee, 1996
*Kinosternon creaseri***	+	+	+	3	Lee, 1996; Legler and Vogt, 2013
Kinosternon leucostomum	+	+	+	3	Lee, 1996; Legler and Vogt, 2013
Kinosternon scorpioides	+	+	+	3	Lee, 1996; Legler and Vogt, 2013
Staurotypidae (2 species)					
Claudius angustatus	+	+	+	3	Lee, 1996; Calderón-Mandujano et al., 2001; Köhler, 2008; Ravell-Ley et al., 2017
Staurotypus triporcatus	+		+	2	Lee, 1996; Legler and Vogt, 2013

COMMENTS ON OUR SPECIES LIST

Several comments on our species list are necessary, as follows:

Hyalinobatrachium fleischmanni. This frog has not been recorded from the Mexican Yucatan Peninsula, but potentially occurs in this region because it has been mapped as ranging into Tabasco, near the southwestern border of Campeche (Melgarejo-Vélez et al., 2010).

Craugastor alfredi. A record for this species exists for Chichén Itzá, Yucatán, based on Natural History Museum of Los Angeles County LACM / urn:lsid:biocol.org:col:34802; no verification for the identification of the species was provided, so this record might be based on a misidentified *C. yucatanensis*, a species common in the area.

Eleutherodactylus leprus. This species is not recorded for the Mexican Yucatan Peninsula, but might occur in southern Campeche because Lee (1996) mentioned its occurrence in the department of El Petén, Guatemala.

Gastrophryne elegans. This species is known from Calakmul, Campeche, near the border with Quintana Roo (Calderón et al., 2003), so this frog probably inhabits the southeastern portion of that state.

Lithobates vaillanti. The presence of this frog in Quintana Roo is suggested by a record in the collection of terrestrial vertebrates of the Escuela Nacional de Ciencias Biológicas IPN (López-Vidal et al., 2008), but no locality information was provided.

Bolitoglossa mexicana. This salamander likely occurs in the state of Yucatán, since Lee (1996) documented its occurrence from an isolated population in Cobá and Pueblo Nuevo X-Can, Quintana Roo, near the northeastern border with Yucatán.

Dermophis mexicanus. Lee (1996) mentioned the doubtful listings (with no specific locality data) of this species by Smith and Smith (1976) for Campeche and Yucatán, but suggested the possibility of its occurrence in westernmost Campeche near the border with Tabasco, a state where this caecilian is known to occur.

Celestus rozellae. This anguid potentially occurs in Campeche. Lee (1996) noted the occurrence of this lizard in the department of El Petén, Guatemala, and based on an ecological niche modeling study, Maciel-Mata (2013) found the forests of Campeche to be suitable habitat.

Anolis allisoni. The presence of this anole in the Mexican Yucatan Peninsula has been controversial. Lee (1996: 227) indicated that, "a single subadult specimen, CM 34388, is said to be from Isla Cozumel. As no other specimens of this generally conspicuous and abundant lizard have been collected there, I consider its occurrence on Cozumel doubtful." McCranie and Köhler (2015: 12), however, stated that, "*Anolis allisoni* occurs on the Islas de la Bahía, Honduras, and cays and islands off the coast of Belize and southern Quintana Roo, Mexico." In addition, Álvarez-Romero et al. (2008) noted this species as native to Cuba, with a single specimen recorded from Isla Cozumel, Quintana Roo, and based on information in Lee (1996), these authors also considered its presence as an established population in Mexico as doubtful. Charruau et al. (2015b), however, reported *A. allisoni*, from the cays of Banco Chinchorro, Quintana Roo, and because the specimen from Cozumel might have been misplaced, the Banco Chinchorro locality is the only site on the Mexican Yucatan Peninsula with a verified record for this species.

Ctenonotus cristatellus. A single specimen of this anole exists from Cozumel, but Lee (1996) regarded the record as doubtful. Colston et al. (2015) indicated *Norops cristellatus* as a new record for Calakmul, but that record likely results from a misidentification. Thus, this species is unlikely to occur on the Mexican Yucatan Peninsula.

Norops lemurinus. Some technical reports list *N. lemurinus* from Banco Chinchorro, Quintana Roo, but no supporting evidence has been provided. These records likely are based on a misidentification of *N. sagrei*. Charruau et al. (2015b) indicated that perhaps the specimens labeled as *N. lemurinus* correspond to neonates of *N. sagrei*.

Norops sagrei. Smith and Burger (1949) described *Anolis sagrei mayensis* with a type locality of Panlao (a small island at the mouth of the Río Mamantel, Laguna de Términos), Campeche, Mexico, and indicated its range as on the Atlantic coast from central Mexico to northern South America. The meristic characteristics used to partition this subspecies from *A. s. sagrei* were a higher number of loreal and dorsal scales, and a longer snout–vent length, respectively; *mayensis* also differed in the color of the dewlap, in which the median line in males is broken by gray mottling, whereas in other subspecies of *sagrei* the median line is distinct and immaculate white. In a phenetic analysis that compared West Indian and Middle American populations of *Anolis* (= *Norops*) *sagrei*, Lee (1992) revealed the existence of two major morphological units in the West Indies (Cuban and Bahamian) and one unit in southeastern Mexico and northern Central America, which demonstrated the distinctness of these populations (Lee, 1996). Subsequently, Nicholson et al. (2012) regarded the Bahamian population (*ordinatus*) as a full species. This information suggests that *mayensis* might constitute a different species, at least in Mexico and northern Central America. More recently, McCranie and Köhler (2015: 166–167) noted that "the populations (of *N. sagrei*) occurring along the coast of the mainland of Middle America from south-central Veracruz, Mexico, to north-central Honduras and those on Roatán Island and many other islands off the coast of Belize and Quintano Roo, Mexico... are introduced or native." These authors also mentioned that, "another population (of *N. sagrei*) has been established in the central portion of the Yucatán Peninsula, Mexico." Additionally, McCranie and Köhler (2015; 169) commented that, "using dewlap color as a diagnostic character for any *N. sagrei* complex population (including isolated island populations) might not be informative." Consequently, more extensive molecular analyses are necessary to determine the origin and relationships of what today is regarded as *N. sagrei*. Importantly, such studies should attempt to verify not only if populations of this anole are native or introduced, but also if they have been transplanted from outside or within the country. The holotype of *mayensis* was collected over 80 years ago (in 1936), so if this population is not considered native it would be interesting to find out when the introduction might have occurred. Conversely, if this taxon turns out to be a native species, it would require an assessment of its conservation status; since populations of *N. sagrei* (*sensu stricto*) are known to have been introduced into Mexico, they likely would be having a detrimental effect on the native population. Because of the complexity of the situation and the unanswered questions that remain, for the purposes of this paper we are considering *N. sagrei* in the Mexican Yucatan Peninsula as an introduced species, as stated by Charruau et al. (2015a).

Norops uniformis. This anole is not known to occur in the Mexican Yucatan Peninsula, but records from Belize, near the border with southern Quintana Roo, are available in the ECOSUR collection.

Iguana iguana. This species frequently is listed for Yucatán, but no confirmed records are available. *Iguana iguana*, however, might occur in the northern part of the peninsula (see Buckley et al, 2016).

Gymnophthalmus speciosus. This lizard potentially occurs in Quintana Roo, inasmuch as it has been recorded from Orange Walk District, in northern Belize (Stafford and Meyer, 2000).

Sceloporus variabilis. The distribution map in Lee (2000) indicates that this species should be present in southwestern Campeche and southern Quintana Roo. This lizard also is mentioned in Charruau et al. (2015a), but no specific locality was provided. This species is common in Pantanos de Centla, so it also should be present in Laguna de Términos. Lee (2000) stated that *S. variabilis* occurs in the northern portion of El Petén, Guatemala, and in northern Belize, and his distribution map encompasses the Rio Hondo basin (south of Quintana Roo) but does not indicate a specific locality.

Sphaerodactylus millepunctatus. This gecko is listed for Isla Cozumel, but the latest taxonomic update by McCranie and Hedges (2012) indicated that *S. continentalis* is the species allocated to that taxonomic group in Mexico, not *S. millepunctatus*; the latter species does not occur any closer to Mexico than eastern Honduras. These authors also commented that *S. continentalis* is known from Utila Island, Honduras, and possibly on Cozumel Island; the latter supposition is based on Harris and Kluge's (1984) comment that the Cozumel specimens possibly are a separate evolutionary lineage (species). Lee (1996) indicated that aside from the Cozumel Island records, *S. continentalis* (listed as *S. millepunctatus*) is not known to occur on the Yucatan Peninsula. No work has addressed the taxonomy of the Cozumel populations, so until this matter is resolved the name should be listed as *S. continentalis*.

Pseudelaphe phaescens. In the past, several authors have listed this taxon as *Elaphe flavirufa phaescens* (e.g., Schulz, 1996; Köhler, 2008), or in the genus *Pseudelaphe* (e.g., Utiger et al., 2002; Pyron and Burbrink, 2009), as *P. flavirufa* (e.g., McCranie, 2011; Lemos-Espinal and Dixon, 2012; Wallach et al., 2014), whereas others have regarded it as *P. phaescens* (e.g., Flores-Villela and Canseco-Márquez, 2004; Liner and Casas-Andreu, 2008; Johnson et al., 2010; Wilson and Johnson, 2010; Wilson et al., 2013b; Heimes, 2016; Uetz et al., 2017). Schulz (1996) noted that the subspecies *phaescens* differs from other members of this group (i.e., subspecies of *E. flavirufa*) by the presence of greatly keeled vertebral scales, a lower number of subcaudals, and a distinctly shorter tail. Further, with regard to color pattern Schulz (1996) demonstrated the occurrence of an ontogenetic color shift in *E. f. phaescens*, indicating that the adult color pattern is noticeably different from that of juveniles, and that the dorsal markings of old individuals sometimes become nearly pitch black. Based on our taxonomic position (see Johnson et al., 2015b), in which allopatric subspecies should not be considered as separate evolutionary lineages, we regard this taxon as a full species. Because both *P. flavirufa* and *P. phaescens* might coexist in areas of potential overlap, such as in Calakmul in southern Campeche, and Othon P. Blanco (Chetumal) and Felipe Carrillo Puerto in southern Quintana Roo, the taxonomic keys in Heimes (2016) can be used to identify these taxa.

Adelphicos quadrivirgatum. This snake is not known to occur on the Mexican Yucatan Peninsula, but has been documented from El Petén, in Guatemala, and from Orange Walk, in Belize (Lee, 1996). *Adelphicos quadrivirgatum* is a secretive snake that is not easily found, and surely has been underreported.

Clelia scytalina. This snake potentially occurs in southern Quintana Roo (along the Río Hondo), since it has been recorded in Corozal and Orange Walk districts in Belize (Stafford and Meyer, 2000).

Oxyrhopus petolarius. This snake is not known to occur in the Mexican Yucatan Peninsula, but perhaps will be found in southern Campeche and southern Quintana Roo, because some records from northern El Petén and northern Belize are available (Lee, 1996).

Sibon dimidiatus. This snake is not recorded in the Mexican Yucatan Peninsula, but probably occurs in Campeche because it has been reported from Uaxactún, Guatemala (Lee, 1996), a few kilometers from the border with Campeche.

Tropidodipsas fischeri. Charruau et al. (2015a) listed this species from the Mexican Yucatan Peninsula, but did not indicate a locality or a source for the record. Thus, this might be an erroneous listing.

Micrurus nigrocinctus. A record from the state of Yucatán is listed at GBIF (MCZ: Herp: R-26837) at the coordinates 2067N, 88,57W, but Yucatán is far distant from its generally understood distribution.

Atropoides mexicanus. This pitviper has not been reported from the Mexican Yucatan Peninsula, but might occur in southeastern Campeche because an ecological niche model for this species indicates suitable habitat in this region (Yañez-Arenas et al., 2016).

Atropoides nummifer. This species might occur in southern Campeche and Quintana Roo, as Campbell and Lamar (2004) indicate a few nearby records from El Petén, Guatemala, and Belize.

Bothriechis schlegelii. This snake might be present in southern Quintana Roo, as Campbell (1998) recorded it from northern Belize and Guatemala.

Porthidium nasutum. This snake is not reported from the Mexican Yucatan Peninsula, but might be present in southern Campeche because Campbell and Lamar (2004) noted populations in El Petén, Guatemala.

Lepidochelys olivacea. Herrera-Pavón (2011) indicated the occasional presence of this chelonian in the waters of Quintana Roo, but did not provide information on nesting sites or terrestrial records.

Thecadactylus rapicauda (Houttuyn, 1782). The Turniptail Gecko is found in a broad range that includes "Yucatan in Mexico, south to southern Colombia on both sides of the Andes, extending east in Venezuela, Guyana, Surinam, French Guyana, Brazilian Roraima, Brazilian Pará, and all of the Lesser Antilles to the exclusion of the Puerto Rican bank (but including Necker Island) and Barbados" (Bergman and Russell, 2007). This individual was found at Reserva Estatal Biocultural del Puuc, in the municipality of Oxkutzcab, in southwestern Yucatán. Wilson et al. (2013a) calculated its EVS as 10, placing it at the lower limit of the medium vulnerability category. Its conservation status has not been assessed by the IUCN, but this gecko is considered a species of special protection (Pr) by SEMARNAT.

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Mesoscincus schwartzei (Fischer, 1884). Schwartze's Skink is distributed in the "Yucatán Peninsula region of Mexico, northern Guatemala, and Belize" (Stafford and Meyer, 2000). This individual was photographed at Chetumal, in the municipality of Othón P. Blanco, in the state of Quintana Roo. Wilson et al. (2013a) determined its EVS as 11, placing it in the lower portion of the medium vulnerability category. Its conservation status has been evaluated as Least Concern by the IUCN, but this species is not listed by SEMARNAT.

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DISTRIBUTION OF HERPETOFAUNAL SPECIES BY STATE

We documented the distribution of the herpetofauna of the Mexican Yucatan Peninsula by state in Table 4, and present a summary of those data in Table 5. The largest number of amphibian species is recorded in Campeche and Quintana Roo, i.e., 23 of 25 species (92.0%), whereas 18 (72.0%) are recorded for Yucatán. Of the 120 crocodylians, squamates, and turtles, the largest number is reported in Quintana Roo (110; 91.7%), followed by that in Campeche (106; 88.3%) and then in Yucatán (90; 75.0%). In total, of the 145 species listed for the entire area, the number in Quintana Roo is 133 (91.7%), followed closely by that in Campeche (129; 89.0%), and more remotely in Yucatán (108; 74.5%). With regard to amphibians and the remainder of the herpetofauna, the lowest species numbers are in Yucatán, likely due to the drier conditions that foster less diverse and more xeric vegetation, as opposed to those in Campeche and Quintana Roo. In addition, Yucatán is the smallest of the three states in surface area (39,524 km^2), as compared to Quintana Roo (44,705 km^2) and Campeche (57, 507 km^2).

Table 5. Summary of the distributional occurrence of herpetofaunal families in the Mexican Yucatan Peninsula by state.

Families	Number of Species	Distributional Occurrence		
		Campeche	Yucatán	Quintana Roo
Bufonidae	2	2	2	2
Craugastoridae	2	1	1	2
Eleutherodactylidae	1	—	1	1
Hylidae	8	8	7	8
Leptodactylidae	3	3	2	3
Microhylidae	2	2	1	1
Phyllomedusidae	1	1	1	1
Ranidae	2	2	1	1
Rhinophrynidae	1	1	1	1
Subtotals	**22**	**20**	**17**	**20**
Plethodontidae	3	3	1	3
Subtotals	**3**	**3**	**1**	**3**
Totals	**25**	**23**	**18**	**23**
Crocodylidae	2	2	2	2
Subtotals	**2**	**2**	**2**	**2**
Anguidae	1	—	—	1
Corytophanidae	5	5	2	5
Dactyloidae	8	7	5	8
Eublepharidae	1	1	1	1
Gekkonidae	2	2	2	1
Iguanidae	4	4	3	4
Mabuyidae	1	1	1	1
Phrynosomatidae	5	5	4	4
Phyllodactylidae	2	1	1	2
Scincidae	2	2	2	2
Sphaerodactylidae	4	1	2	3
Sphenomorphidae	1	1	1	1
Teiidae	8	7	2	6
Xantusiidae	1	—	—	1
Subtotals	**45**	**37**	**26**	**40**

Boidae	1	1	1	1
Colubridae	22	19	21	22
Dipsadidae	21	21	17	19
Elapidae	1	1	1	1
Leptotyphlopidae	2	—	1	2
Natricidae	3	3	2	2
Sibynophiidae	1	—	1	1
Typhlopidae	2	2	2	2
Viperidae	4	4	4	4
Subtotals	**57**	**51**	**50**	**54**
Cheloniidae	4	4	4	3
Chelydridae	1	1	—	—
Dermatemydidae	1	1	1	1
Dermochelyidae	1	1	—	1
Emydidae	2	2	2	2
Geoemydidae	1	1	1	1
Kinosternidae	4	4	3	4
Staurotypidae	2	2	1	2
Subtotals	**16**	**16**	**12**	**14**
Totals	**120**	**106**	**90**	**110**
Sum Totals	**145**	**129**	**108**	**133**

PATTERNS OF PHYSIOGRAPHIC DISTRIBUTION

We utilized a system of six physiographic regions to examine the distribution of the herpetofauna of the Mexican Yucatan Peninsula. We documented the distribution of these species in Table 6, and present a summary of these data in Table 7.

The total number of species in the six regions ranges from a low of 43 in the Tropical Gulf Islands to a high of 120 in the Karstic Hills and Plains of Campeche. The numbers for the other four regions, in ascending order, are 49 (Caribbean Islands), 93 (Tabascan Plains and Marshes), 106 (Low Coast of Quintana Roo), and 118 (Yucatecan Karstic Plains). The lowest number is found in the Tropical Gulf Islands, representing only 35.8% of the total number of species found in the most speciose region, the Karstic Hills and Plains of Campeche.

We expected the highest absolute and relative numbers of species in the various herpetofaunal groups to occur in the Karstic Hills and Plains of Campeche. This turned out to be the case with amphibians (23 of 25 species; 92.0%), squamates (81 of 102 species; 79.4%), and turtles (15 of 16 species; 93.8%), but not the crocodylians (only one of two species occur in this region). In addition, the number of turtle species is the same (15) in this region and in the Tabascan Plains and Marshes (Table 7).

The members of the herpetofauna of the Mexican Yucatan Peninsula occupy from one to six physiographic regions (Table 6), as follows: one (19 of 145 species; 13.1%); two (16; 11.0%); three (30; 20.7%); four (33; 22.8%); five (25; 17.2%); and six (22; 15.2%). The most broadly distributed species (occupying all six physiographic regions) are the anurans *Incilius valliceps*, *Rhinella horribilis*, *Dendropsophus microcephalus*, *Scinax staufferi*, *Smilisca baudinii*, and *Leptodactylus fragilis*, the lizards *Basiliscus vittatus*, *Norops rodriguezii*, *N. sagrei*, *N. ustus*, *Hemidactylus frenatus*, *Ctenosaura similis*, *Sceloporus chrysostictus*, and *Sphaerodactylus glaucus*, the snakes *Boa imperator*, *Conophis lineatus*, and *Leptodeira frenata*, and the turtles *Caretta caretta*, *Chelonia mydas*, *Eretmochelys imbricata*, *Dermochelys coriacea*, and *Kinosternon scorpioides*. As expected, these species either are distributed to the south in Central America, and in some cases more broadly, or they are non-native species whose distributions are enhanced by anthropogenic means.

Table 6. Distribution of the herpetofauna of the Mexican Yucatan Peninsula by physiographic region. * = country endemic; ** regional endemic; and *** = non-native.

Taxa	Physiographic Regions						
	Tabascan Plains and Marshes	Karstic Hills and Plains of Campeche	Yucatecan Karstic Plains	Low Coast of Quintana Roo	Gulf Islands	Caribbean Islands	Total Number of Regions
Anura (22 species)							
Bufonidae (2 species)							
Incilius valliceps	+	+	+	+	+	+	6
Rhinella horribilis	+	+	+	+	+	+	6
Craugastoridae (2 species)							
Craugastor loki	+	+					2
*Craugastor yucatanensis***			+				1
Eleutherodactylidae (1 species)							
*Eleutherodactylus planirostris****			+			+	2
Hylidae (8 species)							
Dendrosophus ebraccatus		+	+	+			3
Dendrosophus microcephalus	+	+	+	+		+	5
Scinax staufferi	+	+	+	+	+	+	6
Smilisca baudinii	+	+	+	+	+	+	6
Tlalocohyla loquax	+	+	+	+			4
Tlalocohyla picta	+	+	+	+			4
Trachycephalus typhonius	+	+	+	+		+	5
Triprion petasatus	+	+	+	+			4
Leptodactylidae (3 species)							
Engystomops pustulosus	+	+		+			3
Leptodactylus fragilis	+	+	+	+	+	+	6
Leptodactylus melanonotus	+	+	+	+			4
Microhylidae (2 species)							
Gastrophyrne elegans	+	+		+			3
Hypopachus variolosus	+	+	+	+	+		5
Phyllomedusidae (1 species)							
Agalychnis callidryas	+	+	+	+			4
Ranidae (2 species)							
Lithobates brownorum	+	+	+	+			4
Lithobates vaillanti	+	+					2
Rhinophrynidae (1 species)							
Rhinophrynus dorsalis	+	+	+	+			4
Caudata (3 species)							
Plethodontidae (3 species)							
Bolitoglossa mexicana		+	+				2
Bolitoglossa rufescens		+		+			2
Bolitoglossa yucatana		+	+	+			3

Table 6 (continued)

Taxa	Physiographic Regions						
	Tabascan Plains and Marshes	Karstic Hills and Plains of Campeche	Yucatecan Karstic Plains	Low Coast of Quintana Roo	Gulf Islands	Caribbean Islands	Total Number of Regions
Crocodylia (2 species)							
Crocodylus acutus	+		+	+		+	4
Crocodylus moreletii	+	+	+	+	+		5
Squamata (102 species)							
Anguidae (1 species)							
Celestus rozellae		+					1
Corytophanidae (5 species)							
Basiliscus vittatus	+	+	+	+	+	+	6
Corytophanes cristatus	+	+	+				3
Corytophanes hernandezii		+	+	+			3
Laemanctus longipes		+					1
Laemanctus serratus		+	+	+			3
Dactyloidae (8 species)							
Anolis allisoni						+	1
Norops beckeri		+		+			2
Norops biporcatus	+	+					2
Norops lemurinus	+	+	+	+		+	5
Norops rodriguezii	+	+	+	+	+	+	6
*Norops sagrei****	+	+	+	+	+	+	6
Norops tropidonotus	+	+	+	+			4
Norops ustus	+	+	+	+	+	+	6
Eublepharidae (1 species)							
Coleonyx elegans	+	+	+	+		+	5
Gekkonidae (2 species)							
*Hemidactylus frenatus****	+	+	+	+	+	+	6
*Hemidactylus turcicus****	+	+	+		+	+	5
Iguanidae (4 species)							
Ctenosaura alfredschmidti		+	+				2
*Ctenosaura defensor***	+	+	+				3
Ctenosaura similis	+	+	+	+	+	+	6
Iguana iguana	+	+		+	+	+	5
Mabuyidae (1 species)							
Marisora brachypoda	+	+	+		+	+	5
Phrynosomatidae (5 species)							
Sceloporus chrysostictus	+	+	+	+	+	+	6
*Sceloporus cozumelae***			+			+	2
Sceloporus lundelli	+	+	+	+			4
Sceloporus serrifer	+	+		+			3
Sceloporus teapensis	+						1

Table 6 (continued)

Taxa	Physiographic Regions						
	Tabascan Plains and Marshes	Karstic Hills and Plains of Campeche	Yucatecan Karstic Plains	Low Coast of Quintana Roo	Gulf Islands	Caribbean Islands	Total Number of Regions
Phyllodactylidae (2 species)							
Phyllodactylus tuberculosus			+				1
Thecadactylus rapicauda		+	+				2
Scincidae (2 species)							
Mesoscincus schwartzei	+	+	+	+		+	5
Plestiodon sumichrasti		+	+				2
Sphaerodactylidae (4 species)							
Aristelliger georgeensis			+			+	2
*Sphaerodactylus argus****			+				1
Sphaerodactylus continentalis						+	1
Sphaerodactylus glaucus	+	+	+	+	+	+	6
Sphenomorphidae (1 species)							
Scincella cherriei	+	+	+	+			4
Teiidae (8 species)							
Aspidoscelis angusticeps	+	+	+	+			4
*Aspidoscelis cozumela***						+	1
Aspidoscelis deppii	+	+			+		3
Aspidoscelis maslini	+			+	+	+	4
*Aspidoscelis rodecki***			+			+	2
*Holcosus gaigeae***	+	+	+	+	+	+	6
Holcosus hartwegi		+	+	+			3
*Holcosus stuarti**	+						1
Xantusiidae (1 species)							
Lepidophyma flavimaculatum			+				1
Boidae (1 species)							
Boa imperator	+	+	+	+	+	+	6
Colubridae (22 species)							
Drymarchon melanurus	+	+	+	+			4
Drymobius margaritiferus	+	+	+	+	+		5
Ficimia publia	+	+	+	+			4
Lampropeltis abnorma	+	+	+	+	+		5
Leptophis ahaetulla	+	+	+	+			4
Leptophis mexicanus	+	+	+	+		+	5
Masticophis mentovarius	+	+	+				3
Mastigodryas melanolomus		+	+	+		+	4
Oxybelis aeneus		+	+	+		+	4
Oxybelis fulgidus		+	+	+		+	4
Phrynonax poecilonotus		+	+	+			3
Pseudelaphe flavirufa	+	+		+	+		4
*Pseudelaphe phaescens***			+				1

Table 6 (continued)

Taxa	Physiographic Regions						
	Tabascan Plains and Marshes	Karstic Hills and Plains of Campeche	Yucatecan Karstic Plains	Low Coast of Quintana Roo	Gulf Islands	Caribbean Islands	Total Number of Regions
Senticolis triaspis	+	+	+	+			4
Spilotes pullatus	+	+	+	+	+		5
Stenorrhina freminvillii	+	+	+	+			4
Symphimus mayae		+	+	+			3
Tantilla cuniculator			+	+			2
Tantilla moesta			+	+		+	3
Tantilla schistosa				+			1
Tantillita canula		+	+	+			3
Tantillita lintoni		+	+	+			3
Dipsadidae (21 species)							
Coniophanes bipunctatus	+	+	+	+			4
Coniophanes imperialis	+	+	+	+	+		5
*Coniophanes meridanus***		+	+	+			3
Coniophanes quinquevittatus			+				1
Coniophanes schmidti		+	+	+			3
Conophis lineatus	+	+	+	+	+	+	6
Dipsas brevifacies		+	+	+	+		4
Imantodes cenchoa	+	+	+	+	+		5
Imantodes gemmistratus	+	+	+	+			4
Imantodes tenuissimus	+	+	+	+			4
Leptodeira frenata	+	+	+	+	+	+	6
Leptodeira septentrionalis	+	+	+	+			4
Ninia diademata		+					1
Ninia sebae	+	+	+	+	+		5
Pliocercus elapoides	+	+	+	+			4
Sibon nebulatus	+	+	+	+	+		5
Sibon sanniolus		+	+	+			3
Tretanorhinus nigroluteus	+	+		+			3
Tropidodipsas fasciata		+	+	+			3
Tropidodipsas sartorii	+	+	+	+	+		5
Xenodon rabdocephalus		+	+	+			3
Elapidae (1 species)							
Micrurus diastema	+	+	+	+	+		5
Leptotyphlopidae (2 species)							
Epictia magnamaculata						+	1
Epictia vindumi			+				1
Natricidae (3 species)							
Nerodia rhombifera	+						1
Thamnophis marcianus		+	+				2
Thamnophis proximus	+	+	+	+		+	5

Table 6 (continued)

Taxa	Physiographic Regions						
	Tabascan Plains and Marshes	Karstic Hills and Plains of Campeche	Yucatecan Karstic Plains	Low Coast of Quintana Roo	Gulf Islands	Caribbean Islands	Total Number of Regions
Sibynophiidae (1 species)							
Scaphiodontophis annulatus		+	+				2
Typhlopidae (1 species)							
Amerotyphlops microstomus		+	+	+			3
*Indotyphlops braminus****			+	+		+	3
Viperidae (4 species)							
Agkistrodon russeolus		+	+	+			3
Bothrops asper	+	+	+	+			4
Crotalus tzabcan	+	+	+	+			4
*Porthidium yucatanicum***		+	+	+			3
Testudines (16 species)							
Cheloniidae (4 species)							
Caretta caretta	+	+	+	+	+	+	6
Chelonia mydas	+	+	+	+	+	+	6
Eretmochelys imbricata	+	+	+	+	+	+	6
Lepidochelys kempii	+	+	+		+		5
Chelydridae (1 species)							
Chelydra rossignonii	+						1
Dermatemydidae (1 species)							
Dermatemys mawii	+	+		+	+		4
Dermochelyidae (1 species)							
Dermochelys coriacea	+	+	+	+	+	+	6
Emydidae (2 species)							
*Terrapene yucatana***	+	+	+				3
Trachemys venusta	+	+	+	+		+	5
Geoemydidae (1 species)							
Rhinoclemmys areolata	+	+	+	+		+	5
Kinosternidae (4 species)							
Kinosternon acutum	+	+		+			3
*Kinosternon creaseri***		+	+	+			3
Kinosternon leucostomum	+	+	+	+			4
Kinosternon scorpioides	+	+	+	+	+	+	6
Staurotypidae (2 species)							
Claudius angustatus	+	+	+	+			4
Staurotypus triporcatus	+	+	+	+	+		5

Aspidoscelis cozumela (Gadow, 1906). The Cozumel Racerunner is a regional endemic in the Mexican Yucatan Peninsula, occurring in the Caribbean Islands of the Yucatán Península region. This individual was photographed at Playa Punta Morena, on the island of Cozumel, Quintana Roo. Wilson et al. (2013a) assessed its EVS as 16, placing it in the middle portion of the high vulnerability category. Its conservation status has been calculated as Least Concern by the IUCN, but this teiid is not listed by SEMARNAT. © Carlos Pavón-Vázquez

Table 7. Summary of the distributional occurrence of herpetofaunal families in the Mexican Yucatan Peninsula by physiographic region.

Families	Number of Species	Distributional Occurrence					
		Tabascan Plains and Marshes	Karstic Hills and Plains of Campeche	Yucatecan Karstic Plains	Low Coast of Quintana Roo	Gulf Islands	Caribbean Islands
Bufonidae	2	2	2	2	2	2	2
Craugastoridae	2	1	1	1	—	—	—
Eleutherodactylidae	1	—	—	1	—	—	1
Hylidae	8	7	8	8	8	2	4
Leptodactylidae	3	3	3	2	3	1	1
Microhylidae	2	2	2	1	2	1	—
Phyllomedusidae	1	1	1	1	1	—	—
Ranidae	2	2	2	1	1	—	—
Rhinophrynidae	1	1	1	1	1	—	—
Subtotals	**22**	**19**	**20**	**18**	**18**	**6**	**8**

Plethodontidae	3	—	3	2	2	—	—
Subtotals	**3**	**—**	**3**	**2**	**2**	**—**	**—**
Totals	**25**	**19**	**23**	**20**	**20**	**6**	**8**
Crocodylidae	2	2	1	2	2	1	1
Subtotals	**2**	**2**	**1**	**2**	**2**	**1**	**1**
Anguidae	1	—	1	—	—	—	—
Corytophanidae	5	2	5	4	3	1	1
Dactyloidae	8	6	7	5	6	3	5
Eublepharidae	1	1	1	1	1	—	1
Gekkonidae	2	2	2	2	1	2	2
Iguanidae	4	3	4	3	2	2	2
Mabuyidae	1	1	1	1	—	1	1
Phrynosomatidae	5	4	3	3	3	1	2
Phyllodactylidae	2	—	1	2	—	—	—
Scincidae	2	1	2	2	1	—	1
Sphaerodactylidae	4	1	1	3	1	1	3
Sphenomorphidae	1	1	1	1	1	—	—
Teiidae	8	5	4	4	4	3	4
Xantusiidae	1	—	—	1	—	—	—
Subtotals	**45**	**27**	**33**	**32**	**23**	**14**	**22**
Boidae	1	1	1	1	1	1	1
Colubridae	22	11	18	20	20	4	5
Dipsadidae	21	13	20	19	19	8	2
Elapidae	1	1	1	1	1	1	—
Leptotyphlopidae	2	—	—	1	—	—	1
Natricidae	3	2	2	2	1	—	1
Sibynophiidae	1	—	1	1	—	—	—
Typhlopidae	2	—	1	2	2	—	1
Viperidae	4	2	4	4	4	—	—
Subtotals	**57**	**30**	**48**	**51**	**48**	**14**	**11**
Cheloniidae	4	4	4	4	3	4	3
Chelydridae	1	1	—	—	—	—	—
Dermatemydidae	1	1	1	—	1	1	—
Dermochelyidae	1	1	1	1	1	1	1
Emydidae	2	2	2	2	1	—	1
Geoemydidae	1	1	1	1	1	—	1
Kinosternidae	4	3	4	3	4	1	1
Staurotypidae	2	2	2	2	2	1	—
Subtotals	**16**	**15**	**15**	**13**	**13**	**8**	**7**
Totals	**120**	**74**	**97**	**98**	**86**	**37**	**41**
Sum Totals	**145**	**93**	**120**	**118**	**106**	**43**	**49**

Unlike the situation with other MCS studies, most of the species do not occur in one or two physiographic regions but are found in three to six regions (110; 75.9%). This outcome was expected, given the large proportion of non-endemic species (127; 87.6%) and the limited proportion of endemic species (12; 8.3%) found on the peninsula. The mean regional occupancy value is 3.7, which is significantly higher than usually reported in similar studies; the range has been from 2.2 to 2.7 (Johnson et al., 2015a; Mata-Silva et al., 2015; Nevárez-de los Reyes et al., 2016; Terán-Juárez et al., 2016; Woolrich-Piña et al., 2016).

The number of native species occupying a single region ranges from none in the Gulf Islands to five in the Yucatecan Karstic Plains (Table 6). The remainder of the regions harbor one (Low Coast of Quintana Roo), three (Karstic Hills and Plains of Campeche), or four (Tabascan Plains and Marshes and Caribbean Islands) species.

Two of the five physiographic regions in the Mexican Yucatan Peninsula are of greatest conservation significance. One is the Karstic Hills and Plains of Campeche, because it harbors the largest total number of species (120 of 145 species) and the second largest number of endemics (six of 12). The other is the Yucatecan Karstic Plains, because it contains the second largest number of species (118) and the largest number of endemics (nine).

In the ensuing lists, * = endemic to Mexico, and ** = endemic to Mexican Yucatan Peninsula. The other species are non-endemic to Mexico. The following five species are restricted to the Yucatecan Karstic Plains:

*Craugastor yucatanensis***
Phyllodactylus tuberculosus
Lepidophyma flavimaculatum
Coniophanes quinquevittatus
Epictia vindumi

The distribution of the following four species is limited to the Tabascan Plains and Marshes:

Sceloporus teapensis
*Holcosus stuarti**
Nerodia rhombifera
Chelydra rossignonii

The occurrence of the following three species is restricted to the Karstic Hills and Plains of Campeche:

Celestus rozellae
Laemanctus longipes
Ninia diademata

The distribution of the following four species is limited to the Caribbean Islands:

Anolis allisoni
Sphaerodactylus continentalis
*Aspidoscelis cozumela***
Epictia magnamaculata

Tantilla schistosa is limited in distribution to the Low Coast of Quintana Roo. No species are limited in distribution to the Gulf Islands.

To examine the distribution of the insular herpetofauna associated with the Mexican Yucatan Peninsula, in Table 8 we documented the occurrence of each species on an island-by-island basis. We also divided the islands involved into two physiographic regions, the Gulf Islands and the Caribbean Islands. The total herpetofauna known to occupy these islands is 66 species (45.5% of the total), which include nine anurans, two crocodylians, 45 squamates (23 lizards, 22 snakes), and 10 turtles. Salamanders have not been recorded from these islands. As noted above, 43 species occur on the Gulf Island group and 49 on the Caribbean Island group.

The nine anuran species distributed on these islands are classified in the families Bufonidae (two of two species known from the peninsula as a whole), Eleutherodactylidae (the single non-native species *Eleutherodactylus planirostris*), Hylidae (four of eight species), Leptodactylidae (one of two), and Microhylidae (one of two). No members of the families Craugastoridae, Phyllomedusidae, Ranidae, or Rhinophrynidae are known from any of the islands. Both species of crocodylians are recorded from these islands. The families for the 23 species of lizards on the islands are the Corytophanidae (one of five), Dactyloidae (five of eight), Eublepharidae (one of one), Gekkonidae (both of the non-native species known from the peninsula), Iguanidae (two of four), Mabuyidae (one of one), Phrynosomatidae (two of five), Scincidae (one of two), Sphaerodactylidae (three of four), and Teiidae (five of eight). No members of the families Anguidae, Phyllodactylidae, or Xantusiidae are found on these islands. The families for the 22 species of snakes on the islands are the Boidae (one of one), Colubridae (nine of 22), Dipsadidae (eight of 21), Elapidae (one of one), Leptotyphlopidae (one of two), Natricidae (one of three), and Typhlopidae (one of two, the non-native *Indotyphlops braminus*). No members of the families Sibynophiidae or Viperidae are represented on the islands. The 10 species of turtles on the islands are assigned to the families Cheloniidae (all four), Dermatemydidae (one of one), Dermochelyidae (one of one), Emydidae (one of two), Geoemydidae (one of one), Kinosternidae (one of four), and Staurotypidae (one of two). The single member of the family Chelydridae is not distributed on any of these islands (Table 8).

Table 8. Distribution of the insular herpetofauna of the Mexican Yucatan Peninsula by island groups. Islas de Laguna de Términos does not include Isla Aguada, because we consider it part of the mainland. Cancún is not listed for the same reason. The herpetofauna of most islets of the peninsula has not been surveyed, so they are not considered here. A single record of a reptile species is available for two islets: *Norops sagrei* in Cayo Culebra, Quintana Roo, and *Chelonia mydas* in Cayo Arcas, Campeche. *Staurotypus triporcatus* is not mentioned by Lee (1996) or any other published reference, but we list it here for Isla del Carmen (Islas de Laguna de Términos) based on the record at www.inaturalist.org/observations/4792157. *Norops sagrei* is indicated as occurring in Arrecife Alacranes in a report from Grupo de Ecología y Conservación de Islas, but the same report omits this species in several tables and only lists *Anolis* sp.; this information likely was taken from the management program for this national protected area, since it only lists *Anolis* sp. The species most likely is *N. sagrei*, but the report contains several errors (e.g., it includes *Anolis maslini* (sic) for another island). Also, *N. rodriguezi* was included in an environmental plan in Holbox, for creating touristic infrastructure, and should be considered doubtful because the information in such plans is not reliable. *Ctenotus cristatellus* often is listed as occurring in Cozumel, but Lee (1996) considered this record doubtful; we omitted this species because no other record is available. Fishermen have been recorded as making incidental sightings of *Crocodylus acutus* on Isla Contoy; however, a permanent population of this species is not established on the island.

Taxa	Insular Physiographic Regions							Total Number of Islands
	Gulf Islands		Caribbean Islands					
	Islas de Laguna de Términos	Arrecife Alacranes	Isla Contoy	Isla Holbox	Isla Mujeres	Cozumel	Banco Chinchorro	
Anura (9 species)								
Bufonidae (2 species)								
Incilius valliceps	+			+	+	+		4
Rhinella horribilis	+					+		2
Eleutherodactylidae (1 species)								
*Eleutherodactylus planirostris****						+		1
Hylidae (4 species)								
Dendrosophus microcephalus						+		1
Scinax staufferi	+					+		2
Smilisca baudinii	+					+		2
Trachycephalus typhonius						+		1
Leptodactylidae (1 species)								
Leptodactylus fragilis	+					+		2
Microhylidae (1 species)								
Hypopachus variolosus	+							1
Crocodylia (2 species)								
Crocodylus acutus			+		+	+	+	4
Crocodylus moreletii	+							1
Squamata (45 species)								
Corytophanidae (1 species)								
Basiliscus vittatus	+					+		2
Dactyloidae (5 species)								
Anolis allisoni							+	1
Norops lemurinus					+			1
Norops rodriguezii	+			?	+	+		3

*Norops sagrei****	+	?	+	+	+	+	+	6
Norops ustus	+				+			2
Eublepharidae (1 species)								
Coleonyx elegans					+			1
Gekkonidae (2 species)								
*Hemidactylus frenatus****	+			+		+	+	4
*Hemidactylus turcicus****	+					+		2
Iguanidae (2 species)								
Ctenosaura similis	+		+	+	+	+	+	6
Iguana iguana	+					+	+	3
Mabuyidae (1 species)								
Marisora brachypoda	+	+	+	+	+	+		6
Phrynosomatidae (2 species)								
Sceloporus chrysostictus	+			+	+			3
*Sceloporus cozumelae**			+	+	+	+		4
Scincidae (1 species)								
Mesoscincus schwartzei						+		1
Sphaerodactylidae (3 species)								
Aristelliger georgeensis			+		+	+	+	4
Sphaerodactylus continentalis						*		1
Sphaerodactylus glaucus	+					+		2
Teiidae (5 species)								
*Aspidoscelis cozumela**						+		1
Aspidoscelis deppii	+							1
Aspidoscelis maslini	+						+	2
*Aspidoscelis rodecki**			+		+			2
*Holcosus gaigeae**	+				+			2
Boidae (1 species)								
Boa imperator	+		+		+	+	+	5
Colubridae (9 species)								
Drymobius margaritiferus	+							1
Lampropeltis abnorma	+							1
Leptophis mexicanus					+			1
Mastigodryas melanolomus						+		1
Oxybelis aeneus			+		+			2
Oxybelis fulgidus				+	+	+		3
Pseudelaphe flavirufa	+							1
Spilotes pullatus	+							1
Tantilla moesta						+		1
Dipsadidae (8 species)								
Coniophanes imperialis	+							1
Conophis lineatus	+		+	+				3
Dipsas brevifacies	+							1
Imantodes cenchoa	+							1
Leptodeira frenata	+					+		2
Ninia sebae	+							1
Sibon nebulatus	+							1
Tropidodipsas sartorii	+							1
Elapidae (1 species)								
Micrurus diastema	+							1
Leptotyphlopidae 1 species)								

Epictia magnamaculata						+		1
Natricidae (1 species)								
Thamnophis proximus						+		1
Typhlopidae (1 species)								
*Indotyphlops braminus****						+		1
Testudines (10 species)								
Cheloniidae (4 species)								
Caretta caretta	+	+	+	+	+	+	+	6
Chelonia mydas	+	+	+	+	+	+	+	7
Eretmochelys imbricata	+	+	+	+	+	+	+	7
Lepidochelys kempii	+							1
Dermatemydidae (1 species)								
Dermatemys mawii	+							1
Dermochelyidae (1 species)								
Dermochelys coriacea		+	+		+	+	+	4
Emydidae (1 species)								
Trachemys venusta						+		1
Geoemydidae (1 species)								
Rhinoclemmys areolata					+	+		2
Kinosternidae (1 species)								
Kinosternon scorpioides	+					+		2
Staurotypidae (1 species)								
Staurotypus triporcatus	+							1

We include distributional data for two islands on the Gulf side of the peninsula, Islas de Laguna de Términos (Isla del Carmen) and the Arrecife Alacranes (Table 8). The former island, which is 40 km long and six to eight km wide (www.wikipedia.org; accessed 13 March 2017) lies on the Gulf side of the Laguna de Términos and is connected to the mainland by eastern and western causeways. The eastern causeway (Puente de la Unidad) connects to Isla Aguada, which we do not consider an island because it is connected to the rest of the mainland in Campeche. On the other hand, Arrecife Alacranes, actually is a "reef surrounding a small group of islands in the Gulf of Mexico off the northern coast of the state of Yucatán…" (www.wikipedia.org; accessed 13 March 2017). Five principal vegetated islands are located in this reef, of which only one (Isla Pérez) is inhabited. This reef lies about 127 km north of the northern coast of the state of Yucatán (Google Earth; accessed 13 March 2017). We expected most of the 43 species recorded from the Gulf Islands to occur on Isla de Laguna de Términos, i.e., 42 species, including six anurans, one crocodylian, 28 squamates, and seven turtles. Only five species are reported from Arrecife Alacranes, of which all but one are sea turtles (the other species is the skink *Marisora brachypoda* [Table 8]). The only species found on Arrecife Alacranes and not recorded from Isla de Laguna de Términos is the Leatherback Sea Turtle (*Dermochelys coriacea*).

We included five of the Caribbean Islands for which herpetological records exist in Table 8. As noted above, a total of 49 species have been reported from these islands. As expected, the largest of these islands, Cozumel (with an area of 647 km^2), supports the greatest number of species (37). The next largest is Isla Mujeres (425 km^2), which contains 23 species, and Isla Holbox (56 km^2) harbors 12 species. In terms of aggregate land surface, Banco Chinchorro is the next largest (6.7 km^2) and supports 13 species. The smallest of the five Caribbean Islands is Isla Contoy (3.2 km^2) contains 14 species (Table 8).

We do not regard Cancún as a true island, because urban development has converted it into a peninsula. Also, we are not considering the interior islands (e.g., Isla Talmacab), because the islands are located within the coastal lagoon of Chetumal Bay; the same is true for Isla la Pasión, which can be considered an integral part of Cozumel (this island is not related to Isla de la Pasión [or Isla Clipperton], which is a French possession in the Pacific Ocean).

Notably, Article 48 of the *Constitución Politica de los Estados Unidos Mexicanos* (Constitution of the United Mexican States) explains that all islands, cays, and reefs inside Mexican territory or territorial seas are under federal jurisdiction, except for those administrated by any state before the date of the decree (1917). Cozumel is an example of this latter case and is administrated by the state of Quintana Roo, but many of the other islands are under federal jurisdiction. Here the islands sometimes are listed by their administrative entity, but rather by the state they are most commonly associated with; thus, we applied this criterion in the species list by state (Table 4), i.e., the species from Banco Chinchorro are added to the Quintana Roo listing, the species from Arrecife Alaranes are added to Yucatán, and so on.

Aspidoscelis rodecki (McCoy and Maslin, 1962). Rodeck's Whiptail is a regional endemic in the Mexican Yucatan Peninsula found in the Yucatecan Karstic Plains and the Caribbean Islands regions in Quintana Roo. Pictured here is an individual from Isla Contoy, Quintana Roo. Wilson et al. (2013a) ascertained its EVS as 16, placing it in the middle portion of the high vulnerability category. Its conservation status has been assessed as Near Threatened by the IUCN, and as endangered (P) by SEMARNAT. © Iago Leonardo

Based on the data in Table 6, we constructed a Coefficient of Biogeographic Resemblance (CBR) matrix (Table 9) to examine herpetofaunal relationships among the six physiographic regions in the Mexican portion of the Yucatan Peninsula. The number of shared species ranges from 26 to 104, with the lowest value (26) between the Caribbean Islands and Gulf Islands and the highest (104) between the Karstic Hills and Plains of Campeche and Yucatecan Karstic Plains. The mean number of shared species among all regions is 73.5. Both the Gulf Islands and Caribbean Islands share a lesser number of species when compared with the four mainland regions; this finding also was true for Nayarit (Woolrich-Peña et al., 2016), a state that also included an insular region. A plausible reason for the lower numbers is that islands generally contain fewer species than on adjacent mainland areas (MacArthur and Wilson, 1967), because of the dispersal ability bias. Additionally, in the case of the Mexican Yucatan Peninsula physiographic regions, the higher numbers of shared species among them is correlated with higher number of species found within them.

The CBR data in Table 9 demonstrate coefficient values ranging from 0.44 to 0.88. The lowest value is between the Karstic Hills and Plains of Campeche and the Caribbean Islands (0.44), which in distance are the farthest from each other. That number is 8% lower than the coefficient value between the Gulf Islands and the adjacent Karstic Hills and Plains of Campeche (0.52); the Gulf Islands are closer to the mainland than the Caribbean Islands are to their adjacent mainland, primarily because of Isla Cozumel, Quintana Roo, the main Caribbean Island surveyed in our study. The overall CBR values among the six physiographic regions are as follows, arranged from highest to lowest values (the species numbers are in parentheses):

Karstic Hills and Plains of Campeche (120)—**0.88**—Low Coast of Quintana Roo (106)

Yucatecan Karstic Plains (118)—**0.87**—Karstic Hills and Plains of Campeche (120)

Low Coast of Quintana Roo (106)—**0.85**—Yucatecan Karstic Plains (118)

Karstic Hills and Plains of Campeche (120)—**0.83**—Tabascan Plains and Marshes (93)

Low Coast of Quintana Roo (106)—**0.78**—Tabascan Plains and Marshes (93)

Yucatecan Karstic Plains (118)—**0.73**—Tabascan Plains and Marshes (93)

Gulf Islands (43)—**0.62**—Tabascan Plains and Marshes (93)

Caribbean Islands (49)—**0.57**—Gulf Islands (43)

Gulf Islands (43)—**0.52**—Karstic Hills and Plains of Campeche (120)

Gulf Islands (43)—**0.52**—Low Coast of Quintana Roo (106)

Caribbean Islands (49)—**0.51**—Tabascan Plains and Marshes (93)

Caribbean Islands (49)—**0.51**—Yucatecan Karstic Plains (118)

Caribbean Islands (49)—**0.50**—Low Coast of Quintana Roo (106)

Gulf Islands (43)—**0.48**—Yucatecan Karstic Plains (118)

Caribbean Islands (49)—**0.44**—Karstic Hills and Plains of Campeche (120)

Based on the data in Table 9, we also assembled a UPGMA dendrogram (Fig. 8) to illustrate resemblance patterns among the six physiographic regions in a hierarchical fashion. The dendrogram indicates that the Low Coast of Quintana Roo (QR) and Karstic Hills and Plains of Campeche (KH) share the highest herpetofaunal resemblance (0.88). Both of these regions contain many generalist species that occur on the Atlantic versant of Mesoamerica and elsewhere. Close behind is the resemblance factor (0.87) between the Yucatan Karstic Plains (YP) and the Karstic Hills and Plains of Campeche (KH), which are adjacent to each other and share several species that are endemic to the northern portion of the Yucatan Peninsula. The other mainland region (the Tabascan Plains and Marshes, TP) forms part of a group that clusters together with QR, KH, and YP at a resemblance value of 0.78, which indicates that the TP region shares many of the same generalist species found in the other mainland regions. The herpetofauna of TP perhaps has been surveyed less than the others, so more fieldwork likely will produce additional records, which thereby would increase the resemblance values with the other mainland regions. Both the Gulf Islands (GI) and Caribbean Islands (CI) have lower resemblance values with all of the mainland regions (0.54 or less), most likely because of the dispersal ability bias alluded to above, especially for Cozumel Island in CI because it is positioned farther from the mainland than all of the Gulf of Mexico islands.

Table 9. Pair-wise comparison matrix of Coefficient of Biogeographic Resemblance (CBR) data of herpetofaunal relationships for the five physiographic regions in the Mexican Yucatan Peninsula. Underlined values = number of species in each region; upper triangular matrix values = species in common between two regions; and lower triangular matrix values = CBR values. The formula for this algorithm is CBR = 2C/N1 + N2 (Duellman, 1990), where C is the number of species in common to both regions, N1 is the number of species in the first region, and N2 is the number of species in the second region. See Fig. 8 for the UPGMA dendrogram produced from the CBR data.

	Tabascan Plains and Marshes	Karstic Hills and Plains of Campeche	Yucatecan Karstic Plains	Low Coast of Quintana Roo	Gulf Islands	Caribbean Islands
Tabascan Plains and Marshes	**93**	88	77	78	42	36
Karstic Hills and Plains of Campeche	0.83	**120**	104	100	42	37
Yucatecan Karstic Plains	0.73	0.87	**118**	95	39	43
Low Coast of Quintana Roo	0.78	0.88	0.85	**106**	39	39
Gulf Islands	0.62	0.52	0.48	0.52	**43**	26
Caribbean Islands	0.51	0.44	0.51	0.50	0.57	**49**

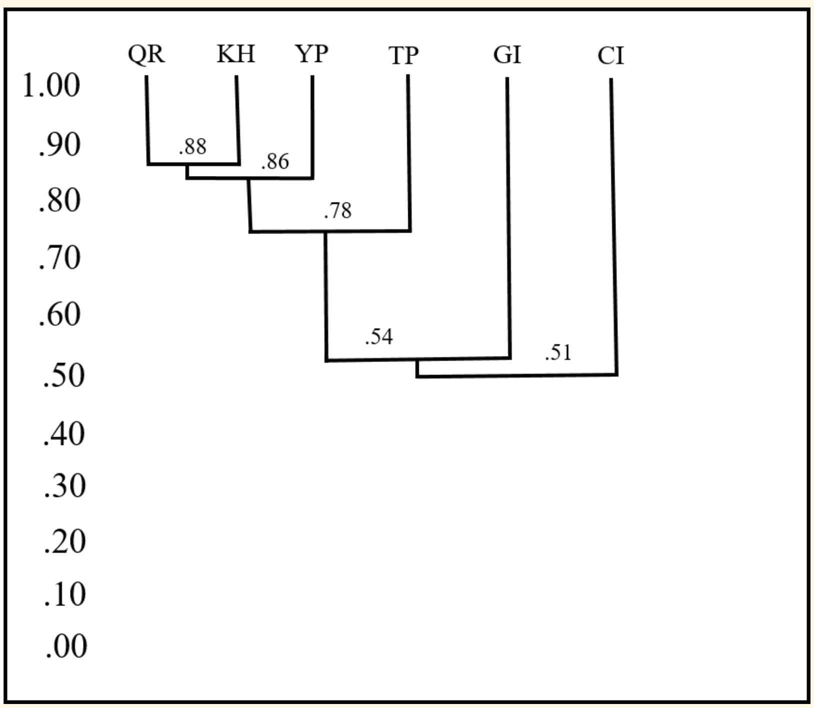

Fig. 8. A UPGMA generated dendrogram illustrating the similarity relationships of species richness among the herpetofauna in the six physiographic regions of the Mexican Yucatan Peninsula (based on the data in Table 9). We calculated the similarity values using Duellman's (1990) Coefficient of Biogeographic Resemblance (CBR).

Holcosus gaigeae (Smith and Laufe, 1946). Gaige's Ameiva, a regional endemic in the Mexican Yucatan Peninsula, is distributed in all the physiographic regions in the states of Campeche and Quintana Roo. This individual was encountered 2 km NE of Buctzotz, in the municipality of Buctzotz, in the state of Yucatán. The EVS of this species can be calculated as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has not been evaluated by the IUCN and this species is not listed by SEMARNAT.

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Oxybelis fulgidus (Daudin, 1803). The Green Vinesnake ranges "on the Atlantic and Pacific versant from the Isthmus of Tehuantepec through Central America to Argentina" (Lee, 1996). This individual is from Rancho Kuncheil, in the municipality of Sotuta, in the state of Yucatán. Wilson et al. (2013a) assessed its EVS as 9, placing it at the upper limit of the low vulnerability category. Its conservation status has not been determined by the IUCN, and this species is not listed by SEMARNAT. © Marcos Serafín Meneses-Millán

DISTRIBUTIONAL STATUS CATEGORIZATIONS

We used the same scheme developed by Alvarado-Díaz et al. (2013), which also was employed by Mata-Silva et al. (2015), Johnson et al. (2015a), Terán-Juárez et al. (2016), Woolrich-Piña et al. (2016), and Nevárez-de los Reyes et al., (2016), to categorize the distributional status of members of the Mexican Yucatan Peninsula herpetofauna. Since we are dealing with the herpetofaunas of three states in this paper, instead of using the "state endemic" category, we use the term "regional endemic" for species that are restricted to the Mexican Yucatan Peninsula. We placed the data based on these categorizations in Table 10, and provide a summary in Table 11.

Table 10. Distributional and conservation status measures for members of the herpetofauna of the Mexican Yucatan Peninsula. Distributional Status: RE = endemic to Mexican Yucatan Peninsula; CE = endemic to country of Mexico; NE = not endemic to state or country; and NN = non-native. Environmental Vulnerability Score (taken from Wilson et al. 2013a, b): low (L) vulnerability species (EVS of 3–9); medium (M) vulnerability species (EVS of 10–13); and high (H) vulnerability species (EVS of 14–20). IUCN Categorization: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; NE = Not Evaluated (no DD species are identified). SEMARNAT (NOM-059) Status: A = Threatened; P = Endangered; Pr = Special Protection; and NS = No Status. See text for explanations of the EVS, IUCN, and SEMARNAT rating systems.

Taxa	Distributional Status	Environmental Vulnerability Category (Score)	IUCN Categorization	SEMARNAT Status
Incilius valliceps	NE	L (6)	LC	NS
Rhinella horribilis	NE	L (3)	NE	NS
Craugastor loki	NE	M (10)	LC	NS
*Craugastor yucatanensis***	RE	H (17)	NT	Pr
*Eleutherodactylus planirostris****	NN	—	—	—
Dendropsophus ebraccatus	NE	M (10)	LC	NS
Dendropsophus microcephalus	NE	L (7)	LC	NS
Scinax staufferi	NE	L (4)	LC	NS
Smilisca baudinii	NE	L (3)	LC	NS
Tlalocohyla loquax	NE	L (7)	LC	NS
Tlalocohyla picta	NE	L (8)	LC	NS
Trachycephalus typhonius	NE	L (4)	LC	NS
Triprion petasatus	NE	M (10)	LC	Pr
Engystomops pustulosus	NE	L (7)	LC	NS
Leptodactylus fragilis	NE	L (5)	LC	NS
Leptodactylus melanonotus	NE	L (6)	LC	NS
Gastrophyrne elegans	NE	L (8)	LC	Pr
Hypopachus variolosus	NE	L (4)	LC	NS
Agalychnis callidryas	NE	M (11)	LC	NS
Lithobates brownorum	NE	L (8)	NE	Pr
Lithobates vaillanti	NE	L (9)	LC	NS
Rhinophrynus dorsalis	NE	L (8)	LC	NS
Bolitoglossa mexicana	NE	M (11)	LC	Pr
Bolitoglossa rufescens	NE	L (9)	LC	Pr
Bolitoglossa yucatana	NE	H (15)	LC	Pr
Crocodylus acutus	NE	H (14)	VU	Pr
Crocodylus moreletii	NE	M (13)	LC	Pr

Table 10 (continued)

Taxa	Distributional Status	Environmental Vulnerability Category (Score)	IUCN Categorization	SEMARNAT Status
Celestus rozellae	NE	M (13)	NT	Pr
Basiliscus vittatus	NE	L (7)	LC	NS
Corytophanes cristatus	NE	M (11)	LC	Pr
Corytophanes hernandezii	NE	M (13)	LC	Pr
Laemanctus longipes	NE	L (9)	LC	Pr
Laemanctus serratus	NE	L (8)	LC	Pr
Anolis allisoni	NE	M (13)	NE	NS
Norops beckeri	NE	M (12)	NE	Pr
Norops biporcatus	NE	M (10)	NE	Pr
Norops lemurinus	NE	L (8)	NE	NS
Norops rodriguezii	NE	M (10)	NE	NS
*Norops sagrei****	NE	—	—	—
Norops tropidonotus	NE	L (9)	NE	NS
Norops ustus	NE	L (8)	NE	NS
Coleonyx elegans	NE	L (9)	LC	A
*Hemidactylus frenatus****	NN	—	—	—
*Hemidactylus turcicus****	NN	—	—	—
Ctenosaura alfredschmidti	NE	H (15)	NT	NS
*Ctenosaura defensor***	RE	H (15)	VU	P
Ctenosaura similis	NE	L (8)	LC	A
Iguana iguana	NE	M (12)	NE	Pr
Marisora brachypoda	NE	L (6)	LC	NS
Sceloporus chrysostictus	NE	M (13)	LC	NS
*Sceloporus cozumelae***	RE	H (15)	LC	Pr
Sceloporus lundelli	NE	H (14)	LC	NS
Sceloporus serrifer	NE	L (6)	LC	NS
Sceloporus teapensis	NE	M (13)	LC	NS
Phyllodactylus tuberculosus	NE	L (8)	LC	NS
Thecadactylus rapicauda	NE	M (10)	NE	Pr
Mesoscincus schwartzei	NE	M (11)	LC	NS
Plestiodon sumichrasti	NE	M (12)	LC	NS
Aristelliger georgeensis	NE	M (13)	LC	Pr
*Sphaerodactylus argus****	NN	—	—	—
Sphaerodactylus continentalis	NE	M (10)	NE	NS
Sphaerodactylus glaucus	NE	M (12)	LC	Pr
Scincella cherriei	NE	L (8)	NE	NS
Aspidoscelis angusticeps	NE	M (13)	LC	NS
*Aspidoscelis cozumela***	RE	H (16)	LC	NS
Aspidoscelis deppii	NE	L (8)	LC	NS
Aspidoscelis maslini	NE	H (15)	LC	NS

Table 10 (continued)

Taxa	Distributional Status	Environmental Vulnerability Category (Score)	IUCN Categorization	SEMARNAT Status
*Aspidoscelis rodecki***	RE	H (16)	NT	P
*Holcosus gaigeae***	RE	H (15)	NE	NS
Holcosus hartwegi	NE	M (13)	NE	NS
*Holcosus stuarti**	CE	M (12)	NE	NS
Lepidophyma flavimaculatum	NE	L (8)	LC	Pr
Boa imperator	NE	M (10)	NE	NS
Drymarchon melanurus	NE	L (6)	LC	NS
Drymobius margaritiferus	NE	L (6)	NE	NS
Ficimia publia	NE	L (9)	LC	NS
Lampropeltis abnorma	NE	L (9)	NE	NS
Leptophis ahaetulla	NE	M (10)	NE	A
Leptophis mexicanus	NE	L (6)	LC	A
Masticophis mentovarius	NE	L (6)	LC	A
Mastigodryas melanolomus	NE	L (6)	LC	NS
Oxybelis aeneus	NE	L (5)	NE	NS
Oxybelis fulgidus	NE	L (9)	NE	NS
Phrynonax poecilonotus	NE	M (10)	LC	NS
Pseudelaphe flavirufa	NE	M (10)	LC	NS
*Pseudelaphe phaescens***	RE	H (16)	NE	Pr
Senticolis triaspis	NE	L (6)	LC	NS
Spilotes pullatus	NE	L (6)	NE	NS
Stenorrhina freminvillii	NE	L (7)	LC	NS
Symphimus mayae	NE	H (14)	LC	Pr
Tantilla cuniculator	NE	M (13)	LC	Pr
Tantilla moesta	NE	M (13)	LC	NS
Tantilla schistosa	NE	L (8)	LC	NS
Tantillita canula	NE	M (12)	LC	NS
Tantillita lintoni	NE	M (12)	LC	Pr
Coniophanes bipunctatus	NE	M (10)	LC	NS
Coniophanes imperialis	NE	L (8)	LC	NS
*Coniophanes meridanus***	RE	H (15)	LC	NS
Coniophanes quinquevittatus	NE	M (13)	LC	NS
Coniophanes schmidti	NE	M (13)	LC	NS
Conophis lineatus	NE	L (9)	LC	NS
Dipsas brevifacies	NE	H (15)	LC	Pr
Imantodes cenchoa	NE	L (6)	NE	Pr
Imantodes gemmistratus	NE	L (6)	NE	Pr
Imantodes tenuissimus	NE	M (13)	LC	Pr
Leptodeira frenata	NE	M (12)	LC	NS
Leptodeira septentrionalis	NE	L (8)	NE	NS

Table 10 (continued)

Taxa	Distributional Status	Environmental Vulnerability Category (Score)	IUCN Categorization	SEMARNAT Status
Ninia diademata	NE	L (9)	LC	NS
Ninia sebae	NE	L (5)	LC	NS
Pliocercus elapoides	NE	M (10)	LC	NS
Sibon nebulatus	NE	L (5)	NE	NS
Sibon sanniolus	NE	M (12)	LC	NS
Tretanorhinus nigroluteus	NE	M (10)	LC	NS
Tropidodipsas fasciata	NE	M (13)	NE	NS
Tropidodipsas sartorii	NE	L (9)	LC	Pr
Xenodon rabdocephalus	NE	M (13)	NE	NS
Micrurus diastema	NE	L (8)	LC	Pr
Epictia magnamaculata	NE	M (11)	LC	NS
Epictia vindumi	NE	H (14)	NE	NS
Nerodia rhombifer	NE	M (10)	LC	NS
Thamnophis marcianus	NE	M (10)	LC	A
Thamnophis proximus	NE	L (7)	LC	A
Scaphiodontophis annulatus	NE	M (11)	LC	NS
Amerotyphlops microstomus	NE	M (12)	NE	NS
*Indotyphlops braminus****	NN	—	—	—
Agkistrodon russeolus	NE	H (15)	NE	NS
Bothrops asper	NE	M (12)	NE	NS
Crotalus tzabcan	NE	H (16)	LC	NS
*Porthidium yucatanicum***	RE	H (17)	LC	Pr
Caretta caretta	NE	—	VU	P
Chelonia mydas	NE	—	EN	P
Eretmochelys imbricata	NE	—	CR	P
Lepidochelys kempii	NE	—	CR	P
Chelydra rossignonii	NE	H (17)	VU	NS
Dermatemys mawii	NE	H (17)	CR	P
Dermochelys coriacea	NE	—	VU	P
*Terrapene yucatana***	RE	H (18)	NE	NS
Trachemys venusta	NE	H (19)	VU	NS
Rhinoclemmys areolata	NE	M (13)	NT	A
Kinosternon acutum	NE	H (14)	NT	Pr
*Kinosternon creaseri***	RE	H (15)	LC	NS
Kinosternon leucostomum	NE	M (10)	NE	Pr
Kinosternon scorpioides	NE	M (10)	NE	Pr
Claudius angustatus	NE	H (14)	NT	Pr
Staurotypus triporcatus	NE	H (14)	NT	A

Of the 145 herpetofaunal species recorded from the Mexican Yucatan Peninsula, a substantial proportion (127; 87.6%) are non-endemics (Table 13); a relatively small number consists of the regional endemics (11; 7.6%); the next largest number comprises the non-native species (six; 4.1%); and only a single species is a country endemic.

The non-endemic species include 20 anurans, all three salamanders, both crocodylians, 88 squamates, and 14 turtles. The regional endemics comprise a craugastorid anuran (*Craugastor yucatanensis*), an iguanid lizard (*Ctenosaura defensor*), a phrynosomatid lizard (*Sceloporus cozumelae*), three teiid lizards (*Aspidoscelis cozumela*, *A. rodecki*, and *Holcosus gaigeae*), one colubrid snake (*Pseudelaphe phaescens*), one dipsadid snake (*Coniophanes meridianus*), one viperid snake (*Porthidium yucatanicum*), one emydid turtle (*Terrapene yucatana*), and one kinosternid turtle (*Kinosternon creaseri*). The single country endemic is a teiid lizard (*Holcosus stuarti*). Of the six non-native species, one is an anuran (*Eleutherodactylus planirostris*), one is a dactyloid lizard (*Norops sagrei*), two are gekkonid lizards (*Hemidactylus frenatus* and *H. turcicus*), one is a sphaerodactylid lizard (*Sphaerodactylus argus*), and one is a typhlopid snake (*Indotyphlops braminus*).

Unlike the information provided for other areas (states) thus far covered in the MCS, the number of regional and country endemics in the three states of the Mexican Yucatan Peninsula is very small compared to the number of non-endemic species. The number of endemic species is 12 (8.3% of the total of 145). The comparable figures for the other six states in descending order are as follows: Michoacán (63.7%; Alvarado-Díaz et al., 2013); Oaxaca (58.1%; Mata-Silva et al., 2015); Nayarit (57.1%; Woolrich-Piña et al., 2016); Tamaulipas (32.1%; Terán-Juárez et al., 2016); Nuevo León (28.8%; Nevárez-de los Reyes, et al., 2016); and Chiapas (17.6%; Johnson et al., 2015a). The total number of endemics in the Mexican Yucatan Peninsula is 1.6% of the total number of 768 in all of Mexico (J. Johnson, unpublished).

The small representation of endemic species in the Mexican Yucatan Peninsula is due to its proximity to the northernmost countries in Central America, i.e., Guatemala and Belize, which, with respect to Guatemala, also is the case with Chiapas (Johnson et al., 2015a). All but one of the 127 non-endemic species in the Mexican Yucatan Peninsula also occur in Central America (Johnson et al., 2015b); the only exception is *Nerodia rhombifer*, whose distribution extends north of Mexico to the central United States (Wallach et al., 2014).

Table 11. Summary of the distributional status of herpetofaunal families in the Mexican Yucatan Peninsula.

Families	Number of Species	Distributional Status			
		Non-endemic (NE)	Country Endemic (CE)	Regional Endemic (RE)	Non-native (NN)
Bufonidae	2	2	—	—	—
Craugastoridae	2	1	—	1	—
Eleutherodactylidae	1	—	—	—	1
Hylidae	8	8	—	—	—
Leptodactylidae	3	3	—	—	—
Microhylidae	2	2	—	—	—
Phyllomedusidae	1	1	—	—	—
Ranidae	2	2	—	—	—
Rhinophrynidae	1	1	—	—	—
Subtotals	**22**	**20**	**—**	**1**	**1**
Plethodontidae	3	3	—	—	—
Subtotals	**3**	**3**	**—**	**—**	**—**
Totals	**25**	**23**	**—**	**1**	**1**

Crocodylidae	2	2	—	—	—
Subtotals	**2**	**2**	**—**	**—**	**—**
Anguidae	1	1	—	—	—
Corytophanidae	5	5	—	—	—
Dactyloidae	8	7	—	—	1
Eublepharidae	1	1	—	—	—
Gekkonidae	2	—	—	—	2
Iguanidae	4	3	—	1	—
Mabuyidae	1	1	—	—	—
Phrynosomatidae	5	4	—	1	—
Phyllodactylidae	2	2	—	—	—
Scincidae	2	2	—	—	—
Sphaerodactylidae	4	3	—	—	1
Sphenomorphidae	1	1	—	—	—
Teiidae	8	4	1	3	—
Xantusiidae	1	1	—	—	—
Subtotals	**45**	**35**	**1**	**5**	**4**
Boidae	1	1	—	—	—
Colubridae	22	21	—	1	—
Dipsadidae	21	20	—	1	—
Elapidae	1	1	—	—	—
Leptotyphlopidae	2	2	—	—	—
Natricidae	3	3	—	—	—
Sibynophiidae	1	1	—	—	—
Typhlopidae	2	1	—	—	1
Viperidae	4	3	—	1	—
Subtotals	**57**	**53**	**—**	**3**	**1**
Cheloniidae	4	4	—	—	—
Chelydridae	1	1	—	—	—
Dermatemydidae	1	1	—	—	—
Dermochelyidae	1	1	—	—	—
Emydidae	2	1	—	1	—
Geoemydidae	1	1	—	—	—
Kinosternidae	4	3	—	1	—
Staurotypidae	2	2	—	—	—
Subtotals	**16**	**14**	**—**	**2**	**—**
Totals	**120**	**104**	**1**	**10**	**4**
Sum Totals	**145**	**127**	**1**	**11**	**6**

Pseudelaphe phaescens (Dowling, 1952). The Yucatecan Ratsnake is a regional endemic in the Mexican Yucatan Peninsula, distributed in the Yucatecan Karstic Plains of Campeche region in Quintana Roo and Yucatán. This individual was photographed at Xcanatún, in the municipality of Mérida, in the state of Yucatán. Wilson et al. (2013a) judged its EVS as 16, placing it in the middle portion of the high vulnerability category. Its conservation status has not been assessed by the IUCN, but this colubrid has been judged as a species of special protection (Pr) by SEMARNAT. © Javier A. Ortiz-Medina

Spilotes pullatus (Linnaeus, 1758). The Black and Yellow Ratsnake occurs "on the Atlantic versant from southern Tamaulipas, Mexico, to northeastern Argentina and on the Pacific versant from southeastern Oaxaca, Mexico, to northwestern Ecuador. It also occurs on Trinidad and Tobago" (McCranie, 2011: 204). This individual was photographed at Zona Arqueológica de Yaxuná, in the municipality of Yaxcabá, in the state of Yucatán. Wilson et al. (2013a) calculated its EVS as 6, placing it in the middle portion of the low vulnerability category. Its conservation status has not been assessed by the IUCN, and this snake is not listed by SEMARNAT. © Elí García-Padilla

PRINCIPAL ENVIRONMENTAL THREATS

In this section we discuss the problems we believe constitute the primary threats to the sustainability of members of the peninsular herpetofauna, as components of the region's natural ecosystems.

Agriculture and Deforestation

The main global threat to biodiversity is habitat loss and fragmentation (Tilman et al., 1994; Vitousek, 1994; Fahring, 2003; Burkey and Reed, 2006; Watling and Donnelly, 2006). This threat is particularly true for the herpetofauna, since both reptiles (Smart et al., 2005; Gardner et al., 2007) and amphibians (Young et al., 2004) are vulnerable to anthropogenic disturbances.

Since pre-Columbian times, the primary source of anthropogenic disturbance in the Yucatan Peninsula has been the shifting slash-and-burn cultivation systems (Fig. 9). This agricultural method has been shaping the peninsula's forests into a complex mosaic of cultivated plots, known as *milpas*, as well as the secondary vegetation with several degrees of regeneration (locally called *acahuales*). This process has turned the region into a landscape characterized by fragmentation and heterogeneity (Hartter et al., 2008).

Fig. 9. *Agriculture and Deforestation.* A Mayan farmer inspects a recently burned area for open spaces to plant crops in the vicinity of X-Hazil, in the municipality of Felipe Carrillo Puerto, Quintana Roo. Shifting cultivation (slash-and-burn agriculture) has been practiced in the Yucatan Peninsula since pre-Columbian times, and remains the principal economic activity of the Mayan people in the region. Although not as invasive as extensive agriculture, this activity has turned most of the peninsula into a landscape of agricultural fields and secondary vegetation, with different stages of regeneration. © Víctor Hugo González-Sánchez

Although the common belief is that secondary forests might contribute to maintaining biodiversity (Chazdon et al., 2009), this might not be true in all cases because repetitive disturbance can limit the structural complexity of the habitat, and thus reduce the availability of niches for species to occupy. When a disturbed landscape displays elevated species richness, often this results from an increase in the abundance of disturbance associated species at the expense of losing specialist species. González-Sánchez (2012, 2016) suggested that the erosion of taxonomic diversity in the herpetofauna of the Yucatan Peninsula was associated with habitat loss, as well as the subsequent increase in abundance of disturbance-associated species in agricultural landscapes. Gibson et al. (2011) opined that primary forests are irreplaceable, and there is growing evidence that herpetofaunal diversity is lower in secondary forest relative to primary forest (Gardner et al., 2007; McAlpine et al., 2015).

In recent decades, the arrival of Mennonite people has resulted in important changes in the agricultural methods practiced in the region. They arrived in the state of Campeche in the early 1980s from northern Mexico, and in the 2000s they settled in southern Quintana Roo, in the municipality of Bacalar. An important difference in the Mennonite agricultural system is that, unlike the milpa system of the local farmers, they practice extensive agriculture that demands clearing large amounts of land, sometimes more than 100 ha, as seen in the community of Holpechén, Campeche. This method of farming is expansive, and larger agricultural plots might be favored by families hoping to maximize the amount of land that can be left to future generations (Vargas-Godínez, 2016). Thus, this practice has contributed to the acceleration of deforestation rates in the region, and likely will continue into the future.

Cattle ranching has become an increasingly common practice in the state of Yucatán, and in the region of Calakmul in Campeche; this activity has been encouraged by the many subsidies and facilities provided by the government since the 1960s, and has been practiced more intensively since the initiation of NAFTA. This system of subsidies has motivated many local people to abandon their traditional Mayan cultivation methods of shifting slash and burn cultivation, and to adopt the clearance of land for creating grasslands for cattle, along with extensive agriculture. These two activities are the most important drivers of deforestation on the peninsula (Ellis et al., 2015), and there is no indication that they will decrease in the future, as the subsidies for the program continue to encourage these activities.

A common pattern associated with agriculture is the alteration of wetlands (Viana et al., 1997; cited by Becker et al., 2007). The lack of continuity among patches of aquatic wetlands forces species with aquatic life cycles, like amphibians, to undergo movement through disturbed habitats and exposes individuals to hostile environments (Becker et al., 2007, Becker et al., 2010). This same scenario also threatens crocodiles (Mazzotti et al., 2007).

Another agriculture-associated impact is water pollution. The biphasic life cycle and thin, vascularized skin of amphibians makes them highly vulnerable to pollutants (Wake and Vredenburg, 2008). Historically, the lack of regulation and a deficient agricultural infrastructure favored the indiscriminate use of pesticides in Central America (Castillo et al., 1997). Many streams and permanent and ephemeral ponds are associated with agricultural landscapes, and thus these water sources are exposed to pesticide discharges; in the past, this situation has been linked to the decline of some amphibian populations (Mann et al., 2009). An important and dominant soil on the peninsula is karst, which allows the filtration and permeation of water underground. Since most of the drinking water of the region comes from karst aquifers, it has been tested intensively for agrochemicals; most of these sources are highly polluted, and under Mexican legislation many have been banned for use. This scenario is especially important in the state of Yucatán, in the area known as the *anillo de cenotes*, a semicircular belt of cenotes (water-filled sinkholes) 90 km in radius, which is the main water recharging point of the region and is recognized as a Ramsar site (Polanco-Rodríguez et al., 2015), i.e., wetland sites of international importance under the Ramsar Convention (www.wikipedia.org; accessed 15 April 2017). The importance of why agrochemical pollutants are a danger to public health has been widely documented, but the negative effects of pollutants on populations of amphibians and other herpetofauna have not been addressed in the region.

Hurricanes and Other Tropical Storms

Another important source of disturbance are the tropical storms that frequently impact the region (Fig. 10). Between the years 1850 and 2000, an estimated 106 tropical storms with the characteristics of a hurricane have affected the peninsula (Boose et al., 2003). These climatic phenomena represent an important historic force in shaping the ecological structure of the region, and some storms have been particularly important. In 2007, Dean (a category 5 hurricane) struck Quintana Roo north of Mahahual and impacted an estimated one million hectares; this hurricane severely damaged the mangrove swamps of the Low Coast of Quintana Roo, as well as the inland forests (Islebe et al., 2009). Hurricanes Wilma (in 2005) and Gilbert (in 1988) are ranked as the first and second most powerful storms to affect the peninsula, respectively, in terms of atmospheric pressure and second and third, respectively, in sustained wind speed recorded in the Atlantic (National Hurricane Center, 2017). Both landed in northern Quintana Roo and crossed the peninsula, leaving a trail of severe infrastructure and vegetational damage. Hurricane Janet (in 1955) was the first category 5 hurricane ever documented in the Atlantic to impact the continental mainland. This hurricane significantly damaged southern Quintana Roo, Campeche, and northern British Honduras (Belize), and was so severe that it completely destroyed the city of Chetumal, along with several villages.

Fig 10. *Hurricanes and Other Tropical Storms.* Extensive damage to a Red Mangrove (*Rhizophora mangle*) forest on Cayo Centro, Banco Chinchorro, caused by the tropical storms that frequently affect the atoll. © Lisbeth Lara-Sánch

The principal effect of a hurricane is the structural damage to or the complete removal of habitat, such as the removal of canopy and the falling of trees (Whigham et al., 1991). The most vulnerable herpetofaunal species are those that nest on beaches, and most obviously the marine turtles (Pike and Stiner, 2007). In the case of crocodiles, the evidence is more limited, but it demonstrates that hurricanes can have contrasting effects. In some populations of *Crocodylus acutus*, tropical storms can have an immediate negative impact on nesting success by the direct destruction of nests, or by altering the site by storm surge salinization and lowering the temperature due the intense rainfall. Conversely, the removal of vegetation and clearance of the canopy can increase the availability of new nesting sites, which can be a long-term positive impact. These effects obviously depend of the intensity of the storm (Charruau et al., 2010).

Hurricanes are considered a driving force of the current environment on the peninsula, and most aspects of the environment seem to recover after the initial disturbance (Whigham et al., 1991). Nonetheless, a possible outcome of the ongoing climate change phenomena, particularly global warming and the rising of sea surface temperatures, is that hurricanes will increase in frequency and severity (Elsner and Jagger, 2016).

Coniophanes meridanus (Schmidt and Andrews, 1936). The Peninsula Stripeless Snake is a regional endemic in the Mexican Yucatan Peninsula, distributed in the Karstic Hills and Plains of Campeche, Yucatecan Karstic Plains, and Low Coast of Quintana Roo regions in the states of Campeche, Quintana Roo, and Yucatán (Lee, 2000). This individual came from the Zona Arqueológica de Dzibilchaltún, in the municipality of Mérida, in the state of Yucatán. Wilson (2013a) ascertained its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has been determined as Least Concern by the IUCN, but this species is not listed by SEMARNAT. © Javier A. Ortiz-Medina

Micrurus diastema (Duméril, Bibron, and Duméril, 1854). The Variable Coral Snake is found "on the Atlantic versant from northern Veracruz and northern Oaxaca, Mexico, to northwestern Honduras" (McCranie, 2011). This individual was photographed 5.8 km WSW of Puerto Morelos, in the municipality of Puerto Morelos, in the state of Quintana Roo. Wilson (2013a) calculated its EVS as 8, placing it in the upper portion of the low vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, and this elapid is listed as a species of special protection (Pr) by SEMARNAT. © Javier A. Ortiz-Medina

Wildfires

Forest fires, which are closely associated with hurricanes, are another important source of disturbance on the Yucatan Peninsula (Fig. 11). After a hurricane the accumulation of vegetation litter greatly increases the risk of subsequent fires, because of the amount of fuel on the land. Since areas with significant topographic relief are lacking throughout most of the region there is an increased risk of fires throughout the three states, but especially in the eastern portion of the peninsula and in protected or managed forests (Rodríguez-Trejo et al., 2011). According to Renken (2006), the herpetofauna is particularly vulnerable to the effects of fire; for example, movement in most species is relatively limited, and thus their ability to escape fires is reduced. Generally, fire removes the organic layer covering of the soil, which serves as a refuge for many herpetofaunal species. Furthermore, alterations in vegetation structure and canopy cover can induce changes in soil moisture and environmental temperatures.

Fig. 11. *Wildfires*. A burned tropical forest on the Chetumal-Cancún highway near X-Hazil Sur, in the municipality of Felipe Carrillo Puerto, Quintana Roo. Wildfires are a common occurrence in the region due to vandalism, as well as from the accumulation of organic material during the dry season resulting from previous tropical storms. © Luis Sánchez

Next to the practice of cattle ranching, forest fires are an important consideration in Quintana Roo. Fires are the second leading driver of deforestation, and from 2001 to 2013 caused a 28% loss of the vegetation cover in the state. The most affected municipalities were Bacalar, Lázaro Cárdenas, and Benito Juárez (in which Cancún is located). The most probable causes of uncontrolled fires are induced or intentional anthropogenic fires, locally called *quemas* (Ellis et al., 2015). These fires are a frequent occurrence, including inside the natural protected areas of the peninsula. For example, in Reserva de la Biósfera Los Pentenes, Campeche, approximately 16% of the land is subjected to this practice (Mas and Correa-Sandoval, 2000). Many of the induced fires are associated with uncontrolled slash and burn practices, but many others are instigated to obtain a land use change permit in order to continue urban expansion or the construction of infrastructure for tourism; the latter likely is the primary motivator of induced fires in northern Quintana Roo (Ellis et al., 2015). In order to discourage this practice, a modification of the Ley General de Desarrollo Forestal Sostenible (General Law of Sustainable Forest Development) was approved in 2015, which bans any land use change in burned areas for 20 years (www.eluniversal.com.mx/articulo/nacion/politica/2015/12/1/aprueban-prohibir-cambio-de-uso-de-suelo-tras-incendios).

Tourism

Tourism is one of the primary economic activities in Mexico, and in 2015 represented the third highest source of income in the country (www.eleconomista.com.mx/industrias/2016/02/22/mexico-bate-record-turistas-2015-sectur). This trend also is seen in Quintana Roo (Fig. 12), as tourism in the state accounts for one-third of the entire revenue for the country (Murray, 2007). The development of the northern coast of the state was planned in the 1970s as a large-scale tourism infrastructure, which offered luxury resorts in combination with what then was a pristine landscape. At that time Cancún was an isolated area occupied only by small, scattered groups of fishermen, and was selected as an ideal site for this model of economic development. This model quickly proved to be highly successful, leading to rapid development that spread to Tulum, Playa del Carmen, and other areas along the shoreline of the state that eventually became known as the "Riviera Maya." By the mid-1990s, the explosive demographic growth and aggressive expansion of infrastructure far surpassed the government's capacity to regulate the development of the area (Murray, 2007). As an example of this phenomenon, in 1980 the population of Cancún was 33,273 inhabitants, but by 2005 the number of inhabitants had risen to 526,701, a 16-fold increase in population; during the same period, Playa del Carmen grew from a small town of 737 inhabitants into a bustling tourist city of 100,383 inhabitants. The entire Riviera Maya region has shown the same pattern (Rubio-Maldonado et al., 2010).

Fig. 12. *Tourism.* Tourists gather in a marine turtle nesting site at Campamento DIF, a beach located in Puerto Aventuras, near Tulum, in the municipality of Tulum, Quintana Roo. The conflict between tourist development and the conservation of habitats along the beaches of Quintana Roo has become a passionate issue. © Alejandro Arenas-Martínez

This trend continues today, with no sign of it being curtailed. Last year, the controversy surrounding the destruction of the Tajamar mangrove swamp to create space for a tourist complex in Cancún is a paradigmatic example of the conflict between the large-scale tourism model and the representatives of the local society demanding preservation of the remaining patches of original vegetation in the city. Similarly, in 2012, the development of Punta Arrecifes Resort in Cozumel was cancelled after a long and bitter controversy on the environmental impacts of the project. The dispute was settled with the decree of a protected area. Even more recently, the development of a large Chinese retail complex called "Dragon Mart" was cancelled in 2015 by the Mexican environmental authorities, following the destruction of 149 ha of mangroves. Still, however, a legal battle to revive this project continues. Although the Riviera Maya is promoted as a luxury and large-scale tourist destination surrounded by nature, these three cases are clear and recent examples of the inability to accommodate both goals.

Along the entire length of the Riviera Maya, there are many signs of environmental degradation due the construction of urban and tourist infrastructure, principally in the form of deforestation, land use change, and wetlands destruction (e.g., 14 of the 18 holes on a championship golf course were built on top of the Nichupté lagoon). Consequently, the hydrological systems of the region show signs of stress occasioned by the increased demand for water and the subsequent pollution due to untreated sewage, which damages the coastal ecosystems. Another impact of tourist development is the traffic generated by the visitors, which directly impacts the natural protected areas of the region; some of these sites receive more than one million visitors per year. Unfortunately, as the interest for visiting natural areas grows, so does the impact from increased traffic (Murray, 2007).

Infectious Diseases

Emerging infectious diseases are another important factor that contributes to the loss of global herpetofaunal diversity (Gibbons et al., 2000), especially with regard to amphibians (Berger et al., 2005). The main pathogen associated with amphibian declines is *Batrachochytrium dendrobatidis* (Bd) (Daszak et al., 1999; Daszak et al., 2003), which has been linked to amphibian mass mortality events in Mesoamerica (Lips et al., 2006). We are not aware of any reports of Bd in the Yucatan Peninsula, but some predictive models indicate that the region is vulnerable to infection (Ron, 2005). Additionally, Bullfrog (*Lithobates catesbeianus*) farms have been established near Mérida, Yucatán (Casas-Andreu et al., 2001). Despite the lack of reports of *L. catesbeianus* having escaped into the wild, the existence of these farms makes it important to monitor the possible spread of Bd and to prevent the introduction of this frog, since it is known as one of the principal reservoirs of Bd (Mendoza-Almeralla et al., 2015).

Another potential disease is fibropapillomatosis (Fp), which affects marine turtles (Fig. 13). Although this disease has been known since the 1930s, in Florida, it was not until the mid 1980s that it was reported to be spreading worldwide. Fibropapillomastosis is a severe, long-lasting, debilitating disease characterized by tumors on the skin, carapace, plastron, and, in many cases, the internal organs. Although the tumors are considered "benign," they can negatively affect the turtle's swimming, hunting, and vision. Additionally, in some cases internal tumors can lead to the death of an organism (Aguirre and Lutz, 2004). The occurrence of Fp was unknown in the waters of the Yucatan Peninsula until 2013, when a few individuals of *Chelonia mydas* with epidermal tumors were sighted in Akumal Bay. Since then and up to the 2016 season, no more than eight individuals with Fb had been documented in that area (Slater, 2016). Nonetheless, an increase in the prevalence of this disease should be anticipated because this infection is associated with sites characterized by poor water quality and consequent immunosuppression due to environmental stress (Aguirre and Lutz, 2004).

The West Nile Virus (WNV) is a tropical virus with a complex life cycle involving mosquitoes as vectors. WNV is a disease of epidemic importance for wildlife and humans, and has been reported in several reptile species, but mainly crocodiles (Van der Meulen et al., 2005). Documented cases of *Crocodylus moreletii* testing seropositive to WNV antibodies farmed in Ciudad del Carmen, Campeche, are available (Farfán-Ale et al., 2006), as well as from other wildlife in the region of Los Petenes, Campeche (Machain-Williams et al., 2013). Moreover, cases of mortality by WNV in American Alligators (*Alligator mississippiensis*) have been reported from a farm in southern Georgia, United States (Miller et al., 2003). Until now, it appears that infected local *C. moreletii* in the peninsula are asymptomatic, and no event of mortality by this virus has been reported. Other vertebrates in the region also seem to be asymptomatic; a hypothesis is that the closely related flavivirus in the region has provided a certain degree of immunity to local species (Farfán-Ale et al., 2006). This assumption, however, has not been proven, and further investigation of WNV and its potential threat to native wildlife in the peninsula is necessary.

Fig. 13. *Infectious Diseases*. An epidermal tumor on a Green Sea Turtle (*Chelonia mydas*) found along a beach in Xcacel-Xcacelito, in the municipality of Tulum, Quintana Roo. Fibropapillomatosis is a common infectious disease in sea turtles, although generally infected individuals don't show signs of infection. Tumors often are seen in immunosuppressed individuals, such as those found in polluted environments. © Roberto Herrera-Pavón

Invasive Species

Introduced species are identified as one of the main causes of biodiversity extinction; however, not all introduced species are considered invasive or are associated with extinctions (Gurevitch and Padilla, 2004). To date, five herpetofaunal species have been reported as introduced into the Mexican portion of the Yucatan peninsula, including *Eleutherodactylus planirostris*, *Hemidactylus frenatus*, *H. turcicus*, *Norops sagrei*, and *Indotyphlops braminus*. *Eleutherodactylus planirostris* is known from Quintana Roo (Cedeño-Vázquez et al., 2014, García-Balderas et al. 2016, Pavón-Vázquez et al. 2016) and Yucatán (Ortíz-Medina et al., 2017). *Norops sagrei* is a widespread lizard in the peninsula and is mostly associated with human settlements (Lee, 1996), but occasionally it can be found in agricultural landscapes (González-Sánchez, 2016). Both *Hemidactylus* species frequently are observed in cities and nearby rural landscapes. *Eleutherodactylus planirostris* has been associated with negative impacts on the invertebrate fauna in other areas (Olson et al. 2012); presently, however, we are unaware of this species having caused a negative impact on the local fauna, since it has been reported only recently on the peninsula.

As mentioned earlier, *L. catesbeianus* is being farmed near the city of Mérida. This species is of special concern, because of its long history of being harmful to native fauna in other areas (Álvarez-Romero et al., 2008). To date, no introduced individuals have been documented in the Mexican Yucatan Peninsula region.

Mammalian invaders can be catastrophic to insular herpetofaunas (Fig. 14); the harmful effects of Black Rats (*Rattus rattus*) and Feral Cats (*Felis silvestris*) are well known. During the present decade, several enforcement initiatives led by Mexican ONGs, the Mexican Navy, and other government agencies, eradicated Black Rats on Arrecife Alacranes and Banco Chinchorro (in two phases), in addition to potentially removing all cats. Unpublished evidence exists indicating that feral cats on Banco Chinchorro prey on lizards. A campaign to eradicate the cats was conducted from 2010 to 2015, and a cat was found dead in 2015, but since that time no confirmed sightings of cats have occurred on the cay (L. Lara-Sánchez, pers. comm. from Amigos de Sian Ka'an).

Fig. 14. *Invasive Species.* The Black Rat (*Rattus rattus*) is one of the most widespread and damaging of all invasive species. This individual was photographed on Banco Chinchorro, an atoll reef lying off the mainland of Quintana Roo in the western Caribbean Sea. This rodent is destructive to native populations of a broad array of plants and animals, and has become a major challenge to conservation managers. It also is a well known vector for several bacterial diseases. In recent years, multi-institutional efforts have been carried out to eradicate this rodent from Arrecife Alacranes and Banco Chinchorro in Cayo Norte, and from Cayo Centro. © Lizbeth Lara-Sánchez

Cozumel perhaps is the island in Mexico most impacted by invasive species. The most harmful invader on this island is *Boa imperator*. Although native to the mainland, this species was absent from the island until 1970, when cinematographers filming the movie *El Jardín de la Tía Isabel* released several boas in order to create a more exotic atmosphere. Today this species is commonly encountered on Cozumel, and is linked to population declines of many local birds and mammals, of which some are endemic to the island. Thus far, no systematic effort has been initiated to control or remove the population of *B. imperator* (Martínez-Morales and Cuarón, 1999; Romero-Nájera et al., 2007).

Global Climate Change

Thomas et al. (2004) predicted that the direct and indirect effects of climate change ultimately would represent the main cause of species extinctions. The recent alteration of climatic patterns has been associated with species declines and extinctions in reptiles (Gibbons et al., 2000) and amphibians (Kiesecker et al., 2001). Global warming can affect reptiles in two principal ways: (1) the alteration of sex proportions in species with temperature-dependent sex determination (Hulin et al., 2009); and (2) the rising temperatures moving outside the physiological tolerances of species (Cahill et al., 2012). The first case is of particular concern in nesting species such as crocodiles and marine turtles. For example, the hatchlings of a population of *Crocodylus acutus* in Banco Chinchorro are slightly male-biased, and a continued global warming trend could accentuate this bias and eventually contribute to the extinction of this insular population, especially because it also is threatened by many other factors (Charruau, 2012).

With respect to the second case, many reptiles avoid reaching their upper thermal thresholds by hiding in cooler shelters, thereby restricting their foraging periods. This strategy, however, has a cost for such metabolic functions as growing and mating, which reduces population growth rates and increases the risk of extinction (Huey et al., 2010; Sinervo et al., 2010). The most vulnerable species in this scenario will be the thermocomformists, those with passive thermoregulatory behavior, and those with body temperatures highly correlated with environmental temperatures. The limited ability of species to survive in a broader spectrum of temperatures might lead to local extinctions or extirpations, as documented in some species of the genus *Sceloporus* in northern Mexico (Sinervo et al., 2010).

Agkistrodon russeolus (Gloyd, 1972). The Yucatecan Cantil occurs in the Yucatan Peninsula in the Mexican states of Campeche, Quintana Roo, and Yucatán, as well as in the Petén region of Guatemala and northern Belize (Porras et al., 2013). This individual was encountered at Komchén, in the municipality of Mérida, in the state of Yucatán. Porras et al. (2013) calculated its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has not been determined by the IUCN, and this viper is not listed by SEMARNAT. © Javier A. Ortiz-Medina

Crotalus tzabcan (Klauber, 1952). The Yucatecan Rattlesnake ranges in the states of Campeche, Quintana Roo, and Yucatán in the Mexican Yucatan Peninsula (Wallach et al., 2014). This individual was found at the vicinity of Justicia Social, in the municipality of Peto, in the state of Yucatán. Wilson et al. (2013a) determined its EVS as 16, placing it in the middle of the high vulnerability category. Its conservation status has been assessed as Least Concern by the IUCN, but this species is not recognized by SEMARNAT. © Javier A. Ortiz-Medina

Another important factor is the alteration of pluvial precipitation patterns, which is a well-documented phenomenon because the peninsula has had a long record of changes in rainfall regimens, fluctuating between multiple seasons of abundant rainfall and severe periods of drought (Mendoza et al., 2007). Also, historically droughts are determinant in the region, as some periods have led to the collapse of the agricultural societies of the past, including the ancient Maya civilization (Gill et al., 2007; Iannone, 2014). More recent effects of droughts on wildlife are well documented in some parts of the Yucatan Peninsula, such as in the Calakmul region (O'Farrill et al., 2014). In particular, these changes are important in amphibians, because they can cause the death of individuals due to hydric stress or by the disappearance of critical habitat for species with aquatic life cycles (Monzón et al., 2011; Cahill et al., 2012). Despite the historical relevance of droughts, how changes in the rainfall regimes influence the herpetofaunal communities is not well understood, and remains a key question to address. The problem, in part, is due to the lack of long-term ecological studies on the Yucatan Peninsula.

Illegal Collecting

Traditionally, crocodile hunting was not a common or widespread practice in the region. This type of hunting, however, became an intensive practice between 1960 and 1980 (although a permanent ban on overharvesting was established in 1970), but the ban was not respected on the peninsula until almost 1980. The motivation of crocodile hunters, locally known as *lagarteros*, was strictly for obtaining the skin of these animals, because the meat was not considered "good food" (Zamudio et al., 2013). The Mayan people considered certain foods to be "hot" or "cold," but this denomination was not necessarily related with temperature. An old lagartero told one of us (VHGS) that hot lagarto (crocodile) meat could produce sickness when consumed with something cold, like orange juice. The savanna region of Sian Ka'an was particularly important for this activity, especially during the dry season. A good lagartero often harvested from five to 12 crocodiles per day, and a group of lagarteros were reported to have harvested 756 lagartos in one year (Zamudio et al., 2013). Also, in the areas around Chetumal and Xcalak, a single person could harvest 75 skins in a single night (Cedeño-Vázquez et al., 2006). Savanna habitat is difficult to access, and often is impenetrable if it is not burned. Thus, numerous crocodiles have been able to survive within this habitat, and after 1980 (when the ban became effective) many crocodiles repopulated other areas and their populations have been recovering (Zamudio et al., 2013).

Sea turtles are extremely vulnerable when they arrive on beaches to lay their eggs, as they are exposed to illegal poaching and egg harvesting (Koch et al., 2006, Peckham et al., 2008; Fig. 15). During this time, their nests also are preyed upon by a variety of creatures (Eckrich and David, 1995). The principal strategy for dealing with these problems has been to protect key sites during periods of turtle arrival and nesting, which has led to positive results for recovering the population numbers (Chaloupka et al., 2008). A sanctuary is a specific category of protected area that has been created for the protection of species with restricted distributions (LGEEPA, 2016). Most of the relevant sites for sea turtles in Mexico have been placed under this categorization, but many important sites are included inside the boundaries of natural protected areas (ANPs) that provide another category of protection, such as Parque Nacional Arrecife Alacranes and Reserva de la Biósfera de Sian Ka'an, as well as many other protected areas along the coast of the peninsula. The state enforced Zona Sujeta a Conservación Ecológica "Santuario de la Tortuga Marina Xcacel-Xcacelito" represents an important site in Quintana Roo for nesting *Caretta caretta* and *Chelonia mydas* (Gobierno del Estado de Quintana Roo, 1998).

The Tortuga Blanca (*Dermatemis mawii*) is a freshwater turtle that has been harvested intensively for food throughout its habitat, and is a species of considerable conservation concern. One of the most important remaining populations on the Yucatan Peninsula is located in the Río Hondo basin, which also forms the natural border between Mexico and Belize. Here, this turtle is hunted most often for personal comsumption, and less frequently for commercial sale. Limited cases of alternative uses (e.g., using the shell to make musical instruments) have been documented. Importantly, there is a difference in the protection status assigned to this turtle in Mexico, where harvesting is banned, and in Belize, where it is legal. This difference in protection status might accelerate a population decline in Belize, as a result of the lack of protection and unregulated hunting (Calderón-Mandujano, 2015). Currently, however, research is being conducted to further evaluate the conservation status of this turtle in the southern portion of the peninsula.

Fig. 15. *Illegal Collecting*. A bag with marine turtle eggs confiscated from a poacher who was arrested on a beach at Tankah by the Mexican navy; the event occurred in an ecological park, in the proximity of Tulum, in the municipality of Tulum, Quintana Roo. The poaching of turtle eggs, although not as prevalent as in the past, still has an important impact on marine turtle populations. © Alejandro Arenas-Martínez

Oil Mining

The most important economic activity in the Tabascan Plains and Marshes, in southwestern Campeche, Tabasco, and southern Veracruz, is the oil industry, which in the Mexican Yucatan Peninsula primarily is present in Campeche in the vicinity of Ciudad del Carmen. Although not directly related to the herpetofauna, since most of this activity and the associated oil spills occur in the Gulf of Mexico (Fig. 16), the overall needs of this industry significantly have altered the terrestrial ecosystems of the area. In 1971, Cantarell, the largest hydrocarbon deposit in Mexico and one of the largest in the world, was discovered in the marine platform next to Términos Lagoon. This discovery led to an intensive exploration and exploitation of oil, amounting to 80% of the crude oil and 30% of the natural gas produced in Mexico (Soto-Galera et al., 2010). The oil industry attracted people seeking employment, and within a few years effectively transformed this region from a rural to an urban setting. This process primarily affected the mangroves, which were deforested during the period of rapid urbanization, and indirectly, the subsequent economic bonanza prompted an investment in cattle ranching and the creation of induced grasslands (Soto-Galera et al., 2010). The exploration and construction of ducts and infrastructure is prohibited inside the protected area of Laguna de Términos, but urban development in nearby areas increasingly has encroached upon the protected land, making many natural sites more accessible and facilitating the fragmentation of ecosystems (INE, 1997).

Fig. 16. *Oil Mining*. A sea turtle affected by an oil spill on a beach in Belize, near San Pedro Island. Individuals affected by oil spills occasionally are encountered along the coast near Xcalak, in the municipality of Othón P. Blanco, Quintana Roo. The production of oil is an important industry along the coast of Campeche. © Kirah Forman

Impact of Roads on Herpetofauna

In biodiversity conservation, the impact of roads on wildlife is a matter of growing concern because roads act as barriers and/or filters, and thus cause habitat fragmentation and population isolation, as well as the loss of habitat when a road is built. Whereas roads impact all vertebrate groups, herpetofaunal species are more vulnerable to road impacts due to their ecological characteristics. For example, when compared to other vertebrates, herpetofaunal species have a lower vagility, which makes them more vulnerable to the effects of fragmentation. Roads also constitute an important heat source for thermoregulation, which makes them an attractive site for snakes and lizards to bask. In the case of amphibians, their complex life cycles usually involve periodic migrations among complementary habitats in order to complete their annual cycle, which might require them to cross roads. Roads also can have secondary effects (e.g., the noisy traffic can overshadow the mating vocalizations of anurans). Additionally, roads can be efficient corridors for the dispersal of invasive species (Colino-Rabanal and Lizana, 2012).

Snakes are particularly affected by the "Dead on Road" (DOR) impact (Fig. 17); this can be attributed to their thermoregulatory activities (basking on warm pavement), their behavior (seasonal migrations), or low-speed movement (Andrews et al., 2008). In other instances, they are victims of fear and thus are intentionally killed by drivers (Secco et al., 2014). A notable attempt to conduct a census of DOR snakes in the region is the long-term, ongoing survey started in 2010 by Köhler et al. (2016) on the roads near the city of Chetumal. During the census, so far these authors have documented 31 species of snakes killed by automobiles, with *Dipsas brevifacies*, *Sibon sanniolus*, *Leptodeira frenata*, *Ninia sebae*, and *Boa imperator* being the most frequently recorded. The impact of automobiles on snake mortality has been more severe during the rainy season. Although these authors noted that the number of individuals found is meaningful, it probably underestimates the real impact because many carcasses likely are removed from the road by scavengers within a few hours, and thus only the more recent road-killed individuals were detected.

Fig. 17. *Impact of Roads on Herpetofauna.* A consequence of urban development is the growing number of roads, where herpetofaunal species often are killed by vehicles, especially in rural areas of the peninsula. Pictured here is a road-killed *Agkistrodon russeolus* (a regional endemic), found in Chankom, in the municipality of Chankom, Yucatán. © Rubén Carbajal-Marquez

Aside from isolated records, no other study has documented the impact of roads on the herpetofauna of the Yucatan Peninsula, so the impact on turtles, crocodiles, lizards, and amphibians remains unknown. Thus, more surveys regarding DOR herpetofauna are necessary, since the mortality is a side effect of the burgeoning tourist economy in Quintana Roo and Yucatán, and the conduct of marine commerce in Campeche and Yucatán and the oil industry in Campeche. In addition, there is a growing demand for highway and road infrastructure on the peninsula, and the expansion of this network is a strategic priority of the Programa Nacional de Infraestructura (National Infrastructure Program), 2014–2018 (D.O.F., 2014).

Direct and Incidental Killing

The anthropogenic killing of wildlife is an important factor that threatens the conservation of many species, especially those that arouse fear in the general public, such as snakes (Akani et al., 2002). In fact, direct killing by humans has been identified as a main cause of population decline in snakes (Fig. 18). The majority of deaths occur in rural tropical areas, where human deaths resulting from snakebite can be common. Unfortunately, killing due to fear affects not only venomous species, but also many innocuous snakes (Balakrishnan, 2010). Although some peninsular species potentially can be harmful, such as *Crotalus tzabcan*, *Bothrops asper*, and *Agkistrodon russeolus*, the incidence of accidents with a venomous snake in rural areas of the Yucatan Peninsula is lower than that in many other tropical states of Mexico (Yañez-Arenas et al., 2016). Nonetheless, the possibility of snakebite motivates people to kill any snake, in order to avoid such a traumatic experience. Other killings can be motivated by popular beliefs, mainly among older people (e.g., green arboreal snakes are associated with evil entities of the forest, such as *X-Tabay* [a spectral man-eater woman] and *Kisin* [the devil], and are viewed as sources of evil curses and bad auguries). This association might lead to a negative attitude toward certain colubrid species, resulting in the killing and, on rare occasions, the incineration of these individuals (Núñez-Núñez, 2017).

Fig. 18. *Direct Killing.* An individual of *Crotalus tzabcan* killed by local people at Laguna Om, in the municipality of Othón P. Blanco, Quintana Roo. Large rattlesnakes are difficult to find, because most are killed earlier in their lives due to fear or popular beliefs.

© Pedro Macario

Accidental killings of herpetofauna also occur in the ocean (e.g., pelagic fishing lines occasionally catch sea turtles; Fig. 19), and worldwide this impact is considered as an important cause of mortality for chelonians (Lewison et al., 2004). No effort has been undertaken on the peninsula to quantify the rate of accidental catch of sea turtles by fishing effort or techniques, but incidental reports indicate that such captures are relatively frequent.

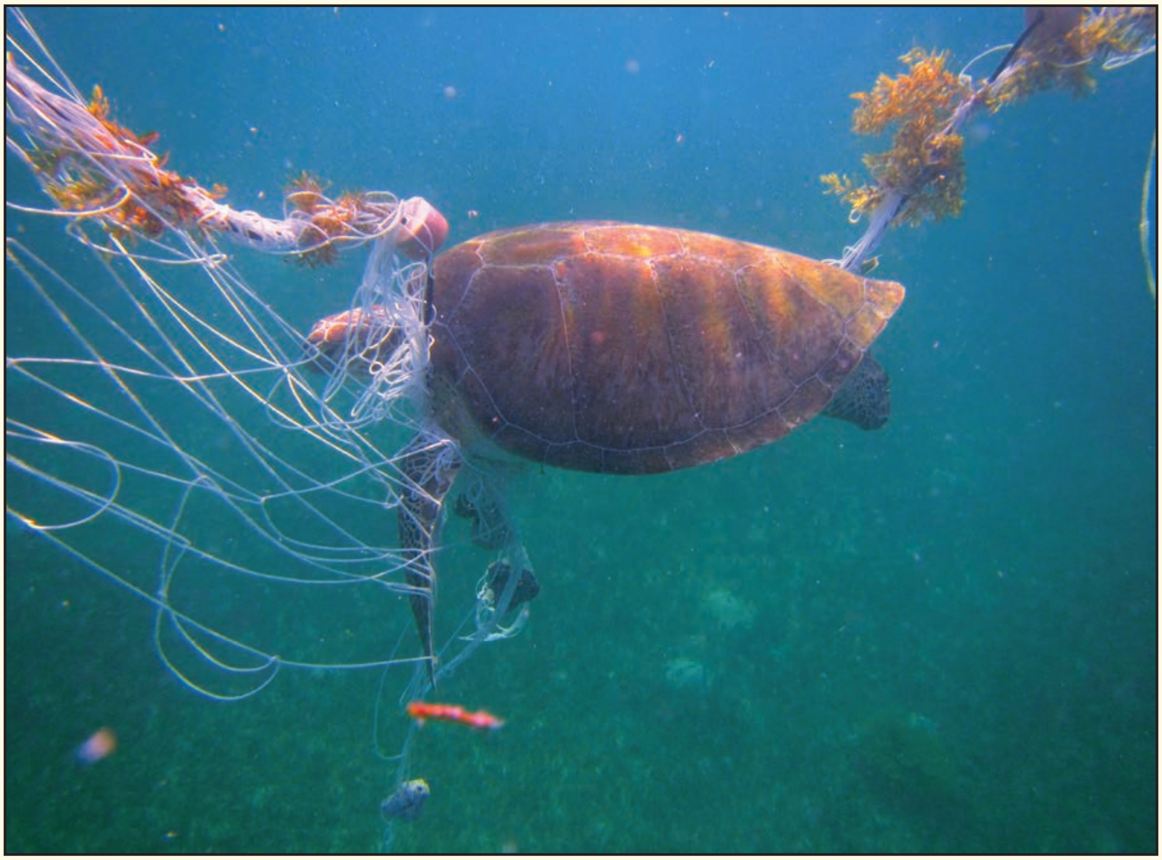

Fig. 19. *Incidental Killing.* A Green Sea Turtle (*Chelonia mydas*) entangled in a fishing net off Cabo Catoche, in the municipality of Isla Mujeres, in northern Quintana Roo. © Roberto Herrera-Pavón

Conservation Status

We utilized the same three systems as Alvarado-Díaz et al. (2013), Mata-Silva (2015), Johnson et al. (2015a), Terán-Juárez et al. (2016), Woolrich-Piña et al. (2016), Nevárez-de los Reyes et al. (2016), and Cruz-Sáenz et al. (2017) to evaluate the conservation status of the herpetofauna of the Mexican Yucatan Peninsula. Except for cases that required updating, we extracted these data from Wilson et al. (2013a, b), and from the Norma Oficial Mexicana NOM-059-SEMARNAT-2010 (SEMARNAT, 2010).

The SEMARNAT System

The SEMARNAT system was developed by the Secretaría de Medio Ambiente y Recursos Naturales and is intended as a means for evaluating the conservation status of members of the Mexican flora and fauna. "The Secretariat is charged with the mission of protecting, restoring, and conserving the ecosystems, natural resources, assets and environmental services of Mexico with the goal of fostering sustainable development" (www.wikipedia.org; accessed 20 December 2016). This system is employed most often by Mexican herpetologists to report conservation evaluations for members of the Mexican herpetofauna. We indicate the available ratings for the members of the herpetofauna of the Mexican Yucatan Peninsula in Table 10, and provide a summary in Table 12.

Table 12. SEMARNAT (NOM-059) categorizations for the herpetofaunal species in the Mexican Yucatan Peninsula arranged by families. Non-native species are not included.

Families	Number of Species	SEMARNAT Categorizations			
		Endangered (P)	Threatened (A)	Special Protection (Pr)	No Status (NS)
Bufonidae	2	—	—	—	2
Craugastoridae	2	—	—	1	1
Hylidae	8	—	—	1	7
Leptodactylidae	3	—	—	—	3
Microhylidae	2	—	—	1	1
Phyllomedusidae	1	—	—	—	1
Ranidae	2	—	—	1	1
Rhinophrynidae	1	—	—	—	1
Subtotals	**21**	**—**	**—**	**4**	**17**
Plethodontidae	3	—	—	3	—
Subtotals	**3**	**—**	**—**	**3**	**—**
Totals	**24**	**—**	**—**	**7**	**17**
Crocodylidae	2	—	—	2	—
Subtotals	**2**			**2**	
Anguidae	1	—	—	1	—
Corytophanidae	5	—	—	4	1
Dactyloidae	7	—	—	2	5
Eublepharidae	1	—	1	—	—
Iguanidae	4	1	1	1	1
Mabuyidae	1	—	—	—	1
Phrynosomatidae	5	—	—	1	4
Phyllodactylidae	2	—	—	1	1
Scincidae	2	—	—	—	2
Sphaerodactylidae	3	—	—	2	1
Sphenomorphidae	1	—	—	—	1
Teiidae	8	1	—	—	7
Xantusiidae	1	—	—	1	—
Subtotals	**41**	**2**	**2**	**13**	**24**
Boidae	1	—	—	—	1
Colubridae	22	—	3	3	16
Dipsadidae	21	—	—	5	16
Elapidae	1	—	—	1	—
Leptotyphlopidae	2	—	—	—	2

Natricidae	3	—	2	—	1
Sibynophiidae	1	—	—	—	1
Typhlopidae	1	—	—	—	1
Viperidae	4	—	—	1	3
Subtotals	**56**	**—**	**5**	**10**	**41**
Cheloniidae	4	4	—	—	—
Chelydridae	1	—	—	—	1
Dermatemydidae	1	1	—	—	—
Dermochelyidae	1	1	—	—	—
Emydidae	2	—	—	—	2
Geoemydidae	1	—	1	—	—
Kinosternidae	4	—	—	3	1
Staurotypidae	2	—	1	1	—
Subtotals	**16**	**6**	**2**	**4**	**4**
Totals	**115**	**8**	**9**	**29**	**69**
Sum Totals	**139**	**8**	**9**	**36**	**86**

Three categories are employed in the SEMARNAT system (NOM-059), i.e., endangered (P), threatened (A), and under special protection (Pr). Previous entries in the MCS by Alvarado-Díaz et al. (2013), Mata-Silva et al. (2015), Johnson et al. (2015a), Terán-Juárez et al. (2016), Woolrich-Piña et al. (2016), and Nevárez-de los Reyes et al. (2016) have shown that a large proportion of the herpetofaunal species in each of the states covered have not been assessed by using this system, and thus these species were placed in a "no status" (NS) category.

Of the 139 native herpetofaunal species in the Mexican Yucatan Peninsula, 86 (61.9%) have not been assessed. The remaining species have been allocated to the P category (eight; 5.8%), the A category (nine; 6.5%), or the Pr category (36; 25.9%). The eight endangered species include the regional endemic lizards *Ctenosaura defensor* and *Aspidoscelis rodecki*, as well as the five sea turtles and the river turtle *Dermatemys mawii*. The nine threatened species are the eublepharid gecko *Coleonyx elegans*, the iguanid lizard *Ctenosaura similis*, three colubrid snakes (*Leptophis ahaetulla*, *L. mexicanus*, and *Masticophis mentovarius*), two gartersnakes (*Thamnophis marcianus* and *T. proximus*), the geoemydid turtle *Rhinoclemmys areolata*, and the staurotypid turtle *Staurotypus triporcatus*. The 36 special protection species include four anurans, all three salamanders, both crocodylians, 23 squamates, and four turtles.

As with other studies in the MCS, given that only 53 of the 139 native species (38.1%) have been placed in one of the three SEMARNAT categories, we find this system of conservation assessment to be of limited use. If at some point SEMARNAT deals with the entire Mexican herpetofauna, this system might prove useful for ascertaining the conservation status of this group of animals.

The IUCN System

The system of conservation assessment developed by the International Union for Conservation of Nature is used for all organisms on a global basis. This system encompasses eight categories, including Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), and Data Deficient (DD). Because not all of the Mesoamerican herpetofaunal species have been assessed, for these species we use the NE designation (for Not Evaluated). We placed the available IUCN ratings for the members of the herpetofauna of the Mexican Yucatan Peninsula in Table 10, and provide a summary in Table 13.

Porthidium yucatanicum (Smith, 1941). The Yucatecan Hog-nosed Pitviper is a regional endemic in the Mexican Yucatan Peninsula, occurring in the Karstic Hills and Plains of Campeche, Yucatecan Karstic Plains, and Low Coast of Quintana Roo regions in the states of Campeche, Quintana Roo, and Yucatán. This individual came from Tihosuco, in the municipality of Felipe Carrillo Puerto, in the state of Quintana Roo. Wilson et al. (2013a) calculated its EVS as 17, placing it in the middle portion of the high vulnerability category. Its conservation status has been assessed as Least Concern, and this snake is considered a species of special concern (Pr) by SEMARNAT.

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Caretta caretta (Linnaeus, 1758). The Loggerhead Sea Turtle is found "worldwide in tropical and subtropical seas" (Savage, 2002). This individual was photographed in the waters off Isla Mujeres, in the municipality of Isla Mujeres, in the state of Quintana Roo. As a marine species, its EVS cannot be calculated. Its conservation status has been evaluated as Vulnerable by the IUCN, and as endangered (P) by SEMARNAT.

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Table 13. IUCN Red List categorizations for the herpetofaunal families in the Mexican Yucatan Peninsula. Non-native species are excluded. The shaded columns on the left are the "threat categories," and the one on the right is the category summarizing those that have not been evaluated.

Families	Number of Species	IUCN Red List categorizations					
		Critically Endangered	Endangered	Vulnerable	Near Threatened	Least Concern	Not Evaluated
Bufonidae	2	—	—	—	—	1	1
Craugastoridae	2	—	—	—	1	1	—
Hylidae	8	—	—	—	—	8	—
Leptodactylidae	3	—	—	—	—	3	—
Microhylidae	2	—	—	—	—	2	—
Phyllomedusidae	1	—	—	—	—	1	—
Ranidae	2	—	—	—	—	1	1
Rhinophrynidae	1	—	—	—	—	1	—
Subtotals	**21**	**—**	**—**	**—**	**1**	**18**	**2**
Plethodontidae	3	—	—	—	—	3	—
Subtotals	**3**	**—**	**—**	**—**	**—**	**3**	**—**
Totals	**24**	**—**	**—**	**—**	**1**	**21**	**2**
Crocodylidae	2	—	—	1	—	1	—
Subtotals	**2**	**—**	**—**	**1**	**—**	**1**	**—**
Anguidae	1	—	—	—	1	—	—
Corytophanidae	5	—	—	—	—	5	—
Dactyloidae	7	—	—	—	—	—	7
Eublepharidae	1	—	—	—	—	1	—
Iguanidae	4	—	—	1	1	1	1
Mabuyidae	1	—	—	—	—	1	—
Phrynosomatidae	5	—	—	—	—	5	—
Phyllodactylidae	2	—	—	—	—	1	1
Scincidae	2	—	—	—	—	2	—
Sphaerodactylidae	3	—	—	—	—	2	1
Sphenomorphidae	1	—	—	—	—	—	1
Teiidae	8	—	—	—	1	4	3
Xantusiidae	1	—	—	—	—	1	—
Subtotals	**41**	**—**	**—**	**1**	**3**	**23**	**14**
Boidae	1	—	—	—	—	—	1
Colubridae	22	—	—	—	—	15	7
Dipsadidae	21	—	—	—	—	15	6

Elapidae	1	—	—	—	—	1	—
Leptotyphlopidae	2	—	—	—	—	1	1
Natricidae	3	—	—	—	—	3	—
Sibynophiidae	1	—	—	—	—	1	—
Typhlopidae	1	—	—	—	—	—	1
Viperidae	4	—	—	—	—	2	2
Subtotals	**56**	**—**	**—**	**—**	**—**	**38**	**18**
Cheloniidae	4	—	1	1	—	—	—
Chelydridae	1	—	—	1	—	—	—
Dermatemydidae	1	1	—	—	—	—	—
Dermochelyidae	1	—	—	1	—	—	—
Emydidae	2	—	—	1	—	—	1
Geoemydidae	1	—	—	—	1	—	—
Kinosternidae	4	—	—	—	1	1	2
Staurotypidae	2	—	—	—	2	—	—
Subtotals	**16**	**3**	**1**	**4**	**4**	**1**	**3**
Totals	**115**	**3**	**1**	**6**	**7**	**63**	**35**
Sum Totals	**139**	**3**	**1**	**6**	**8**	**84**	**37**
Category Totals	**139**	**10**			**92**		**37**

Conservation assessments based on the IUCN system have been determined for 102 of 139 Mexican Yucatan species (73.4%), excluding the six non-native species. Each of these 102 species has been placed in one of five categories, including the CR (three species), EN (one), VU (six), NT (eight), and LC (84). Thirty-seven species (26.6%), however, have not been assessed. No species are allocated to the EX, EW, or DD categories.

Ten species have been assigned to one of the three "threat" categories. Of the three species allocated to the CR category, all are turtles (two sea turtles, *Eretmochelys imbricata* and *Lepidochelys kempii*, and one is a river turtle *Dermatemys mawii*). A single species, the sea turtle *Chelonia mydas*, has been categorized in the EN category. The six species placed in the VU category include the crocodylian *Crocodylus acutus*, the regional endemic iguanid lizard *Ctenosaura defensor*, and four turtles (the sea turtles *Caretta caretta* and *Dermochelys coriacea*, the snapping turtle *Chelydra rossignonii*, and the slider *Trachemys venusta*).

As with other MCS studies, two principal problems are evident with the IUCN system of conservation assessment. One is that the majority of species are placed in the LC category. In the case of the Mexican Yucatan herpetofauna, this figure is 84 (60.4% of the total). The other problem is that a sizable proportion of the species have not been assessed; this value is 37 (26.6%). Thus, only 18 native species (12.9%) occurring in the Mexican Yucatan Peninsula have been placed in a category other than LC or NE. Given that six of every 10 species in this region have been allocated to the LC category, on the surface it would appear that the Mexican Yucatan herpetofauna is in reasonably good shape. We test this assumption below, however, by comparing it to the EVS system of conservation assessment. We also examine the likely status of the NE species.

The EVS System

Wilson et al. (2013a, b) and Johnson et al. (2015b) discussed the development and use of the Environmental Vulnerability Score (EVS), as well as its advantages, so we do not repeat the information here.

The EVS system has been used in several studies on the herpetofauna of some countries in Central America (Murphy and Méndez de la Cruz, 2010; Stafford et al., 2010; Acevedo et al., 2010; Townsend and Wilson, 2010; Sunyer and Köhler, 2010; Sasa et al., 2010; Jaramillo et al., 2010) and states in Mexico (Alvarado-Díaz et al., 2013; Mata-Silva et al., 2015; Johnson et al., 2015a; Terán-Juárez et al., 2016, Woolrich-Piña et al., 2016; Nevárez-de los Reyes et al., 2016), as well as for the entire country of Mexico (Wilson et al., 2013a, b).

In this study, we applied EVS values to 134 species for which they could be calculated (excluding the 11 non-native and marine species) and placed them in Table 14. The values range from 3, the lowest possible score, to 19, one less than the highest possible score. The most frequent values (for 10 or more species) are 6 (13 species), 8 (16), 9 (12), 10 (16), 12 (12), 13 (17), and 15 (10). These seven scores are applied to 96 of 134 species (71.6%) for which the EVS can be determined. We calculated the lowest score of 3 to two anuran species, the bufonid *Rhinella horribilis* and the hylid *Smilisca baudinii*, and the highest score of 19 to a single species, the pond and river slider *Trachemys venusta*.

Table 14. Environmental Vulnerability Scores (EVS) for the herpetofaunal species in the Mexican Yucatan Peninsula arranged by family. Shaded area on the left encompasses the low vulnerability scores, and the one on the right the high vulnerability scores. Non-native and marine species are not included.

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	2	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Craugastoridae	5	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—
Hylidae	8	1	2	—	—	2	1	—	1	—	1	—	—	—	—	—	—	—
Leptodactylidae	3	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
Microhylidae	2	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Phyllodactylidae	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Ranidae	2	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—
Rhinophrynidae	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Subtotals	**21**	**2**	**3**	**1**	**2**	**3**	**4**	**1**	**2**	**1**	**1**	—	—	—	—	**1**	—	—
Plethodontidae	3	—	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—
Subtotals	**3**	—	—	—	—	—	—	**1**	—	**1**	—	—	—	**1**	—	—	—	—
Totals	**24**	**2**	**3**	**1**	**2**	**3**	**4**	**2**	**2**	**2**	**1**	—	—	**1**	—	**1**	—	—
Crocodylidae	2	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
Subtotals	**2**	—	—	—	—	—	—	—	—	—	—	**1**	**1**	—	—	—	—	—
Anguidae	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Corytophanidae	5	—	—	—	—	1	1	1	—	1	—	1	—	—	—	—	—	—
Dactyloidae	7	—	—	—	—	—	2	1	2	—	1	1	—	—	—	—	—	—
Eublepharidae	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Iguanidae	4	—	—	—	—	—	1	—	—	—	1	—	—	2	—	—	—	—
Mabuyidae	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Phrynosomatidae	5	—	—	—	1	—	—	—	—	—	—	2	1	1	—	—	—	—
Phyllodactylidae	2	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—

Scincidae	2	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
Sphaerodactylidae	3	—	—	—	—	—	—	—	1	—	1	1	—	—	—	—	—	—
Sphenomorphidae	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Teiidae	8	—	—	—	—	—	1	—	—	—	1	2	—	2	2	—	—	—
Xantusiidae	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Subtotals	**41**	**—**	**—**	**—**	**2**	**1**	**8**	**3**	**4**	**2**	**5**	**8**	**1**	**5**	**2**	**—**	**—**	**—**
Boidae	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Colubridae	22	—	—	1	7	1	1	3	3	—	2	2	1	—	1	—	—	—
Dipsadidae	21	—	1	1	2		2	4	2	—	2	5	—	2	—	—	—	—
Elapidae	1	—	—	—	—	—	1	—		—	—	—	—	—	—	—	—	—
Leptotyphlopidae	2	—	1	—	—	—	—	—		1	—	—	—	—	—	—	—	—
Natricidae	3	—	—	—	—	1	—	—	2	—	—	—	—	—	—	—	—	—
Sibynophiidae	1	—	—	—	—	—	—	—		1	—	—	—	—	—	—	—	—
Typhlopidae	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Viperidae	4	—	—	—	—	—	—	—	—	—	1	—	—	1	1	1	—	—
Subtotals	**56**	**—**	**2**	**2**	**9**	**2**	**4**	**7**	**8**	**2**	**6**	**7**	**1**	**3**	**2**	**1**	**—**	**—**
Chelydridae	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Dermatemydidae	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Emydidae	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Geoemydidae	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Kinosternidae	4	—	—	—	—	—	—	—	2	—	—	—	1	1	—	—	—	—
Staurotypidae	2	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
Subtotals	**11**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**2**	**—**	**—**	**1**	**3**	**1**		**2**	**1**	**1**
Totals	**110**	**—**	**2**	**2**	**11**	**3**	**12**	**10**	**14**	**4**	**11**	**17**	**6**	**9**	**4**	**3**	**1**	**1**
Sum Totals	**134**	**2**	**5**	**3**	**13**	**6**	**16**	**12**	**16**	**6**	**12**	**17**	**6**	**10**	**4**	**4**	**1**	**1**
Category Totals	**134**	**57**							**51**				**26**					

As with other MCS studies, we placed the 134 species into one of three summary categories: low, medium, and high. In previous studies, the EVS scores generally increased from low through medium to high or from low to medium and down to high; instead, however, the summary numbers for the Mexican Yucatan Peninsula decrease from low through medium to high, i.e., 57 to 51 to 26. This pattern reflects the relatively high proportion of non-native species in the herpetofauna of this region, of which all but one occur in Central America, and the corresponding low proportion of endemic species. In addition, 12 of the non-native species also occur in the United States, most of them in southern Texas or southern Arizona.

We compared the results of the IUCN and EVS categorizations in Table 15. Our comparison demonstrates that only five of the 26 high vulnerability species (19.2%) are allocated to one of the two threat categories applicable to the Mexican Yucatan herpetofauna. At the other extreme of the assessed IUCN categories (LC), 84 species amount to 1.5 times the number of low vulnerability species (57). As with other MCS studies (Mata-Silva et al., 2015; Johnson et al., 2015a; Terán-Juárez et al., 2016; Woolrich-Piña et al., 2016; Nevárez-de los Reyes et al., 2016), the results of these two systems of conservation assessment do not concur with one other.

Chelonia mydas (Linnaeus, 1758). The Green Sea Turtle occurs in the "Atlantic, Pacific, and Indian oceans, chiefly in the tropics" (Reptile Database; assessed 25 March 2017). This pair of individuals, accompanied by a fleet of remoras, was seen in the waters off Isla Mujeres, in the municipality of Isla Mujeres, in the state of Quintana Roo. Inasmuch as this is a marine species, its EVS cannot be determined. Its conservation status has been assessed as Endangered by the IUCN, and as endangered (P) by SEMARNAT.

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Eretmochelys imbricata (Linnaeus, 1766). The Hawksbill Sea Turtle is distributed "worldwide in warms seas and reaching temperate oceans in the Northern Hemisphere and South Africa and New Zealand in the Southern Hemisphere" (Savage, 2002). This individual was photographed in the waters off Cozumel, in the municipality of Cozumel, in the state of Quintana Roo. Because this is a marine species, its EVS cannot be calculated. Its conservation status has been determined as Critically Endangered by the IUCN, and as endangered (P) by SEMARNAT.

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Table 15. Comparison of the Environmental Vulnerability Scores (EVS) and applicable IUCN categorizations for members of the herpetofauna of the Mexican Yucatan Peninsula. No species are allocated to the Endangered or the Data Deficient categories. Non-native and marine species are excluded. Shaded area at the top encompasses the low vulnerability category scores, and the one at the bottom the high vulnerability category scores.

EVS	IUCN Categories					
	Critically Endangered	Vulnerable	Near Threatened	Least Concern	Not Evaluated	Totals
3	—	—	—	1	1	2
4	—	—	—	4	1	5
5	—	—	—	1	2	3
6	—	—	—	9	4	13
7	—	—	—	6	—	6
8	—	—	—	11	5	16
9	—	—	—	9	3	12
10	—	—	—	8	8	16
11	—	—	—	6	—	6
12	—	—	—	7	5	12
13	—	—	2	11	4	17
14	—	1	3	2	—	6
15	—	1	1	6	2	10
16	—	—	1	2	1	4
17	1	1	1	1	—	4
18	—	—	—	—	1	1
19	—	1	—	—	—	1
Totals	**1**	**4**	**8**	**84**	**37**	**134**

As noted in earlier MCS studies, there are two main reasons why the IUCN and EVS systems do not coincide with one another, and we also provide them in our analysis of the herpetofauna of the Mexican Yucatan Peninsula. One reason is that a substantial number of species have not been evaluated using the IUCN methodology (37 species; Table 15). We placed these species and their EVS calculations in Table 16. Perusal of this group indicates that most are non-endemic species, except for three regional endemics (*Holcosus gaigeae*, *Pseudelaphe phaescens*, and *Terrapene yucatana*) and one country endemic (*Holcosus stuarti*). In general, the non-endemic species also are distributed to the south of the Mexican Yucatan Peninsula, to some point in Central- or South America. Presumably, the IUCN assessments will become available for these species once the results of a 2012 workshop become available or a future workshop is held in the appropriate countries of South America. The EVS values for these 37 species range from 3 to 18, almost the entire range seen in the Mexican Yucatan herpetofauna, and fall into the following three summary categories: low (16 species); medium (17); and high (four). We suggest that until the IUCN categorizations are available for these species, the low category species should be allocated to the LC category, the medium category species to the NT category, and the high category species to one of the three threat categories. Three of the four high category species are regional endemics (*Holcosus gaigeae*, *Pseudelaphe phaescens*, and *Terrapene yucatana*), and the fourth (*Agkistrodon russeolus*) is a near-regional endemic.

Table 16. Environmental Vulnerability Scores (EVS) for members of the herpetofauna of the Mexican Yucatan Peninsula currently not evaluated (NE) by the IUCN. Non-native and marine taxa are not included.

Taxa	Environmental Vulnerability Score (EVS)			
	Geographic Distribution	Ecological Distribution	Reproductive Mode/Degree of Persecution	Total
Rhinella horribilis	1	1	1	3
Lithobates brownorum	4	3	1	8
Anolis allisoni	3	7	3	13
Norops beckeri	3	6	3	12
Norops biporcatus	3	4	3	10
Norops lemurinus	3	2	3	8
Norops rodriguezii	4	3	3	10
Norops tropidonotus	4	2	3	9
Norops ustus	4	1	3	8
Iguana iguana	3	3	6	12
Thecadactylus rapicauda	3	4	3	10
Sphaerodactylus continentalis	4	3	3	10
Scincella cherriei	3	2	3	8
*Holcosus gaigeae***	5	7	3	15
Holcosus hartwegi	4	6	3	13
*Holcosus stuarti**	5	4	3	12
Boa imperator	3	1	6	10
Drymobius margaritiferus	1	1	4	6
Lampropeltis abnorma	1	3	5	9
Leptophis ahaetulla	3	3	4	10
Oxybelis aeneus	1	1	3	5
Oxybelis fulgidus	3	2	4	9
*Pseudelaphe phaescens***	5	7	4	16
Spilotes pullatus	1	1	4	6
Imantodes cenchoa	1	3	2	6
Imantodes gemmistratus	1	3	2	6
Leptodeira septentrionalis	2	2	4	8
Sibon nebulatus	1	2	2	5
Tropidodipsas fasciata	5	4	4	13
Xenodon rabdocephalus	3	5	5	13
Epictia vindumi	5	8	1	14
Amerotyphlops microstomus	4	7	1	12
Agkistrodon russeolus	4	6	5	15
Bothrops asper	3	4	5	12
*Terrapene yucatana***	5	7	6	18
Kinosternon leucostomum	3	4	3	10
Kinosternon scorpioides	3	4	3	10

The other reason for substantial disagreement in the assessments provided by the IUCN and EVS systems is that a sizable number of species have been allocated to the LC category. In the case of the Mexican Yucatan herpetofauna, that number is 84 (62.7% of the total number for which an EVS can be determined; Table 17). So, the question arises as to which of these two systems provides the more realistic appraisal of the conservation status of the species involved. We indicate the EVS calculations for these 84 species in Table 19. Interestingly, similar to the situation with the NE species, the range of EVS values is 3 to 17, two values shy of the entire range for the Mexican Yucatan herpetofauna. When arranged into the three summary categories, the results are as follows: low (40; 47.6%); medium (33; 39.3%); and high (11; 13.1%). Following the same assumptions we made in the previous paragraph, we believe that the low category species should be placed in the LC category, the medium category species in the NT category, and the high category species in one of the three threat categories. The 11 high category species and their EVS calculations are as follows:

Bolitoglossa yucatana (4+7+4 = 15)
*Sceloporus cozumelae*** (5+7+3 = 15)
Sceloporus lundelli (4+7+3 = 14)
*Aspidoscelis cozumela*** (5+8+3 = 16)
Aspidoscelis maslini (4+8+3 = 15)
Symphimus mayae (4+7+3 = 14)
*Coniophanes meridanus*** (5+7+3 = 15)
Dipsas brevifacies (4+7+4 = 15)
Crotalus tzabcan (4+7+5 = 16)
*Porthidium yucatanicum*** (5+7+5 = 17)
*Kinosternon creaseri*** (5+7+3 = 15)

Most obviously, five of the 11 species are regional endemics (species indicated by double asterisks), and therefore their distribution is limited to the Mexican Yucatan Peninsula. The other six species are near regional endemics, also distributed in northern Guatemala and/or northern Belize, relatively close to the border of the Mexican Yucatan Peninsula. All 11 species occur only in one or two forest formations. Thus, in total, all of these species are limited in both geographic and ecological distribution, and we believe that all should be removed from the LC category and otherwise placed as follows: CR (*Aspidoscelis cozumela*, *Crotalus tzabcan*, and *Porthidium yucatanicum*); EN (*Bolitoglossa yucatana*, *Sceloporus cozumelae*, *Aspidoscelis maslini*, *Coniophanes meridanus*, *Dipsas brevifacies*, and *Kinosternon creaseri*); and VU (*Sceloporus lundelli* and *Symphimus mayae*). Naturally, it is not within our purview to make these changes, but their EVS values can be used to indicate the degree of attention they should be accorded.

Table 17. Environmental Vulnerability Scores (EVS) for members of the herpetofauna of the Mexican Yucatan Peninsula assigned to the IUCN Least Concern category. Non-native and marine taxa are not included.

Taxa	Environmental Vulnerability Score (EVS)			
	Geographic Distribution	Ecological Distribution	Reproductive Mode/Degree of Persecution	Total Score
Incilius valliceps	3	2	1	6
Craugastor loki	2	4	4	10
Dendropsophus ebraccatus	3	6	3	12
Dendropsophus microcephalus	3	3	1	7
Scinax staufferi	2	1	1	4
Smilisca baudinii	1	1	1	3
Tlalocohyla loquax	3	3	1	7
Tlalocohyla picta	2	5	1	8
Trachycephalus typhonius	1	2	1	4
Triprion petasatus	4	5	1	10

Engystomops pustulosus	3	2	2	7
Leptodactylus fragilis	1	2	2	5
Leptodactylus melanonotus	1	3	2	6
Gastrophyrne elegans	2	5	1	8
Hypopachus variolosus	2	1	1	4
Agalychnis callidryas	3	5	3	11
Lithobates vaillanti	3	5	1	9
Rhinophrynus dorsalis	2	5	1	8
Bolitoglossa mexicana	4	3	4	11
Bolitoglossa rufescens	1	4	4	9
Bolitoglossa yucatana	4	7	4	15
Crocodylus moreletii	2	5	6	13
Basiliscus vittatus	1	3	3	7
Corytophanes cristatus	3	5	3	11
Corytophanes hernandezii	4	6	3	13
Laemanctus longipes	1	5	3	9
Laemanctus serratus	2	3	3	8
Coleonyx elegans	2	3	4	9
Ctenosaura similis	1	4	3	8
Marisora brachypoda	1	2	3	6
Sceloporus chrysostictus	4	6	3	13
*Sceloporus cozumelae***	5	7	3	15
Sceloporus lundelli	4	7	3	14
Sceloporus serrifer	2	1	3	6
Sceloporus teapensis	4	6	3	13
Phyllodactylus tuberculosus	1	4	3	8
Mesoscincus schwartzei	2	6	3	11
Plestiodon sumichrasti	4	5	3	12
Aristelliger georgeensis	3	7	3	13
Sphaerodactylus glaucus	4	5	3	12
Aspidoscelis angusticeps	4	6	3	13
*Aspidoscelis cozumela***	5	8	3	16
Aspidoscelis deppii	1	4	3	8
Aspidoscelis maslini	4	8	3	15
Lepidophyma flavimaculatum	1	5	2	8
Drymarchon melanurus	1	1	4	6
Ficimia publia	4	3	2	9
Leptophis mexicanus	1	1	4	6
Masticophis mentovarius	1	1	4	6
Mastigodryas melanolomus	1	1	4	6
Phrynonax poecilonotus	3	4	3	10
Pseudelaphe flavirufa	2	4	4	10

Senticolis triaspis	2	1	3	6
Stenorrhina freminvillei	1	2	4	7
Symphimus mayae	4	7	3	14
Tantilla cuniculator	4	7	2	13
Tantilla moesta	4	7	2	13
Tantilla schistosa	3	3	2	8
Tantillita canula	4	6	2	12
Tantillita lintoni	4	6	2	12
Coniophanes bipunctatus	1	5	3	9
Coniophanes imperialis	2	3	3	8
*Coniophanes meridanus***	5	7	3	15
Coniophanes quinquevittatus	4	6	3	13
Coniophanes schmidti	4	6	3	13
Conophis lineatus	2	3	4	9
Dipsas brevifacies	4	7	4	15
Imantodes tenuissimus	4	7	2	13
Leptodeira frenata	4	4	4	12
Ninia diademata	4	3	2	9
Ninia sebae	1	1	2	4
Pliocercus elapoides	4	1	5	10
Sibon sanniolus	4	6	2	12
Tretanorhinus nigroluteus	3	5	2	10
Tropidodipsas sartorii	2	2	5	9
Micrurus diastema	2	1	5	8
Epictia magnamaculata	3	7	1	11
Nerodia rhombifer	1	5	4	10
Thamnophis marcianus	1	5	4	10
Thamnophis proximus	1	2	4	7
Scaphiodontophis annulatus	1	5	5	11
Crotalus tzabcan	4	7	5	16
*Porthidium yucatanicum***	5	7	5	17
*Kinosternon creaseri***	5	7	3	15

RELATIVE HERPETOFAUNAL PRIORITY

Johnson et al. (2015a) originated the concept of Relative Herpetofauna Priority (RHP), which was intended as a simple device to measure the relative importance of the herpetofauna documented in the various physiographic regions recorded within any geographical entity (e.g., the state of Chiapas in Johnson et al., 2015a). The two means used involve: (1) the cumulative absolute number of country and state (or regional) endemic species; and (2) the absolute number of high category EVS species in each regional herpetofauna.

We constructed two tables to determine the RHP for the Mexican Yucatan Peninsula herpetofauna, one for the endemicity figures (Table 18) and the other for the high EVS values (Table 19). The data in Table 18 indicate the number of country and regional endemics, at 10 (83.3% of 12 species), is highest for the Yucatecan Karstic Plains. The rest of the regions (and the size of their respective endemic herpetofaunal components) in rank order, from highest to lowest (2 to 5), is as follows: the Karstic Hills and Plains of Campeche (7, 58.3%); the Tabascan Plains and Marshes (5, 41.7%); the Low Coast of Quintana Roo (5, 41.7%); the Caribbean Islands of the Yucatan Peninsula (4, 33.3%); and the Tropical Islands of the Gulf (1, 8.3%). Two regions (the Tabascan Plains and Marshes and the Low Coast of Quintana Roo) occupy the same rank (3).

In Table 19 we calculated the numbers of herpetofaunal species in each of the three EVS categories, i.e., low, medium, and high. The most important physiographic region, based on the total number of high category species, is the Yucatecan Karstic Plains, with 21 of a total of 26 species (80.8%). The remainder of the regions (and the absolute and relative numbers of their respective high EVS species) in rank order, from highest to lowest (2 to 6), are as follows: the Karstic Hills and Plains of Campeche (18, 69.2%); the Low Coast of Quintana Roo (17, 65.4%); the Tabascan Plains and Marshes (12, 46.2%); the Caribbean Islands (7, 26.9%); and the Gulf Islands (6, 23.1%).

The rank orders of the five physiographic regions in Tables 18 and 19 are not identical, but they are reasonably close to one another because in Table 18 two regions have the same rank (3). The rankings based on these two tables are as follows:

Yucatecan Karstic Plains (1, 1)

Karstic Hills and Plains of Campeche (2, 2)

Low Coast of Quintana Roo (3, 3)

Tabascan Plains and Marshes (3, 4)

Caribbean Islands (4, 5)

Gulf Islands (5, 6)

Based on this pair of RHP measures, the highest-priority region is the Yucatecan Karstic Plains, because it harbors the greatest number of (regional) endemics (10 of 11) and the highest number of high category EVS species (21 of 26). The next highest priority region is the adjacent and relatively large Karstic Hills and Plains of Campeche, with seven regional endemics and 18 high category EVS species. As expected, the lowest priority area is the Gulf Islands, with one regional endemic and six high category EVS species, because of the relatively low number of native species recorded there (Table 6). In our opinion, the RHP measure provides a fundamental idea for appropriating the usually scarce conservation funds, but with the proviso that none of the physiographic regions in the three states should be short-changed.

Table 18. Numbers of herpetofaunal species of four distributional categories among the six physiographic provinces of the Mexican Yucatan Peninsula. Rank determined by adding regional and country endemics. Note: Although *Boa imperator* is native for the Yucatan Peninsula, it is non-native on Cozumel; thus, we counted this snake as non-native for the Caribbean Islands of the Yucatan Peninsula.

Physiographic Provinces	Non-endemics	Country Endemics	Regional Endemics	Non-natives	Totals	Rank Order
Tabascan Plains and Marshes	85	1	4	3	93	3
Karstic Hills and Plains of Campeche	110	—	7	3	120	2
Yucatecan Karstic Plains	102	—	10	6	118	1
Low Coast of Quintana Roo	98	—	5	3	106	3
Caribbean Islands of the Yucatan Peninsula	39	—	4	6	49	4
Tropical Islands of the Gulf	39	—	1	3	43	5
Total Species	**127**	**1**	**11**	**6**	**145**	—

Dermatemys mawii Gray, 1847. The Central American River Turtle occurs "from southern Veracruz through northern Guatemala and Belize" (Lee, 1996: 150). This individual was photographed near the border of Mexico and Belize, at the locality of "La Unión" (elev. 11 m), in the municipality of Othón P. Blanco, in southern Quintana Roo. Wilson (2013a) calculated its EVS as 17, placing it in the middle portion of the high vulnerability category. Its conservation status has been deemed as Critically Endangered by the IUCN, and as endangered (P) by SEMARNAT. © Humberto Bahena-Basave, courtesy of HBahena-ECOSUR

Terrapene yucatana (Boulenger, 1895). The Yucatecan Box Turtle is a regional endemic in the Mexican Yucatan Peninsula, and inhabits the Tabascan Plains and Marshes, Karstic Hills and Plains of Campeche, and Yucatecan Karstic Plains of Campeche regions in Quintana Roo and Yucatán. This individual was found at Reserva Estatal Biocultural del Puuc, in the municipality of Oxkutzcab, in southwestern Yucatán. Wilson et al. (2013a) determined its EVS as 18, placing it in the upper portion of the high vulnerability category. Its conservation status has not been evaluated by the IUCN, and this species is not recognized by SEMARNAT. © Javier A. Ortiz-Medina

PROTECTED AREAS IN THE MEXICAN YUCATAN PENINSULA

Habitat degradation and destruction is the principal cause of biodiversity decline, and for any attempt at herpetofaunal conservation it would be critically important to create a system of protected areas in which healthy populations of all the native species can be maintained for perpetuity. This fundamental goal of conservation herpetology, however, is much easier to conceive than to execute. The principal reason for this obstacle is because a protected areas system always is established within a larger entity (e.g., a Mexican state) that already contains a certain-sized human population, whose actions constitute the overriding reasons for the creation of the system. Another important reason why these attempts prove difficult is that systems for protected areas generally are developed with little to no consideration for the conservation needs of the herpetofauna. As a result, determining the conservation needs of a herpetofauna usually takes place "after the fact," i.e., after the components of the system already have been established. Thus, one of the responsibilities of any herpetofaunal study, like this one, should be to evaluate the degree of representation of members of the herpetofauna within the system's components. Other conservation questions, such as "To what extent do sustainable herpetofaunal populations exist within the established areas?" only can be answered after such work has been accomplished. Nonetheless, answering this sort of question requires long-term population monitoring by competent personnel, which in turn requires adequate funding for such studies.

In this study, the best we are able to accomplish is to determine the extent of the system of protected areas in the Mexican Yucatan Peninsula (Fig. 20), and the degree of completeness of the features desired for these areas, in the manner previously done in MCS studies for Tamaulipas (Terán-Juárez et al., 2016), Nayarit (Woolrich-Piña et al., 2016), and Nuevo León (Nevárez-de los Reyes et al., 2016). Thus, based on the approach used by Jaramillo et al. (2010), in Table 20 we examined a number of desirable features of protected areas in order to evaluate the effectiveness of the established components of this system.

The data in Table 20 indicate that of the 44 protected areas we identified in the Mexican Yucatan Peninsula (Fig. 20), 24 are administered at the federal and international levels, and 20 at the state level. Of the protected areas with federal and international jurisdiction, two are UNESCO World Heritage Sites, nine are biosphere reserves (including the two World Heritage Sites), eight are national parks, and seven are Áreas de Protección de Flora y Fauna (Table 20).

Table 19. Number of herpetofaunal species in the three EVS categories among the six physiographic regions of the Mexican Yucatan Peninsula. Rank determined by the relative number of high EVS species. Marine and non-native species are not included.

Physiographic Provinces	Low	Medium	High	Totals	Rank Order
Tabascan Plains and Marshes	45	28	12	85	4
Karstic Hills and Plains of Campeche	52	42	18	112	2
Yucatecan Karstic Plains	46	40	21	107	1
Low Coast of Quintana Roo	46	35	17	98	3
Caribbean Islands of the Yucatan Peninsula	18	15	7	40	5
Tropical Islands of the Gulf	20	9	6	35	6
Total Species	**57**	**51**	**26**	**134**	—

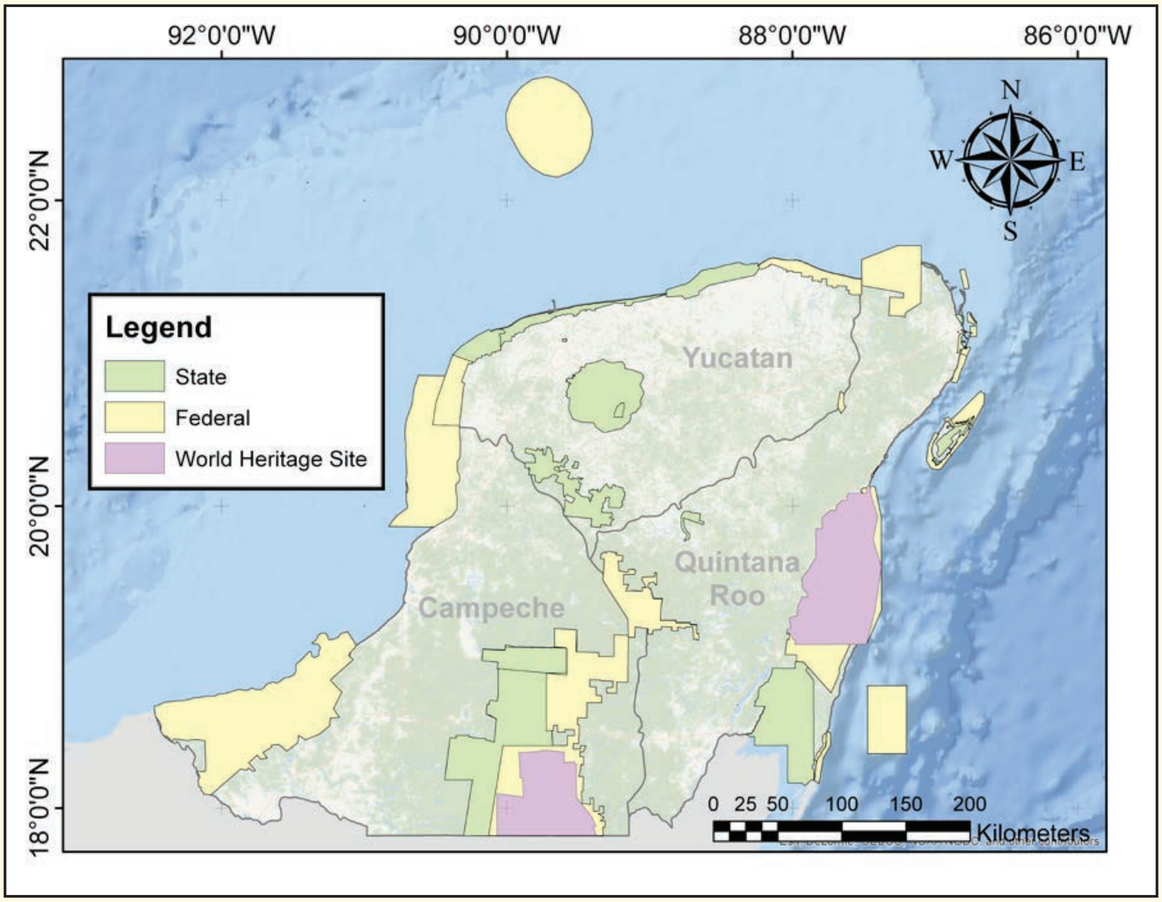

Fig. 20. Protected areas on the Mexican Yucatan Peninsula.

The assemblage of 24 federal/international protected areas is highly impressive, and vitally important for the protection of the natural and cultural resources located on the Mexican Yucatan Peninsula. At the uppermost level of significance are the two UNESCO World Heritage Sites, Calakmul and Sian Ka'an. Calakmul, or officially the Ancient Maya City and Protected Tropical Forests of Calakmul, Campeche, is a Maya archaeological site in the southeastern sector of the state of Campeche in which the cultural and biological resources are protected (www.wikipedia.org; accessed 8 March 2017). Calakmul is situated within the Karstic Hills and Plains of Campeche physiographic region. This site was established as a biosphere reserve in 1989 in connection with the Man and Biosphere Programme, and as a World Heritage Site in 2002; both initiatives are products of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). The other World Heritage Site, Sian Ka'an is located in the eastern portion of Quintana Roo. This natural site contains terrestrial and marine components, as well as numerous Maya civilization sites (www.wikipedia.org; accessed 8 March 2017). Sian Ka'an lies within the Low Coast of Quintana Roo physiographic region and contains a total area of 528,148 ha, of which 375,012 ha (71.0%) comprise terrestrial and inland aquatic settings. This site was established as a biosphere reserve in 1986, and as a World Heritage Site the following year.

Beyond the two World Heritage Sites there are seven biosphere reserves (Table 20), of which only four contain terrestrial environments capable of supporting land-based members of the herpetofauna. Three of the four land-based reserves (Los Petenes, Ría Celestún, and Ría Lagartos) are located in the Yucatecan Karstic Plains region, and the fourth is situated in both the Yucatecan Karstic Plains and the Low Coast of Quintana Roo regions. The remaining three reserves are in marine locations (Table 20).

Rhinoclemmys areolata (Duméril, Bibron & Duméril, 1851). The Furrowed Wood Turtle occurs "from southern Veracruz through Tabasco and northern Chiapas, through the Yucatán Peninsula, and possibly to eastern Honduras" (Lee, 1996: 165). This individual was found on Isla Cozumel, Quintana Roo. Wilson et al. (2013a) assessed its EVS as 13, placing it at the upper limit of the medium vulnerability category. Its conservation status has been assessed as Near Threatened by the IUCN, but this species is not listed by SEMARNAT.

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Kinosternon creaseri Hartweg, 1934. Creaser's Mud Turtle is a regional endemic in the Mexican Yucatan Peninsula, ranging in the states of Campeche, Quintana Roo, and Yucatán. This individual was found 2 km NE of Cuncunul, in the municipality of Cuncunul, in the state of Yucatán. Wilson et al. (2013a) calculated its EVS as 15, placing it in the lower portion of the high vulnerability category. Its conservation status has been determined as Least Concern by the IUCN, but this turtle is not listed by SEMARNAT.

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Table 20. Characteristics of 44 Natural Protected Areas in the Mexican Yucatan Peninsula. Abbreviations in the Facilities available are as follows: A = administrative services; R = park guards; S = systems of pathways; and V = facilities for visitors. NA means that the terrestrial surface is not important for members of the herpetofauna, since it is only a small portion of the protected area.

Name	Category	Date of Decree	Total Area (ha)	Terrestrial and Inland Waters Area (ha)	Municipalities	Jurisdiction	Physiographic Regions	Facilities Available	Occupied by Landowners	Herpetofaunal Survey Completed	Management Plan Available
Laguna de Términos	Area de Protección de Flora y Fauna	6 June 1994	706,147.67	547,279	Carmen, Champoton, Palizada	Federal	Tabascan Plains and Marshes Tropical Islands of the Gulf	A, R, S, V	Yes	No	Yes
Los Petenes*	Reserva de la Biósfera	24 May 1999	282,857.62	100,867	Campeche, Calkini, Hecelchakan, Tenabo	Federal	Yucatecan Karstic Plains	A, R, S, V	Yes	No	Yes
Ría Celestún	Reserva de la Biósfera	27 November 2000	81,482.33	61,927	Calkini, Celestun, Maxcanu	Federal	Yucatecan Karstic Plains	A, R, S, V	Yes	No	Yes
Arrefice Alacranes	Parque Nacional	6 June 1994	333,768.50	53	Progreso	Federal	Tropical Islands of the Gulf	A, R, S, V	No	No	Yes
Dzibilcntún	Parque Nacional	14 March 1987	539	539	Merida	Federal	Yucatecan Karstic Plains	A, R, S, V	No	No	Yes
Ría Lagartos	Reserva de la Biósfera	21 May 1999	60,348	60,348	Lazaro Cardenas, Rio Lagartos, San Felipe, Tizimin	Federal	Yucatecan Karstic Plains	A, R, S, V	Yes	No	Yes
Yum Balam	Área de Protección de Flora y Fauna	6 June 1994	154,052.25	52,308	Isla Mujeres, Lazaro Cardenas	Federal	Yucatecan Karstic Plains	A, R, S, V	Yes	No	No
Tiburón Ballena	Reserva de la Biósfera	6 May 2009	145,988.13	—	Isla Mujeres, Lazaro Cardenas	Federal	Marine Location	A, R, V	NA	NA	Yes
Isla Contoy	Parque Nacional	2 February 1998	5,126.25	230	Isla Mujeres	Federal	Caribbean Islands of the Yucatan Península	A, R, S, V	No	No	Yes
Otoch Ma'ax Yetel Kooh	Área de Protección de Flora y Fauna	6 May 2002	5,367.42	5,367	Solidaridad, Valladolid	Federal	Yucatecan Karstic Plains	A, R, S, V	No	No	Yes

Table 20 (continued)

Name	Category	Date of Decree	Total Area (ha)	Terrestrial and Inland Waters Area (ha)	Municipalities	Jurisdiction	Physiographic Regions	Facilities Available	Occupied by Landowners	Herpetofaunal Survey Completed	Management Plan Available
Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	Parque Nacional	19 July 1996	8,673.06	0.6	Benito Juarez, Isla Mujeres	Federal	Caribbean Islands of the Yucatan Península	A, R, S, V	NA	NA	Yes
Manglares de Nichupté	Área de Protección de Flora y Fauna	26 February 2008	4,257	4,257	Benito Juarez	Federal	Yucatecan Karstic Plains	A, R, S, V	Yes	No	Yes
Arrecife de Puerto Morelos	Parque Nacional	2 February 1998	9,066.63	38	Benito Juarez	Federal	Yucatecan Karstic Plains	A, R, V	Yes	NA	Yes
La Porción Norte y la Franja Costera Oriental, Terrestres y Marinas de la Isla de Cozumel	Área de Protección de Flora y Fauna	25 September 2012	37,829.17	5,733	Cozumel	Federal	Caribbean Islands of the Yucatan Península	A, R, S, V	Yes	No	Yes
Arrecifes de Cozumel	Parque Nacional	19 July 1996	11,987.87	82	Cozumel	Federal	Caribbean Islands of the Yucatan Península	A, R, V	No	NA	Yes
Tulum	Parque Nacional	23 April 1981	664.32	664	Tulum	Federal	Yucatecan Karstic Plains	A, R, S, V	Yes	No	No
Sian Ka'an	Reserva de la Biósfera (World Heritage Site)	20 January 1986 (1987)	528,147.66 ha (Ídem)	375,011.87 ha (Ídem)	Felipe Carrillo Puerto, Othón P. Blanco, Solidaridad	Federal (International)	Low Coast of Quintana Roo	A, R, S, V	Yes	Yes	Yes
Arrecifes de Sian Ka'an	Reserva de la Biósfera	2 February 1998	34,927.15	1,361	Felipe Carrillo Puerto, Solidaridad	Federal	Low Coast of Quintana Roo	A, R, S, V	No	NA	Yes
Uaymil	Área de Protección de Flora y Fauna	17 November 1994	89,118	89,118	Felipe Carrillo Puerto, Othón P. Blanco	Federal	Low Coast of Quintana Roo	A, R, S, V	Yes	No	Yes
Banco Chinchorro	Reserva de la Biósfera	19 July 1996	144,360.00	586	Othón P. Blanco	Federal	Caribbean Islands of the Yucatan Península	A, R, S, V	No	Yes	Yes
Arrecifes de Xcalak	Parque Nacional	27 November 2000	17,949.45	4,522	Othón P.Blanco	Federal	Low Coast of Quintana Roo	A, R, S, V	Yes	No	Yes
Bala'an K'aax	Área de Protección de Flora y Fauna	5 March 2005	128,390	128,390	Jose Maria Morelos, Bacalar	Federal	Karstic Hills and Plains of Campeche	A, R, S, V	Yes	No	Yes

Table 20 (continued)

Name	Category	Date of Decree	Total Area (ha)	Terrestrial and Inland Waters Area (ha)	Municipalities	Jurisdiction	Physiographic Regions	Facilities Available	Occupied by Landowners	Herpetofaunal Survey Completed	Management Plan Available
Calakmul (Antigua Ciudad Maya y Bosques Tropicales Protegidos de Calakmul)	Reserva de la Biósfera (World Heritage Site)	23 May 1989 (2002)	723,185 (331,397)	723,185.12 ha	Calakmul, Hopelchen	Federal (International)	Karstic Hills and Plains of Campeche	A, R, S, V	Yes	Yes	Yes
Caribe Mexicano	Reserva de la Biósfera	7 December 2016	5,754,055	28,589	Benito Juárez, Isla Mujeres, Lázaro Cárdenas, Tulum, Solidaridad, Cozumel, Bacalar y Othón P. Blanco, Puerto Morelos.	Federal	Carso Yucateco Costa Baja de Quintana Roo	Unknown	Unknown	No	No
Santuario del Manatí	Zona Sujeta a Conservación Ecológica	8 March 2008	277, 734	97,734 (180,000 Has of Lagoon)	Othón P. Blanco	State	Costa Baja de Quintana Roo	A, S	Yes	Yes	Yes
Balam-kin	Zona Sujeta a Conservación Ecológica	15 December 1999	110,990	110,990	Champotón	State	Carso y Lomeríos de Campeche	A, R, S, V	Yes	Yes	Yes
Balam-ku	Zona Sujeta a Conservación Ecológica	14 August 2003	409,200	409,200	Calakmul, Candelaria, Escárcega	State	Carso y Lomeríos de Campeche	A, R, S, V	Yes	Yes	Yes
Laguna de Chankanaab	Parque Natural	26 September 1983	13.647	9	Cozumel	State	Carso Yucateco	A, S, V	Yes	No	No
Parque Kabah	Parque Urbano	10 November 1995	41.4892	41	Benito Juárez	State	Carso Yucateco	A, R, S, V	No	No	No
Xcacel-Xcacelito	Zona Sujeta a Conservación Ecológica, Santuario de la Tortuga Marina	21 February 1998	362.100	35	Tulum	State	Carso Yucateco	A,R,V	No	Yes	Yes
Laguna Manati	Zona Sujeta a Conservación Ecológica, Refugio de flora y fauna, Quintana Roo	9 Ausust 1999	2 02.990	203*	Benito Juárez	State	Carso Yucateco	A	Yes	No	No
Laguna Colombia	Parque Ecologico Quintana Roo	15 July 1996	1,130.644	1,131	Cozumel	State	Carso Yucateco	A,S	No	No	Yes
Sistema Lagunar Chichankanab	Reserva Estatal	1 April 2011	11609.732	11,610	José María Morelos	State	Carso Yucateco	A	Yes	No	No

Table 20 (continued)

Name	Category	Date of Decree	Total Area (ha)	Terrestrial and Inland Waters Area (ha)	Municipalities	Jurisdiction	Physiographic Regions	Facilities Available	Occupied by Landowners	Herpetofaunal Survey Completed	Management Plan Available
Parque Lagunar de Bacalar	Parque Ecologico Estatal	1 April 2011	5.367	5	Bacalar	State	Costa Baja de Quintana Roo, Carso Yucateco	A	Yes	No	No
Sistema Lagunar Chacmochuch	Zona Sujeta a Conservación Ecológica, Refugio Estatal de Flora y Fauna	9 August 1999	1914.52	1,690	Isla Mujeres, Benito Juárez	State	Carso Yucateco	A	No	No	No
Selvas y Humedales de Cozumel	Reserva Estatal	1 April 2011	19846.45	19,846	Cozumel	State	Carso Yucateco	A,S	Yes		Yes
Dzilam	Reserva Estatal	25 January 1989	69, 039.29	51,527	Dzilam de Bravo, San Felipe	State	Carso Yucateco	A, R, S, V	Yes	Yes	Yes
Kabah	Parque Estatal	9 June 1993	949.76	950	Santa Elena	State	Carso y Lomeríos de Campeche	A, R, S, V	Yes	No	No
San Juan Bautista Tabi y Anexa Sacnicté	Área Natural Protegida de Valor Escénico Histórico y Cultural	7 June 1994	1,355.74	1,356	Ticul	State	Carso y Lomeríos de Campeche	A, R, S, V	No	No	Yes
Lagunas de Yalahau	Parque Estatal	8 June 1999	5,683.28	5,683	Homún, Huhí, Tekit, Sotuta	State	Yucatecan Karstic Plains	A, R, S, V	Yes	No	Yes
Ciénagas y Manglares de la Costa Norte de Yucatán	Reserva Estatal	19 March 2010	54,776.726	54,777*	Hunucmá, Ucú, Progreso, Ixil, Motul, Dzemul, Telchac Puerto, Sinanché, Yobaín, Dzidzantún, Dzilam de Bravo	State	Yucatecan Karstic Plains	A,S	Yes	No	No
El Palmar	Reserva Estatal	29 January 1990	49,605.39	401,63	Hunucmá, Celestún	State	Yucatecan Karstic Plains	A, R, S, V	Yes	No	Yes
Biocultural del Puuc	Reserva Estatal	1 November 2011	135,848	135,848	Muna, Santa Elena, Oxkutzcab, Tekax, Ticul	State	Carso y Lomeríos de Campeche	A, R, S, V	Yes	Yes	No
Anillo de Cenotes	Reserva Estatal Geohidrológica	28 October 2013	219,207.83	219,208	Seyé, Acanceh, Timucuy, Homún, Cuzamá, Tecoh, Tekit, Tahmek, Hoctún, Xocchel, Hocabá, Sanahcat, Huhí	State	Yucatecan Karstic Plains	A, S	Yes	No	No

The national parks comprise the next level of significance, and, as noted above, there are eight such parks; interestingly, however, three of these are marine parks. Of the remaining five, four are located in the Yucatecan Karstic Plains region and the other in the Low Coast of Quintana Roo region.

All of the remaining seven protected areas of federal jurisdiction are Áreas de Protección de Flora y Fauna (Table 20), and this class of protected areas is more broadly represented among the physiographic regions in the Mexican Yucatan Peninsula. One of these is a marine park that also contains terrestrial environments, and all of the remaining areas consist of land-based environments. Three of the land-based protected areas are located in the Yucatecan Karstic Plains, and one each in the Tabascan Plains and Marshes, Low Coast of Quintana Roo, and Karstic Hills and Plains of Campeche.

In summary, of the 24 protected areas administered at the federal and/or international levels, seven primarily are situated in marine locations. Of the remaining 17, 10 are found within the Yucatecan Karstic Plains and one is located both in this region and in the Low Coast of Quintana Roo. Otherwise, three are located in the Low Coast of Quintana Roo, two in the Karstic Hills and Plains of Campeche, and one in the Tabascan Plains and Marshes (Table 20).

The 20 state-level protected areas in the Mexican Yucatan Peninsula represent an eclectic amalgam of several administrative designs, including *zonas sujetas a conservación ecológica* (ecological conservation zones), *parques estatales* (state parks), *parques naturales* (natural parks), *parques urbanos* (urban parks), *santuarios de la tortuga marina* (marine turtle sanctuaries), *refugios estatales de flora y fauna* (state refuges for flora and fauna), *parques ecológicos estatales* (state ecological parks), *reservas estatales* (state reserves), áreas naturales protegidas de valor escénico, histórico, y cultural (natural protected areas of scenic, historic, and cultural value), and *reservas estatales geohidrológicas* (state geohydrological reserves). The majority of these areas (14 of 20) are located in the Yucatecan Karstic Plains, with the next largest number in the Karstic Hills and Plains of Campeche (four), and the remainder (two) in the Low Coast of Quintana Roo (Table 20).

With respect to both federal/international and state level areas, evidently at both levels the greatest representation falls within the Yucatecan Karstic Plains physiographic region, which is the largest of the six regions we recognize. The next largest group of areas lies within the Karstic Hills and Plains of Campeche, which also is the next largest of the six regions. As might be expected, the smaller physiographic regions contain fewer protected areas, with the number declining from the Low Coast of Quintana Roo to the Tabascan Plains and Marshes; the latter region is represented within the Área de Protección de Flora y Fauna Laguna de Términos, which also encloses the Offshore Islands located in the named lagoon. Finally, seven of the 44 protected areas are marine reserves located at various points along the coastal perimeter of the peninsula (Table 20). Below we discuss the significance of this organization and distribution of federal/international and state protected areas to the Mexican Yucatan Peninsula herpetofauna.

The protected areas with federal jurisdiction were established from 1981 to 2016, with the majority in the decades of the 1990s and 2000s. The oldest of these areas is Parque Nacional Tulum (23 April 1981), erected to protect the 664 ha surrounding the pre-Columbian Mayan city and located in the Yucatecan Karstic Plains in coastal Quintana Roo, about 128 km south of Cancún. This national park is the third most-visited archaeological site in Mexico, after Teotihuacan and Chichen Itza (www.wikipedia.org; accessed 10 March 2017). The most recently established federal protected area (7 December 2016) is the Reserva de la Biósfera Caribe Mexicano, a very large and primarily marine reserve, with an area encompassing 5,754,055 ha (only 28,589 ha [0.5%] consists of terrestrial and inland waters). This biosphere reserve (Table 20) encloses almost all of the waters of the Mexican Caribbean and the offshore islands and coastal regions of eastern Quintana Roo. During the process of this paper's review, the possibility of creating two other federal protected areas is being discussed for the lagoon systems of Bacalar and Sayab Ha' in northeastern Quintana Roo, both of which will be raised to the category of Área de Protección de Flora y Fauna. The goal is to achieve both decrees before the end of the present federal administration (in 2018). The state-level protected areas have been erected over the three decades between 1983 and 2013 (Table 20), and most of them between 1990 and 2011. The oldest of these areas is Parque Natural Laguna de Chankanaab, a 13,647 ha facility located on Isla Cozumel (Table 20). The newest is the Reserva Estatal Geohidrológical Anillo de Cenotes, a 219,208 ha area located in the Yucatecan Karstic Plains in northwestern Yucatán, which consists of a semicircular ring of sinkholes (*cenotes*) associated with the Chicxulub crater (Table 20); the crater was created about ~65.5

million years ago by the impact of an approximately 10 km diameter asteroid, during the Cretaceous-Paleogene boundary. As widely known, this point in geological time is when the fifth mass extinction event is theorized to have occurred, which led to the loss of about 75% of all plant and animal life on Earth, including all of the non-avian dinosaurs, marine and flying reptiles, ammonites, and rudists (Shulte et al. 2010).

The protected areas in the Mexican Yucatan Peninsula vary tremendously in size (Table 20; Fig. 20). One might expect that the areas of federal and international jurisdiction generally would be larger than those administered at the state level. This generalization, however, is complicated because many of these protected areas include marine waters, which allows for expansion of given areas beyond the limits of the peninsular land surface (Table 20). Nevertheless, the land-based portion of the areas of federal and international jurisdiction ranges in size from 0.6 to 723,185 ha, and a total area of 2,697,735 ha (26977 km^2), with an average size of 112,406 ha (1,124 km^2). The land-based portions of the state-level areas range in size from 5.3 to 409,200 ha, and a total area of 1,162,006 (11,620 km^2), with an average size of 58,100 ha. The federal and state-level areas total 3,859,741 ha (38,597 km^2). This figure represents 30.5% of the total land surface of the Mexican Yucatan Peninsula, which is about 2.8 times the percentage (11%) for the entire country of Mexico (www.wikipedia.org; accessed 15 March 2017).

We catalogued the types of facilities available in the 44 protected areas (Table 20) into four categories (administrative services, park guards, systems of pathways, and facilities for visitors). The full range of facilities is available in 29 of the 44 areas. Five of the remaining 15 areas have administrative services and systems of pathways, four have administrative services, park guards, and facilities for visitors, four have administrative services only, and one has administrative services, systems of pathways, and facilities for visitors. This type of information was unknown in only a single case. This situation is rather different from that reported for Nuevo León (Nevárez-de los Reyes et al., 2016) in terms of the range of services available, or for Nayarit (Woolrich-Piña et al., 2016) with respect to the number of protected areas designated.

Unfortunately, only 12 of the 44 protected areas are unoccupied by landowners. In 29 cases, however, they are; in two cases, this question does not apply, and in one the answer is unknown. The advisability of moving landowners in the Mexican Yucatan Peninsula from the protected areas they occupy is a management goal worthy of consideration for future planning, but the landowners would have to be compensated fairly.

Management plans are available for 33 of the 44 protected areas (75.0%), but not for the remaining 11. Obviously, one of the management goals would be to construct plans for these areas, as any real efforts to conserve the biological resources of these areas would be contingent upon their completion.

A significant problem with the protected areas system in the Mexican Yucatan Peninsula is that relatively few herpetofaunal surveys have been completed. For the 44 areas, surveys are available for only nine. In five of the areas, herpetofaunal surveys are not necessary (indicated as “NA” in Table 20), because the area available to the terrestrial herpetofauna is too small to be of importance. Obviously, a major goal for conservation efforts in most of the protected areas in the peninsula is to conduct comprehensive herpetofaunal surveys in the near future. Given the extent of this problem, however, completing this goal will be a major undertaking.

We made a concerted effort to assist in the completion of herpetofaunal surveys for the protected areas of the Mexican Yucatan Peninsula. This effort resulted in the compilation of the available information on the herpetofaunal content of 26 of the 44 protected areas (59.1%) identified in Table 20; we placed this compilation in Table 21.

We found the results of this effort relatively amazing, since the list of herpetofaunal species in Table 21 includes all but 11 of those recorded from the Mexican Yucatan Peninsula (i.e., 134 of 145 species). These 11 species are as follows: *Craugastor loki*, *Engystomops pustulosus*, *Celestus rozellae*, *Ctenosaura alfredschmidti*, *Sceloporus teapensis*, *Holcosus stuarti*, *Pseudelaphe phaescens*, *Tantilla schistosa*, *Ninia diademata*, *Nerodia rhombifer*, and *Chelydra rossignonii*. Only one of these species (*P. phaescens*) is a regional endemic. Of the previous MCS studies, this is the first time we experienced such a result (92.4%). The following percentages were presented in four of these studies: 63.0% in Tamaulipas (Terán-Juárez et al., 2016); 72.0% in Nayarit (Woolrich-Piña et al., 2016); 83.5% in Nuevo León (Nevárez-de los Reyes et al., 2016); and 69.5% in Jalisco (Cruz-Sáenz et al., 2017). We demonstrated, therefore, that the first major step toward the goal of identifying the set of protected areas in which all members of the herpetofauna are recorded already is nearly accomplished. Only the 11 species mentioned above remain to be recorded within a protected area in the Mexican Yucatan Peninsula.

Table 21. Distribution of amphibians and reptiles in the 26 Natural Protected Areas of the Mexican Yucatan Peninsula. Abbreviations are as follows: ** = species endemic to the Mexican portion of the Yucatan Peninsula; and *** = non-native species. Single species endemic to Mexico are not represented.

Families	Natural Protected Areas																									
	Laguna de Términos	Los Petenes	Ría Celestún–El Palmar	Arrecife Alacranes	Dzibilchaltún	Ría Lagartos	Yum Balam	Isla Contoy	Otoch Ma'ax Yetel Kooh	Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	Manglares de Nichupté	Arrecife de Puerto Morelos	Cozumel complex	Tulum	Sian Ka'an complex	Banco Chinchorro	Arrecifes de Xcalak	Bala'an K'aax	Calakmul complex	Santuario del Manatí	Xcacel-xcacelito	Dzilam	Ciénegas y Manglares de la costa Norte de Yucatán	San Juan Bautista Tabi y Anexa Sacnicté	Lagunas de Yalahau	Biocultural del Puuc
Anura (22 species)																										
Bufonidae (2 species)																										
Incilius valliceps		+	+		+	+			+			+	+	+	+		+	+	+	+		+	+	+	+	
Rhinella horribilis		+	+		+	+						+	+		+		+	+	+	+		+		+	+	
Craugastoridae (1 species)																										
*Craugastor yucatanensis***												+			+											
Eleutherodactylidae (1 species)																										
*Eleutherodactylus planirostris****													+													
Hylidae (8 species)																										
Dendrosophus ebraccatus												+			+				+							
Dendrosophus microcephalus		+	+			+						+	+		+		+	+	+	+		+			+	
Scinax staufferi		+	+			+							+	+	+		+	+	+	+		+	+		+	
Smilisca baudinii	+	+	+		+	+			+			+	+	+	+		+	+	+	+		+			+	
Tlalocohyla loquax						+									+			+	+			+				
Tlalocohyla picta						+									+			+	+	+						
Trachycephalus typhonius		+	+		+	+						+	+	+	+		+	+	+	+		+			+	
Triprion petasatus		+	+		+	+									+			+	+	+		+			+	+
Leptodactylidae (2 species)																										
Leptodactylus fragilis		+	+		+	+						+	+	+	+			+	+	+		+	+		+	
Leptodactylus melanonotus		+	+			+						+			+			+	+	+		+			+	
Microhylidae (2 species)																										

Table 21 (continued)

Families	Natural Protected Areas																									
	Laguna de Términos	Los Petenes	Ría Celestún–El Palmar	Arrecife Alacranes	Dzibilchaltún	Ría Lagartos	Yum Balam	Isla Contoy	Otoch Ma'ax Yetel Kooh	Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	Manglares de Nichupté	Arrecife de Puerto Morelos	Cozumel complex	Tulum	Sian Ka'an complex	Banco Chinchorro	Arrecifes de Xcalak	Bala'an K'aax	Calakmul complex	Santuario del Manatí	Xcacel-xcacelito	Dzilam	Ciénegas y Manglares de la costa Norte de Yucatán	San Juan Bautista Tabi y Anexa Sacnicté	Lagunas de Yalahau	Biocultural del Puuc
Gastrophyrne elegans															+			+	+							
Hypopachus variolosus		+	+		+	+						+			+		+	+	+	+		+			+	
Phyllomedusidae (1 species)																										
Agalychnis callidryas						+						+			+			+	+	+						
Ranidae (2 species)																										
Lithobates brownorum	+	+	+			+						+			+			+	+	+		+	+		+	+
Lithobates vaillanti																		+	+							
Rhinophrynidae (1 species)																										
Rhinophrynus dorsalis		+	+			+					+	+			+			+	+	+		+			+	+
Caudata (3 species)																										
Plethodontidae (3 species)																										
Bolitoglossa mexicana			+																+							
Bolitoglossa rufescens														+	+				+							
Bolitoglossa yucatana		+	+		+	+						+						+	+	+		+			+	+
Crocodylia (2 species)																										
Crocodylus acutus						+	+	?		+	+		+		+	+	+			+		+				
Crocodylus moreletii	+	+	+			+	+		+	+	+	+			+		+	+	+	+		+			+	
Squamata (102 species)																										
Corytophanidae (5 species)																										
Basiliscus vittatus		+			+	+			+		+	+	+	+	+		+	+	+	+		+		+	+	
Corytophanes cristatus						+									+			+	+							
Corytophanes hernandezii																		+	+							
Laemanctus longipes																		+	+							
Laemanctus serratus					+	+			+			+			+			+	+	+		+	+	+	+	+

Table 21 (continued)

Families	Natural Protected Areas																									
	Laguna de Términos	Los Petenes	Ría Celestún–El Palmar	Arrecife Alacranes	Dzibilchaltún	Ría Lagartos	Yum Balam	Isla Contoy	Otoch Ma'ax Yetel Kooh	Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	Manglares de Nichupté	Arrecife de Puerto Morelos	Cozumel complex	Tulum	Sian Ka'an complex	Banco Chinchorro	Arrecifes de Xcalak	Bala'an K'aax	Calakmul complex	Santuario del Manatí	Xcacel-xcacelito	Dzilam	Ciénegas y Manglares de la costa Norte de Yucatán	San Juan Bautista Tabi y Anexa Sacnicté	Lagunas de Yalahau	Biocultural del Puuc
Dactyloidae (8 species)																										
Anolis allisoni																+										
Norops beckeri																			+	+						
Norops biporcatus															+				+							
Norops lemurinus		+			+	+									+			+	+	+		+				
Norops rodriguezii		+	+		+	+						+	+	+	+			+	+	+		+		+	+	
*Norops sagrei****			+			+	+	+				+	+	+	+	+		+	+	+		+	+	+	+	
Norops tropidonotus						+									+			+	+							
Norops ustus	+				+	+									+			+	+	+					+	
Eublepharidae (1 species)																										
Coleonyx elegans		+	+		+	+								+	+			+	+	+		+		+	+	+
Gekkonidae (2 species)																										
*Hemidactylus frenatus****	+	+	+			+	+						+		+	+	+	+	+	+			+		+	
*Hemidactylus turcicus****			+			+							+									+	+	+	+	
Iguanidae (3 species)																										
*Ctenosaura defensor***					+										+			+	+						+	
Ctenosaura similis	+	+	+		+	+	+	+			+	+	+	+	+	+	+	+		+	+	+	+	+	+	+
Iguana iguana	+												+			+				+						
Mabuyidae (1 species)																										
Marisora brachypoda		+		+	+	+	+	+					+		+		+	+	+	+		+	+		+	
Phrynosomatidae (4 species)																										
Sceloporus chrysostictus		+	+		+	+						+			+			+	+	+		+	+	+	+	+
*Sceloporus cozumelae***			+		+	+	+	+				+	+	+	+								+			
Sceloporus lundelli			+		+	+									+			+	+	+					+	

Table 21 (continued)

Families	Natural Protected Areas																									
	Laguna de Términos	Los Petenes	Ría Celestún–El Palmar	Arrecife Alacranes	Dzibilchaltún	Ría Lagartos	Yum Balam	Isla Contoy	Otoch Ma'ax Yetel Kooh	Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	Manglares de Nichupté	Arrecife de Puerto Morelos	Cozumel complex	Tulum	Sian Ka'an complex	Banco Chinchorro	Arrecifes de Xcalak	Bala'an K'aax	Calakmul complex	Santuario del Manatí	Xcacel-xcacelito	Dzilam	Ciénegas y Manglares de la costa Norte de Yucatán	San Juan Bautista Tabi y Anexa Sacnicté	Lagunas de Yalahau	Biocultural del Puuc
Sceloporus serrifer					+	+																+			+	
Phyllodactylidae (2 species)																										
Phyllodactylus tuberculosus															+											
Thecadactylus rapicauda		+			+	+									+			+	+			+		+	+	
Scincidae (2 species)																										
Mesoscincus schwartzei					+	+							+		+			+	+			+			+	+
Plestiodon sumichrasti						+									+			+	+	+						
Sphaerodactylidae (4 species)																										
Aristelliger georgeensis								+					+			+										
*Sphaerodactylus argus****						+																				
Sphaerodactylus continentalis													+		+											
Sphaerodactylus glaucus	+	+			+	+						+	+		+			+	+	+			+		+	
Sphenomorphidae (1 species)																										
Scincella cherriei		+													+			+	+	+						
Teiidae (7 species)																										
Aspidoscelis angusticeps			+		+	+									+			+	+	+		+	+	+	+	+
*Aspidoscelis cozumela***													+		+		+									
Aspidoscelis deppii																			+							
Aspidoscelis maslini															+	+				+						
*Aspidoscelis rodecki***							+	+				+														
*Holcosus gaigeae***		+				+						+			+			+				+	+	+	+	
Holcosus hartwegi																			+	+						
Xantusiidae (1 species)																										
Lepidophyma flavimaculatum															+											

Table 21 (continued)

Families	Natural Protected Areas																								
	Laguna de Términos	Los Petenes	Ría Celestún–El Palmar	Arrecife Alacranes	Dzibilchaltún	Ría Lagartos	Yum Balam	Isla Contoy	Otoch Ma'ax Yetel Kooh	Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	Manglares de Nichupté	Arrecife de Puerto Morelos	Cozumel complex	Tulum	Sian Ka'an complex	Banco Chinchorro	Arrecifes de Xcalak	Bala'an K'aax	Calakmul complex	Santuario del Manatí	Xcacel-xcacelito	Dzilam	Ciénegas y Manglares de la costa Norte de Yucatán	San Juan Bautista Tabi y Anexa Sacnicté	Lagunas de Yalahau	Biocultural del Puuc
Boidae (1 species)																										
Boa imperator	+	+	+		+	+		+			+	+	+	+	+	+	+	+	+	+		+	+	+	+	+
Colubridae (20 species)																										
Drymarchon melanurus		+				+						+			+			+	+	+					+	
Drymobius margaritiferus	+	+				+						+		+	+		+	+	+	+		+		+	+	
Ficimia publia					+	+									+			+	+	+		+			+	
Lampropeltis abnorma		+			+	+												+	+	+				+	+	+
Leptophis ahaetulla						+					+				+			+	+							+
Leptophis mexicanus		+			+	+								+	+			+	+	+		+		+	+	+
Masticophis mentovarius		+				+						+						+							+	
Mastigodryas melanolomus		+			+	+							+		+			+	+	+		+			+	
Oxybelis aeneus	+					+		+						+	+		+	+	+	+					+	
Oxybelis fulgidus		+				+							+					+	+	+		+			+	
Phrynonax poecilonotus						+								+	+			+	+	+					+	
Pseudelaphe flavirufa		+			+	+												+	+	+		+			+	
Senticolis triaspis					+	+												+	+			+			+	
Spilotes pullatus		+				+						+			+		+		+	+					+	
Stenorrhina freminvillii					+	+												+		+		+			+	
Symphimus mayae		+			+	+	+								+			+	+						+	+
Tantilla cuniculator			+			+												+							+	
Tantilla moesta					+	+							+					+							+	
Tantillita canula					+	+												+	+						+	
Tantillita lintoni																			+	+						

Table 21 (continued)

Families	Laguna de Términos	Los Petenes	Ría Celestún–El Palmar	Arrecife Alacranes	Dzibilchaltún	Ría Lagartos	Yum Balam	Isla Contoy	Otoch Ma'ax Yetel Kooh	Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	Manglares de Nichupté	Arrecife de Puerto Morelos	Cozumel complex	Tulum	Sian Ka'an complex	Banco Chinchorro	Arrecifes de Xcalak	Bala'an K'aax	Calakmul complex	Santuario del Manatí	Xcacel-xcacelito	Dzilam	Ciénegas y Manglares de la costa Norte de Yucatán	San Juan Bautista Tabi y Anexa Sacnicté	Lagunas de Yalahau	Biocultural del Puuc
	Natural Protected Areas																									
Dipsadidae (20 species)																										
Coniophanes bipunctatus		+	+			+						+											+			
Coniophanes imperialis	+	+	+			+									+			+	+	+		+		+	+	
*Coniophanes meridanus***					+	+												+							+	
Coniophanes quinquevittatus																							+			
Coniophanes schmidti		+			+	+									+			+	+	+		+			+	
Conophis lineatus	+				+	+		+				+		+									+		+	
Dipsas brevifacies		+				+						+			+		+	+	+	+		+			+	
Imantodes cenchoa						+									+			+	+	+						
Imantodes gemmistratus					+	+												+	+						+	
Imantodes tenuissimus		+			+	+												+	+				+		+	
Leptodeira frenata		+			+	+							+		+		+	+	+	+					+	
Leptodeira septentrionalis						+												+	+							
Ninia sebae		+	+		+	+									+			+	+	+					+	
Pliocercus elapoides						+									+				+							
Sibon nebulatus						+												+	+							
Sibon sanniolus					+	+									+			+	+	+		+			+	
Tretanorhinus nigroluteus															+											
Tropidodipsas fasciata						+													+						+	
Tropidodipsas sartorii			+		+	+								+	+			+	+						+	
Xenodon rabdocephalus						+												+	+							
Elapidae (1 species)																										
Micrurus diastema		+	+		+	+			+			+			+			+	+	+		+		+	+	

Table 21 (continued)

Families	Natural Protected Areas																									
	Laguna de Términos	**Los Petenes**	**Ría Celestún–El Palmar**	**Arrecife Alacranes**	**Dzibilchaltún**	**Ría Lagartos**	**Yum Balam**	**Isla Contoy**	**Otoch Ma'ax Yetel Kooh**	**Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc**	**Manglares de Nichupté**	**Arrecife de Puerto Morelos**	**Cozumel complex**	**Tulum**	**Sian Ka'an complex**	**Banco Chinchorro**	**Arrecifes de Xcalak**	**Bala'an K'aax**	**Calakmul complex**	**Santuario del Manatí**	**Xcacel-xcacelito**	**Dzilam**	**Ciénegas y Manglares de la costa Norte de Yucatán**	**San Juan Bautista Tabi y Anexa Sacnicté**	**Lagunas de Yalahau**	**Biocultural del Puuc**
Leptotyphlopidae (2 species)																										
Epictia magnamaculata													+													
Epictia vindumi					+																		+			
Natricidae (2 species)																										
Thamnophis marcianus												+			+				+							
Thamnophis proximus		+	+			+					+	+	+		+			+		+						+
Sibynophiidae (1 species)																										
Scaphiodontophis annulatus																				+						
Typhlopidae (2 species)																										
Amerotyphlops microstomus					+													+	+	+					+	
*Indotyphlops braminus****													+							+						
Viperidae (4 species)																										
Agkistrodon russeolus						+												+	+	+		+		+	+	+
Bothrops asper						+			+			+			+		+	+	+	+	+	+				+
Crotalus tzabcan		+	+			+									+		+	+	+	+		+		+	+	+
*Porthidium yucatanicum***						+			+						+			+						+	+	
Testudines (16 species)																										
Cheloniidae (4 species)																										
Caretta caretta			+	+		+	+	+		+		+	+		+	+	+			+	+		+			
Chelonia mydas				+		+	+	+		+	+	+	+	+	+	+	+			+	+		+			
Eretmochelys imbricata			+	+		+	+	+		+		+	+	+	+	+	+			+		+	+			
Lepidochelys kempii	?						?	?														?	?			
Dermatemydidae (1 species)																										
Dermatemys mawii	+																			+						

Table 21 (continued)

Families	Natural Protected Areas																									
	Laguna de Términos	**Los Petenes**	**Ría Celestún–El Palmar**	**Arrecife Alacranes**	**Dzibilchaltún**	**Ría Lagartos**	**Yum Balam**	**Isla Contoy**	**Otoch Ma'ax Yetel Kooh**	**Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc**	**Manglares de Nichupté**	**Arrecife de Puerto Morelos**	**Cozumel complex**	**Tulum**	**Sian Ka'an complex**	**Banco Chinchorro**	**Arrecifes de Xcalak**	**Bala'an K'aax**	**Calakmul complex**	**Santuario del Manatí**	**Xcacel-xcacelito**	**Dzilam**	**Ciénegas y Manglares de la costa Norte de Yucatán**	**San Juan Bautista Tabi y Anexa Sacnicté**	**Lagunas de Yalahau**	**Biocultural del Puuc**
Dermochelyidae (1 species)																										
Dermochelys coriacea				+		+	+	+		+			+		+	+	+					+				
Emydidae (2 species)																										
*Terrapene yucatana***			+			+												+	+			+			+	
Trachemys venusta	+	+	+			+			+		+	+	+	+	+			+	+	+		+			+	
Geoemydidae (1 species)																										
Rhinoclemmys areolata		+	+		+	+					+	+	+		+		+	+	+	+		+	+		+	+
Kinosternidae (4 species)																										
Kinosternon acutum																		+	+							
*Kinosternon creaseri***						+						+			+			+	+	+					+	+
Kinosternon leucostomum		+				+								+	+			+	+	+						
Kinosternon scorpioides	+	+	+			+					+	+	+		+			+	+	+		+	+		+	+
Staurotypidae (2 species)																										
Claudius angustatus																			+							
Staurotypus triporcatus	+	+													+			+	+							
Totals (134 species)	**17**	**52**	**40**	**5**	**49**	**96**	**13**	**13**	**9**	**6**	**12**	**44**	**38**	**23**	**87**	**13**	**27**	**91**	**95**	**75**	**4**	**54**	**26**	**22**	**74**	**22**

The number of species recorded in the 26 protected areas (Table 21) ranges from a low of four in Xcacel-Xcacelito, an ecological conservation zone and sea turtle sanctuary located in the Yucatecan Karstic Plains, to 96 in Ría Lagartos, a biosphere reserve also located in the Yucatecan Karstic Plains.

Three of the protected areas are known to contain more than 90 species (Table 21), and thus they are the most important in the peninsula. The Ría Lagartos reserve is noted above, and the other two areas are the Calakmul complex (95 species) and Bala'an K'aax (91). In combination, these three protected areas are host to a total of 114 species (85.1% of the total of 134). Interestingly, only seven species are added when the protected area with the next largest number (87) is added (the Sian Ka'an complex). Another five species are added when considering the Santuario del Manatí, leaving eight species to be accounted for among the remaining areas.

Of the 134 species recorded from the 26 protected areas listed in Table 20, 118 are non-endemics (88.0%), 10 are regional endemics (7.5%), and six are non-natives (4.5%; Table 22). The 118 non-endemic species comprise 92.9% of the 127 known from the Mexican Yucatan Peninsula. Of these 118 species, the most broadly represented within the protected areas are *Ctenosaura similis* (22 of 26 areas) and *Boa imperator* (21). The 10 regional endemics make up 90.9% of the 11 species recorded from the area; as noted above, *Pseudelaphe phaescens* is not represented. The most widely occurring of the regional endemics are *Sceloporus cozumelae* (10 of 26 areas) and *Holcosus gaigeae* (nine). The single Mexican endemic species, *Holcosus stuarti*, is not recorded in any protected area. Finally, although their presence within protected areas is not desirable, all six non-native species are recorded from one or more of these areas. The most widely distributed of these non-native species are *Norops sagrei* (found in 16 of 26 areas) and *Hemidactylus frenatus* (14).

Table 22. Summary of the distributional status of the herpetofaunal species in protected areas in the Mexican Yucatan Peninsula. Totals = total number of species recorded in all of the listed protected areas. The single country endemic is not included.

Protected Areas	Number of Species	Distributional Status		
		Non-endemic (NE)	Regional Endemic (RE)	Non-native (NN)
Laguna de Términos	17	16	—	1
Los Petenes	52	50	1	1
Ría Celestún–El Palmar	40	35	2	3
Arrecife Alacranes	5	5	—	—
Dzibilchaltún	49	46	3	—
Ría Lagartos	96	86	6	4
Yum Balam	13	9	2	2
Isla Contoy	13	10	2	1
Otoch Ma'ax Yetel Kooh	9	8	1	—
Costa Occidental de Isla Mujeres, Punta Cancún y Punta Nizuc	6	6	—	—
Manglares de Nichupté	12	12	—	—
Arrecife de Puerto Morelos	44	38	5	1
Cozumel Complex	38	31	2	5
Tulum	23	21	1	1
Sian Ka'an Complex	87	78	7	2
Banco Chinchorro	13	11	—	2
Arrecifes de Xcalak	27	25	1	1
Bala'an K'aax	91	83	6	2
Calakmul Complex	95	90	3	2
Santuario del Manatí	75	71	1	3
Xcacel-xcacelito	4	4	—	—
Dzilam	54	50	2	2

Ciénegas y Manglares de la Costa Norte de Yucatán	26	21	2	3
San Juan Bautista Tabi y Anexa Sacnicté	22	18	2	2
Lagunas de Yalahau	74	65	6	3
Biocultural del Puuc	22	21	1	—
Totals	**134**	**118**	**10**	**6**

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

A. The herpetofauna of the Mexican Yucatan Peninsula currently is comprised of 145 species, including 22 anurans, three salamanders, two crocodylians, 102 squamates, and 16 turtles. The number of native species is 139, which represents 11.0% of the 1,269 species presently known from Mexico.

B. The number of herpetofaunal species distributed among the six physiographic regions we recognize in the Mexican Yucatan Peninsula ranges from 43 in the Gulf Islands to 120 in the Karstic Hills and Plains of Campeche.

C. The species shared between the four physiographic regions range from 28 between the Offshore Islands and the Tabascan Plains and Marshes, as well as between the Offshore Islands and the Karstic Hills and Plains of Campeche, to 104 between the Karstic Hills and Plains of Campeche and the Yucatecan Karstic Plains. The CBR values range from 0.44 between the Caribbean Islands and the Karstic Hills and Plains of Campeche to 0.88 between the Karstic Hills and Plains of Campeche and the Low Coast of Quintana Roo. The UPGMA analysis indicates that the four mainland physiographic regions are most closely related to one another, and that they are relatively distinct from the two insular regions.

D. A moderately low level of herpetofaunal endemism exists within the Mexican Yucatan Peninsula. Of the 145 species reported from the peninsula, only 11 are regional endemics (i.e., restricted to the peninsula) and one is a country endemic (the total of 12 species is 8.3% of the peninsular total). This limited level of endemism is due to the large number of species shared between the Mexican Yucatan Peninsula and Central America (126; 86.9%).

E. The distributional status of members of the Mexican Yucatan Peninsula herpetofauna is as follows (in descending order of the four categories): non-endemic species (127; 87.6% of 145 species); regional endemics (11; 7.6%); non-native species (six; 4.1%); and country endemics (one; 0.7%).

F. The principal environmental threats in the Mexican Yucatan Peninsula include agriculturally induced deforestation, hurricanes and other tropical storms, forest fires, tourist development, infectious diseases, invasive species, climate change, and illegal collecting, oil mining, killing on roads, and other forms of direct and incidental killing.

G. We utilized the SEMARNAT (NOM-059), IUCN, and EVS systems to evaluate the conservation status of members of the peninsular herpetofauna. As in previous studies we found the SEMARNAT system to be of limited utility, since only 38.1% of the native species have been assessed. Of the species evaluated, eight are placed in the endangered (P) category, nine in the threatened (A) category, and 36 in the special protection (Pr) category.

H. The IUCN system of conservation assessment is the most widely used in the world. Nonetheless, the effectiveness of this system as applied to the Mesoamerican herpetofauna has been criticized in several studies. With regard to the herpetofauna of the Mexican Yucatan Peninsula, the category, number, and percentage for the 139 native species are as follows: CR (three; 2.2%); EN (one; 0.7%); VU (six; 4.3%); NT (8; 5.8%); LC (84; 60.4%); and NE (37; 26.6%). No species have been allocated to the DD category.

I. The EVS system of conservation assessment is designed to work around the deficiencies of the other systems commonly used in Mexico. We calculated the EVS values for the 134 native non-marine species recorded in the Mexican Yucatan Peninsula, and organized them into three categories of low (3–9), medium (10–13), and high scores (14–20). Accordingly, the species numbers decrease, respectively, from 57 (low; 42.5% of the 134 species for which these scores can be calculated), to 51 (medium; 38.1%), and to 26 (high; 19.4%).

J. A comparison of the IUCN and EVS conservation status categorizations indicates that only 19.2% of the high vulnerability species have been placed in one of the two IUCN threat categories applicable to the Yucatan herpetofauna, and that about 1.5 times the number of low vulnerability species has been allocated to the LC category. Thus, these two systems of conservation assessment do not agree closely with one another.

K. An assessment of the conservation status of the species placed in the NE and LC categories by the IUCN, compared to their respective EVS categorizations, demonstrates that many of the IUCN categorizations are ill-determined and should be reassigned to other categories to more properly indicate their prospects for survival.

L. We utilized the Relative Herpetofaunal Priority (RHP) measure to ascertain the conservation significance of the six regional herpetofaunas in the Mexican Yucatan Peninsula. One method of calculating the RHP involves adding the country and state endemics, and by using this method we found the conservation importance of the regional herpetofaunas to be greatest for the Yucatecan Karstic Plains, next greatest for the Karstic Hills and Plains of Campeche, the Low Coast of Quintana Roo, the Tabascan Plains and Marshes, the Caribbean Island, and, finally, the Gulf Islands. The other method of determining the RHP is based on the number of high vulnerability species, and by utilizing this method we found the following ranking, from high to low: the Yucatecan Karstic Plains; the Karstic Hills and Plains of Campeche; the Low Coast of Quintana Roo; the Tabascan Plains and Marshes; the Caribbean Islands; and the Gulf Islands. The rankings elucidated by these two RHP methods are nearly the same, except that when using the first method two regions (the Low Coast of Quintana Roo and the Tabascan Plains and Marshes) occupy the same rank (number 3).

M. We constructed a table of 44 protected areas in the Mexican Yucatan Peninsula and included a list of their salient features; 24 of these areas are under federal and/or international jurisdiction, and 20 are under state-level jurisdiction. Given that the sea bounds this peninsula to the west, north, and east, several of these protected areas encompass, either partially or entirely, marine environments of potential importance for sea turtles. Two of the federal/international areas are World Heritage Sites, established to protect both biological and cultural resources. The remaining federal/international protected areas have been established as biosphere reserves, national parks, and Áreas de Protección de Flora y Fauna. Most of the land-based areas are located within the Yucatecan Karstic Plains and/or the Low Coast of Quintana Roo. The least well-represented physiographic regions are the Karstic Hills and Plains of Campeche and the Tabascan Plains and Marshes. The Offshore Islands region is represented in the Área de Protección de Flora y Fauna Laguna de Términos (the Gulf island of Carmen) and the Reserva de la Biósfera Caribe Mexicano (islands along the Mexican Caribbean, including Cozumel and Isla Mujeres). The 20 state-level protected areas include a broad array of administrative types designed to protect the biological, cultural, historical, and/or scenic resources. As with the protected areas of federal and/or international jurisdiction, the majority of the state-level protected areas are located in the Yucatecan Karstic Plains regions, with the remainder in the Karstic Hills and Plains of Campeche and the Low Coast of Quintana Roo.

N. The available information on the distribution of the herpetofauna among 26 protected areas indicates that 134 of the total of 145 species in the Mexican Yucatan Peninsula are recorded from one or more of these areas, which is the highest proportion (92.4%) seen thus far in the MCS studies. Three of the 26 areas are of greatest importance, the Ría Lagartos (with 96 species), the Calakmul complex (95), and the Bala'an K'aax (91).

O. Future herpetofaunal conservation efforts in the Mexican Yucatan Peninsula should be directed toward determining where the 11 species currently not recorded from any protected area can be found. Moreover, herpetofaunal surveys also should be conducted in protected areas where they are lacking.

Recommendations

A. In this study, our principal interest was in evaluating the conservation status of members of the herpetofauna of the Mexican Yucatan Peninsula. By using the EVS methodology, we found that the numbers of species allocated to the three categories of vulnerability decrease from low through medium to high. This pattern differs from that reported in most other MCS studies, in which the numbers generally increase from low through medium to high. The reason for this differing pattern is because of the relatively small number of regional and state-level endemics (12 of 145 species). Thus, slightly more than 90% of the species are non-endemic to this portion of the Yucatan Peninsula. Even given this situation, our use of the Relative Herpetofaunal Priority methods demonstrates that the physiographic region of greatest significance is the Yucatecan Karstic Plains, located in the northern and northeastern portions of the Mexican Yucatan Peninsula. Based on these conclusions, we recommend that the conservation needs of the herpetofauna should focus most heavily on this region, with appropriate attention given to the remaining physiographic regions.

B. Again in contrast to the situation in other MCS studies, we found that a large proportion of the herpetofauna (134 of 145 species) has been recorded in one or more of the 26 protected areas for which we were able to assemble herpetofaunal lists; this proportion is the highest found thus far in the MCS studies. Three of these 26 protected areas contain more than 90 species (of 139 native species). Our next most fundamental recommendation is to find locations within protected areas for the 11 species not currently recorded. One of these is the regional endemic *Pseudelaphe phaescens*.

C. Once the occupancy of one or more protected areas has been assured for all 139 native members of the herpetofauna, the next step would be to determine the sustainability of populations for all of these species within the system of protected areas in the Mexican Yucatan Peninsula.

D. Given that the herpetofauna comprises only one of many interrelated faunal and floral groups within the Mexican Yucatan Peninsula, assessing the sustainability of populations of all of these animals should be made within the system of protected areas.

E. As established in other MCS studies, the system of protected areas and its resident organisms is interrelated with the human societies occupying the Mexican Yucatan Peninsula. Thus, conservation efforts should be integrated with other human activities, especially those of people living in the vicinity of (or within) these protected areas.

F. Efforts at herpetofaunal conservation will need to proceed as rapidly as possible, given the rate at which the human occupants are transforming the environments in the Mexican Yucatan Peninsula.

"Yet it's on this connection [with the natural world] that the future of both humanity and the natural world will depend. And surely, it is our responsibility to do everything within our power to create a planet that provides a home not just for us, but for all life on Earth."

—David Attenborough (2016)

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The ancient Maya enjoyed a deep, abiding relationship with the herpetofauna of the areas they occupied in Mesoamerica (Lee, 1996), and this cultural connection is exemplified by the image we chose to conclude this paper. Pictured here is temple II of Chicannáh, a Mayan city in Campeche. The name of the city was based on this temple, and was derived from the Yucatec Maya words *chi'* (= mouth), *can* (or *kaan* [= snake]), *nah* (or *naaj* [= house]), meaning "the house with the snake mouth."

Victor Hugo González-Sánchez is a Ph.D. student from El Colegio de la Frontera Sur (ECOSUR). His main interests are studying species diversity and distributional patterns, and his experiences include wildlife monitoring and research, and ecological restoration. Previously he was an Associate Professor at the Universidad Autónoma de Aguascalientes, where he taught courses in biological diversity and environmental impact. Victor also has been involved in environmental education and wildlife monitoring through the group "Conservación de la Biodiversidad del Centro de México A.C.," of which he is a co-founding member. Additionally, he was the coordinator of the faunal control and birdstrike prevention program at the Chetumal International Airport, and a technical consultant for the same program at the Benito Juárez International Airport, in Mexico City. Finally, Víctor was coordinator of the Seabird Restoration Program on the Pacific Islands of Baja California.

Jerry D. Johnson is Professor of Biological Sciences at The University of Texas at El Paso, and has extensive experience studying the herpetofauna of Mesoamerica, especially that of southern Mexico. Jerry is the Director of the 40,000-acre "Indio Mountains Research Station," was a co-editor on *Conservation of Mesoamerican Amphibians and Reptiles* and co-author of four of its chapters. He also is the senior author of the recent paper "A conservation reassessment of the Central American herpetofauna based on the EVS measure" and is the Mesoamerica/Caribbean editor for the Geographic Distribution section of *Herpetological Review*. Johnson has authored or co-authored over 100 peer-reviewed papers, including two 2010 articles, "Geographic distribution and conservation of the herpetofauna of southeastern Mexico" and "Distributional patterns of the herpetofauna of Mesoamerica, a Biodiversity Hotspot." One species, *Tantilla johnsoni*, has been named in his honor. Presently, he is an Associate Editor and Co-chair of the Taxonomic Board for the journal *Mesoamerican Herpetology*.

Elí García-Padilla is a herpetologist primarily focused on the study of the ecology and natural history of the Mexican herpetofauna. His research efforts have centered on the Mexican states of Baja California, Tamaulipas, Chiapas, and Oaxaca. His first experience in the field was researching the ecology of insular populations of the rattlesnakes *Crotalus tortugensis* (= *C. atrox*), *C. muertensis* (= *C. pyrrhus*), and the endemic *C. catalinensis* in the Gulf of California. For his Bachelor's degree he presented a thesis on the ecology of *C. muertensis* (= *C. pyrrhus*) on Isla El Muerto, Baja California, Mexico. To date, he has authored or co-authored over 70 peer-reviewed scientific publications. Currently, he is employed as a formal Curator of Reptiles from Mexico in the electronic platform "Naturalista" of the Comisión Nacional para el Uso y Conocimiento de la Biodiversidad (CONABIO; www.naturalista.mx). One of his main passions is environmental education, and for several years he has been working on a variety of projects that include the use of audiovisual media as a powerful tool to reach large audiences and to promote the importance of the knowledge, protection, and conservation of the Mexican biodiversity. Elí's interests include wildlife and conservation photography, and his art has been published in several recognized scientific, artistic, and educational books, magazines, and websites.

Vicente Mata-Silva is a herpetologist from Río Grande, Oaxaca, Mexico. His interests include ecology, conservation, natural history, and geographic distribution of the herpetofaunas of Mexico (particularly Oaxaca) and the southwestern United States. He earned his Bachelor's degree at the Universidad Nacional Autónoma de México (UNAM), and his thesis focused on a comparison of herpetofaunal richness in Puebla, Mexico, in habitats with different degrees of human-related disturbance. Vicente's Master's thesis at the University of Texas at El Paso (UTEP) focused primarily on the diet of two syntopic whiptail lizard species, one unisexual and the other bisexual, in the Trans-Pecos region of the Chihuahuan Desert. He earned a Ph.D., also at UTEP, and his dissertation was on the ecology of the Rock Rattlesnake, *Crotalus lepidus*, in the northern Chihuahuan Desert. To date, Vicente has authored or co-authored over 100 peer-reviewed scientific publications. Currently, he is a researcher, lecturer, and departmental advisor at the University of Texas at El Paso. He also is the Distribution Notes Section Editor for the journal *Mesoamerican Herpetology*.

Dominic L. DeSantis currently is a Ph.D. candidate and National Science Foundation-Graduate Research Fellow at the University of Texas at El Paso, in the Ecology and Evolutionary Biology program. He received his Bachelor's degree at Texas State University, where he also completed multiple research projects on the antipredator behavior of the Critically Endangered Barton Springs Salamander (*Eurycea sosorum*). His ongoing dissertation research integrates radio-telemetry with recent advances in animal biotelemetry technologies, to study movement and behavioral ecology in the Western Diamond-backed Rattlesnake (*Crotalus atrox*). Dominic accompanied Vicente Mata-Silva, Elí García-Padilla, and Larry David Wilson on survey and collecting trips to Oaxaca in 2015, 2016, and 2017, and is a co-author on numerous natural history publications resulting from those visits. To date, Dominic has authored or co-authored 40 peer-reviewed scientific publications.

Larry David Wilson is a herpetologist with lengthy experience in Mesoamerica. He has authored or co-authored 380 peer-reviewed papers and books on herpetology, including two papers published in 2013 entitled "A conservation reassessment of the amphibians of Mexico based on the EVS measure" and "A conservation reassessment of the reptiles of Mexico based on the EVS measure," one in 2014 entitled "Snakes of the genus *Tantilla* (Squamata: Colubridae) in Mexico: taxonomy, distribution, and conservation," four in 2015 entitled "A conservation reassessment of the Central American herpetofauna based on the EVS measure," "The herpetofauna of Oaxaca, Mexico: composition, physiographic distribution, and conservation status," "The herpetofauna of Chiapas, Mexico: composition, distribution, and conservation," and "A checklist and key to the snakes of the *Tantilla* clade (Squamata: Colubridae), with comments on taxonomy, distribution, and conservation," and three in 2016 entitled "The herpetofauna of Tamaulipas: composition, distribution, and conservation," "The herpetofauna of Nayarit: composition, distribution, and conservation status," and "The herpetofauna of Nuevo León: composition, distribution, and conservation." He is also a coauthor of a 2017 paper entitled "The herpetofauna of Jalisco, Mexico: composition, distribution, and conservation status." Larry is the senior editor of *Conservation of Mesoamerican Amphibians and Reptiles* and the co-author of seven of its chapters. His other books include *The Snakes of Honduras*, *Middle American Herpetology*, *The Amphibians of Honduras*, *Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras*, *The Amphibians and Reptiles of the Honduran Mosquitia*, and *Guide to the Amphibians & Reptiles of Cusuco National Park, Honduras*. To date, he has authored or co-authored the descriptions of 71 currently recognized herpetofaunal species, and seven species have been named in his honor, including the anuran *Craugastor lauraster*, the lizard *Norops wilsoni*, and the snakes *Oxybelis wilsoni*, *Myriopholis wilsoni*, and *Cerrophidion wilsoni*. Currently, Larry is an Associate Editor and Co-chair of the Taxonomic Board for the journal *Mesoamerican Herpetology*.