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Conservation status of *Sceloporus* lizards

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Abstract.—*Sceloporus* is a diverse genus of lizards that has been widely studied regarding its evolution, behavior, and ecology. Although evidence suggests *Sceloporus* lizards are threatened by several factors, there are few studies concerning their conservation issues and status. Here we analyzed the conservation status of species of the genus *Sceloporus* based on two different systems: the IUCN Red List and the Environmental Vulnerability Scores (EVS) system. We updated the taxonomic state of the genus, investigated the conservation status of the existing species, calculated the EVS for previously unevaluated species, and generated potential distribution maps of all species based on species distribution modelling. We determined that 116 species of *Sceloporus* are currently recognized. For conservation status, we found differences between the IUCN Red List and the EVS system. According to the Red List, 64 species are in the Least Concern category, two Near Threatened, three Vulnerable, three Endangered, and one Critically Endangered (and 38 Not Evaluated); however, based on the EVS system, most of the species (69) are in the high vulnerability category, 37 in the medium category, and 10 in the low category. About half of the species in the high vulnerability category in the EVS either have not been evaluated, are deficient in data, or are of Least Concern in the IUCN Red list. Of the 116 species, we assigned 46 to conservation priority level I. Because *Sceloporus* is a widely distributed genus and there have been new cryptic species discovered, the information provided here is vital for the conservation of the genus, since it will allow us to identify *Sceloporus* species urgently in need of conservation.

Keywords. Conservation priority levels, distribution, endemic species, environmental vulnerability score, IUCN Red List, taxonomic update

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Introduction

The latest Global Assessment on Biodiversity and Ecosystem Services stated: "Nature is now declining globally at rates unprecedented in human history" (IPBES 2019). According to this assessment, approximately 1,000,000 species are threatened with extinction due to five direct drivers: 1) changes in land and sea use; 2) direct exploitation of organisms; 3) climate change; 4) pollution, and 5) invasive species (IPBES 2019). Identifying species at risk of extinction is essential for addressing this biological crisis (Böhm et al. 2016).

Even though the extinction crisis has been explored for some groups of invertebrates (Dirzo et al. 2014) and vertebrates (Ceballos et al. 2015), reptiles as a group have received less attention and are often overlooked when it comes to conservation assessments (Gibbons et al. 2000; Todd et al. 2010; Böhm et al. 2013, 2016; Saha et al. 2018). There is also evidence that the five direct drivers of extinction act on reptile populations (see Todd et al. 2010 and Fitzgerald et al. 2018 for reviews).

Böhm et al. (2013) conducted the first global

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assessment of extinction risk for reptiles based on the IUCN Red List categories of 1,500 species. They found that 20% of the world's reptiles were threatened and 21% of the listed reptiles were in the Data Deficient category. In this context, understanding and summarizing the conservation status of reptiles is becoming a major priority (Fitzgerald et al. 2018).

Although Böhm et al. (2013) based their assessment on the IUCN Red List categorization, some other authors have questioned the usefulness of this system for assessing the conservation status of reptiles (e.g., Wilson et al. 2013; Johnson et al. 2015) and other taxa (e.g., terrestrial vertebrates, Mayani-Parés et al. 2022). Wilson et al. (2013) proposed an alternative system for evaluating the conservation status of reptiles based on three critical aspects: 1) geographic distribution, 2) ecological distribution, and 3) the degree of human persecution. Their system of EVS (Environmental Vulnerability Scores) has been widely used to evaluate the conservation status of reptiles throughout Mesoamerica (e.g., Johnson et al. 2015, 2017; Mata-Silva et al. 2019). Moreover, Johnson et al. (2017) and Mata-Silva et al. (2019) proposed the Conservation Priority status for Mesoamerican reptiles. The Conservation Priority is calculated by combining the data on the physiographic distribution and EVS group categorization of a species and considers that the smaller the number of physiographic regions occupied by a species, the more difficult its conservation will be (Johnson et al. 2017).

Sceloporus Wiegmann, 1828, is a genus of diurnal, insectivorous lizards in the family Phrynosomatidae. This genus has been the focus of several herpetological investigations, in part due to its high species diversity (up to 100+ species distributed in 18 species groups), broad geographic distribution (from northern USA to Panama), and its great ecological, morphological, and ethological diversity (Sites et al. 1992; Hall 2009; Leaché et al. 2016; Uetz et al. 2022). Evidence suggests that *Sceloporus* lizards are being threatened by several factors (Hokit and Branch 2003; Sinervo et al. 2010; Gadsden et al. 2018; Trumbo et al. 2021; Rurik et al. 2022), however, few studies have examined the conservation issues and status for the genus as a whole. Sinervo et al. (2010) predicted that about 60% of *Sceloporus* species in Mexico would be extinct by 2080 due to climate change. In addition, factors such as habitat degradation (Hokit and Branch 2003; Ernst et al. 2004; Chan et al. 2013; Gadsden et al. 2018; Walkup et al. 2018; Rurik et al. 2022) and invasive alien species (Lance et al. 2009; Thawley and Langkilde 2016; Trumbo et al. 2021) are negatively affecting populations of *Sceloporus*.

Based on the above considerations, and since there is no synthesis of the conservation status of many species in the genus *Sceloporus*, our aim was to assess the conservation status of the constituent species by employing the IUCN Red List categorizations and the Environmental Vulnerability Score (Wilson et al. 2013) for all the species of *Sceloporus*. After a taxonomic update for the genus, we then evaluated the conservation status and developed distribution maps for each species in the genus *Sceloporus*. We also determined the conservation priority level for each species.

Materials and Methods

Taxonomic Update

The list of species of *Sceloporus* found in The Reptile Database (Uetz et al. 2022) served as a basis for the taxonomic update that followed the taxonomy proposed by Wilson et al. (2013), Leaché et al. (2016), and Johnson et al. (2017). The historic and recent literature regarding each species or species group were consulted to update the taxonomy used and identify the extant species of *Sceloporus*.

Systems for Determining Conservation Status

Both the IUCN Red List (https://www.iucnredlist.org/) and the EVS system (Wilson et al. 2013; Johnson et al. 2015; 2017; Mata-Silva et al. 2019; García-Padilla et al. 2020) were used to assess the conservation status of each species in the genus *Sceloporus*. The IUCN system considers seven categories of extinction risk status: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CE), Endangered (EN), Vulnerable (VU), Near Threatened (NT), and Least Concern (LC). Two other categories include taxa with insufficient information as Data Deficient (DD) and taxa that have not been evaluated by IUCN criteria as Not Evaluated (NE). Unlike the IUCN system, the EVS system does not consider the details of a species' population status. Rather, it is based on three components: 1) geographic distribution, 2) ecological distribution, and 3) degree of human persecution. The sum of the scores of these three components equals the Environmental Vulnerability Score, which ranges from 3 to 20. An EVS of 3 to 9 is considered low vulnerability to environmental degradation, while 10 to 13 indicates medium vulnerability, and 14 to 20 represents high vulnerability (Wilson et al. 2013).

EVS Calculation, and Updating and Conservation Priority Assessment of *Sceloporus* species

Since the EVS assessment was designed for Mesoamerican reptiles (Wilson and McCranie 2004; Wilson et al. 2013; Johnson et al. 2015, 2017; Mata-Silva et al. 2019), the species of *Sceloporus* endemic to the United States (US) have not been previously evaluated using the EVS criteria. Thus, we calculated the EVS for the seven species endemic to the US (*S. arenicolus*, *S. becki*, *S. consobrinus*, *S. graciosus*, *S. tristichus*, *S. undulatus*, and *S. woodi*). As mentioned above, the EVS algorithm consists of three components or scales

(Wilson et al. 2013). The first scale regarding geographic distribution was revised for use with the US *Sceloporus* species, based their occurrence data points, as follows:

1 = distribution broadly represented both inside and outside the US (large portions of the range are both inside and outside the US)
2 = distribution prevalent inside the US, but limited outside the US (most of the range is inside the US)
3 = distribution limited inside the US, but prevalent outside the US (most of the range is outside the US)
4 = distribution limited both inside and outside the US (most of the range is restricted to areas near the US-Mexico border)
5 = distribution only within the US, but not restricted to the vicinity of the type locality
6 = distribution limited to the US in the vicinity of the type locality

The second scale deals with the extent of ecological distribution and was based on the number of vegetation formations occupied according to the Ecological Regions of North America Level III (Wiken et al. 2011). The eight categories are as follows:

1 = occurs in eight or more formations
2 = occurs in seven formations
3 = occurs in six formations
4 = occurs in five formations
5 = occurs in four formations
6 = occurs in three formations
7 = occurs in two formations
8 = occurs in one formation

The third and final scale considers the degree of human persecution as proposed by Wilson et al. (2013). However, note that all *Sceloporus* species are terrestrial and generally ignored by humans (i.e., level 3):

1 = fossorial, usually escape human notice
2 = semifossorial, or nocturnal arboreal or aquatic, nonvenomous and usually non-mimicking, sometimes escape human notice
3 = terrestrial and/or arboreal or aquatic, generally ignored by humans
4 = terrestrial and/or arboreal or aquatic, thought to be harmful, might be killed on sight
5 = venomous species or mimics thereof, killed on sight
6 = commercially or non-commercially exploited for hides, meat, eggs, and/or the pet trade

As numerous taxonomic changes have occurred since Johnson et al. (2017), Mata-Silva et al. (2019), and García-Padilla et al. (2020) published their assessments, the EVS were calculated for those Mesoamerican species that have been recently described or elevated to the species level (*S. binocularis*, *S. dixoni*, *S. geminus*, *S. hesperus*, *S. huichol*, *S. madrensis*, *S. melanogaster*, *S. mikeprestoni*, and *S. olloporus*) and the EVS of species whose distributional range changed (*S. torquatus* and *S. variabilis*) were re-evaluated. The new EVS assessments were made following the criteria of Wilson et al. (2013) and Johnson et al. (2017).

Finally, the conservation priority of each *Sceloporus* species was investigated according to Johnson et al. (2017). All the species within priority level one were obtained from Johnson et al. (2017), Mata-Silva et al. (2019), and García-Padilla et al. (2020). The conservation priority of the endemic herpetofauna of Mexico and Central America was obtained from Johnson et al. (2017) and Mata-Silva et al. (2019), respectively. The conservation priorities for the remaining species were evaluated by considering the number of physiographic regions and the EVS calculation for each species (Johnson et al. 2017).

Geographic Distribution and Endemism of *Sceloporus* Species

Species Distribution Models (SDMs) were used to obtain a more complete picture of the distributions of the *Sceloporus* species. Occurrence points were obtained from the Global Biodiversity Information Facility (GBIF) and manually cleaned. SDMs were developed using the Wallace EcoMod package for the R programming language (R Development Core Team 2015; Kass et al. 2023). The 11 climatic variables identified by Lawing et al. (2016) were used, as they are the most important for describing the modern distribution of lizards in the genus *Sceloporus*: mean diurnal range, isothermality, temperature seasonality, minimum temperature of the coldest month, temperature annual range, mean temperature of the wettest quarter, mean temperature of the driest quarter, mean temperature of coldest quarter, precipitation of the driest month, precipitation seasonality, and precipitation of coldest quarter. The set of areas accessible to each species over relevant periods of its history is termed "M," and it is a critical determinant of the outcome of model calibration, evaluation, and comparison (Barve et al. 2011). The M was set to the Extent of Occurrence (EOO) based on raw data with a buffer of 100 km to allow for a sufficiently wide range of background localities without creating models that extend too far beyond the known distribution of the species (VanDerWal et al. 2009). Of the available data, 50% of the occurrences were used for training and 50% were used for testing. For species with between five and twenty occurrence points, their occurrences were partitioned using jackknife, which is the best method for models with few occurrences (Guisan and Zimmermann 2000). SDMs for species with fewer than five occurrences were not built. The models were limited to include only the linear and quadratic features to prevent

overfitting. Regularization multipliers were set from 0.5 to 2 in intervals of 0.5. For model selection, the average AUC, omission rate, and AICc were considered, and the statistically significant models with the lowest omission rate and delta AICc values were selected. Finally, the models were then converted to binary presence/absence maps by using the 10th percentile training presence threshold, i.e., the probability value above which 90% of the raw data will be present in the presence/absence maps (see Phillips et al. 2006). The distribution maps of each species can be found in the **Supplementary Material**. Based on the SDMs and the literature, the species of *Sceloporus* that occur in only one country (i.e., endemic species) were identified.

Results and Discussion

A Taxonomic Update

Our taxonomic update revealed that there are currently 116 species in the genus *Sceloporus* (Table 1), including some species not listed in The Reptile Database (RDB) (Uetz et al. 2022). For example, Leaché et al. (2016) recognized *S. vandenburgianus* as an independent species and *Sceloporus prezygus* was elevated to the species level by Martínez-Méndez et al. (2012). In addition, several new *Sceloporus* species have been recently described (e.g., *S. dixoni*, Bryson et al. 2021; *S. hesperus*, Bryson et al. 2021; *S. huichol*, Flores-Villela et al. 2022; and *S. geminus*, Campillo-García et al. 2023) and others have been elevated from subspecies to species (e.g., *S. olloporus*, Solis-Zurita et al. 2019; as well as *S. binocularis*, *S. madrensis*, *S. melanogaster*, and *S. mikeprestoni*, Campillo-García et al. 2021). We also did not include *S. bimaculosus*, *S. edbelli*, and *S. scitulus*, which are subspecies not recognized as species by Leaché et al. (2016).

Conservation Status of *Sceloporus* Lizards: The IUCN vs. EVS Systems

In the current version of the IUCN Red List, 38 species of *Sceloporus* are Not Evaluated, five species are Data Deficient, 64 are Least Concern, two are Near Threatened,

Table 1. *Sceloporus* species and their conservation status levels according to IUCN Red List and the Environmental Vulnerability Score (EVS). Priority level one species are in bold. Asterisks (*) indicate species for which the EVS was re-evaluated in this work.

Species	Author	IUCN	EVS	EVS citation
Sceloporus acanthinus	Bocourt, 1873	LC	Medium (13)	Wilson et al. 2013
Sceloporus adleri	Smith and Savitzky, 1974	LC	High (15)	Wilson et al. 2013
Sceloporus aeneus	Wiegmann, 1828	LC	High (16)*	This study
Sceloporus albiventris	Smith, 1939	NE	High (16)	Wilson et al. 2013
Sceloporus anahuacus	Lara-Gongora, 1983	LC	High (15)	Wilson et al. 2013
Sceloporus angustus	(Dickerson, 1919)	LC	High (16)	Wilson et al. 2013
Sceloporus arenicolus	Degenhardt and Jones, 1972	V	High (15)	This study
Sceloporus asper	Boulenger, 1897	LC	High (14)	Wilson et al. 2013
Sceloporus aurantius	Grummer and Bryson, 2014	NE	High (14)	Carbajal-Márquez and Quintero-Díaz 2016
Sceloporus aureolus	Smith, 1942	NE	High (15)	Johnson et al. 2017
Sceloporus becki	Van Denburgh, 1905	NE	High (17)	This study
Sceloporus bicanthalis	Smith, 1937	LC	Medium (13)	Wilson et al. 2013
Sceloporus binocularis	Dunn, 1936	NE	High (16)	This study
Sceloporus brownorum	Smith, Watkins-Colwell, Lemos-Espinal, and Chiszar, 1997	NE	High (14)	Carbajal-Márquez and Quintero-Díaz 2016
Sceloporus bulleri	Boulenger, 1895	LC	High (15)	Wilson et al. 2013
Sceloporus caeruleus	Smith, 1936	NE	High (16)	Johnson et al. 2017
Sceloporus carinatus	Smith, 1936	LC	Medium (12)	Wilson et al. 2013
Sceloporus cautus	Smith, 1938	LC	High (15)	Wilson et al. 2013
Sceloporus chaneyi	Liner and Dixon, 1992	E	High (15)	Wilson et al. 2013
Sceloporus chrysostictus	Cope, 1866	LC	Medium (13)	Wilson et al. 2013
Sceloporus clarkii	Baird and Girard, 1852	LC	Medium (10)	Wilson et al. 2013
Sceloporus consobrinus	Baird and Girard, 1854	NE	Low (9)	This study
Sceloporus couchii	Baird, 1859	NE	High (15)	Wilson et al. 2013
Sceloporus cowlesi	Lowe and Norris, 1956	NE	Medium (13)	Wilson et al. 2013
Sceloporus cozumelae	Jones, 1927	LC	High (15)	Wilson et al. 2013
Sceloporus cryptus	Smith and Lynch, 1967	LC	High (14)	Wilson et al. 2013

Table 1 (continued). *Sceloporus* species and their conservation status levels according to IUCN Red List and the Environmental Vulnerability Score (EVS). Priority level one species are in bold. Asterisks (*) indicate species for which the EVS was re-evaluated in this work.

Species	Author	IUCN	EVS	EVS Citation
Sceloporus cupreus	Bocourt, 1873	NE	High (16)	Wilson et al. 2013
Sceloporus cyanogenys	Cope, 1885	NE	High (16)	Wilson et al. 2013
Sceloporus cyanostictus	Axtell and Axtell, 1971	E	High (16)	Wilson et al. 2013
Sceloporus dixoni	Bryson and Grummer, 2021	NE	High (16)	This study
Sceloporus druckercolini	Perez-Ramos and Saldana De La Riva, 2008	NE	High (14)	Wilson et al. 2013
Sceloporus dugesii	Bocourt, 1874	LC	Medium (13)	Wilson et al. 2013
Sceloporus edwardtaylori	Smith, 1936	LC	High (14)	Wilson et al. 2013
Sceloporus esperanzae	Mccranie, 2018	NE	High (14)	Mccranie 2018
Sceloporus exsul	Dixon, Ketchersid and Lieb, 1972	CE	High (17)	Wilson et al. 2013
Sceloporus formosus	Wiegmann, 1834	LC	High (15)	Wilson et al. 2013
Sceloporus gadoviae	Boulenger, 1905	LC	Medium (11)	Wilson et al. 2013
Sceloporus gadsdeni	Castañeda-Gaytán and Díaz-Cárdenas, 2017	NE	High (17)	Johnson et al. 2017
Sceloporus geminus	Campillo-García, Flores-Villela, Butler, Benabib, and Castiglia, 2023	NE	High (17)	This study
Sceloporus goldmani	Smith, 1937	E	High (15)	Wilson et al. 2013
Sceloporus graciosus	Baird and Girard, 1852	LC	Low (9)	This study
Sceloporus grammicus	Wiegmann, 1828	LC	Low (9)	Wilson et al. 2013
Sceloporus grandaevus	(Dickerson, 1919)	LC	High (16)	Wilson et al. 2013
Sceloporus halli	Dasmann and Smith, 1974	DD	High (17)	Wilson et al. 2013
Sceloporus hesperus	Bryson and Grummer, 2021	NE	High (17)	This study
Sceloporus heterolepis	Boulenger, 1895	LC	High (14)	Wilson et al. 2013
Sceloporus hondurensis	Mccranie, 2018	NE	Medium (13)	Mccranie 2018
Sceloporus horridus	Wiegmann, 1834	LC	Medium (11)	Wilson et al. 2013
Sceloporus huichol	Flores-Villela, Smith, Campillo-García, Martínez-Méndez, and Campbell, 2022	NE	High (16)	This study
Sceloporus hunsakeri	Hall and Smith, 1979	LC	High (14)	Wilson et al. 2013
Sceloporus insignis	Webb, 1967	LC	High (16)	Wilson et al. 2013
Sceloporus internasalis	Smith and Bumzahem, 1955	LC	Medium (11)	Wilson et al. 2013
Sceloporus jalapae	Günther, 1890	LC	Medium (13)	Wilson et al. 2013
Sceloporus jarrovii	Cope, 1875	NE	Medium (11)	Wilson et al. 2013
Sceloporus lemosespinali	Lara-Góngora, 2004	DD	High (16)	Wilson et al. 2013
Sceloporus licki	Van Denburgh, 1895	LC	Medium (13)	Wilson et al. 2013
Sceloporus lineatulus	Dickerson, 1919	LC	High (17)	Wilson et al. 2013
Sceloporus lunae	Bocourt, 1873	LC	High (15)	Mata-Silva et al. 2019
Sceloporus lundelli	Smith, 1939	LC	High (14)	Wilson et al. 2013
Sceloporus macdougalli	Smith and Bumzahem, 1953	LC	High (16)	Wilson et al. 2013
Sceloporus maculosus	Smith, 1934	V	High (16)	Wilson et al. 2013
Sceloporus madrensis	Olson, 1986	NE	High (17)	This study
Sceloporus magister	Hallowell, 1854	LC	Low (9)	Wilson et al. 2013
Sceloporus malachiticus	Cope, 1864	NE	Medium (10)	Mata-Silva et al. 2019
Sceloporus marmoratus	Hallowell, 1852	NE	Medium (11)	Wilson et al. 2013
Sceloporus megalepidurus	Smith, 1934	NE	High (14)	Wilson et al. 2013
Sceloporus melanogaster	Cope, 1885	NE	High (14)	This study
Sceloporus melanorhinus	Bocourt, 1876	LC	Low (9)	Wilson et al. 2013
Sceloporus merriami	Stejneger, 1904	LC	Medium (13)	Wilson et al. 2013

Table 1 (continued). *Sceloporus* species and their conservation status levels according to IUCN Red List and the Environmental Vulnerability Score (EVS). Priority level one species are in bold. Asterisks (*) indicate species for which the EVS was re-evaluated in this work.

Species	Author	IUCN	EVS	EVS Citation
Sceloporus mikeprestoni	Smith and Alvarez, 1974	NE	High (17)	This study
Sceloporus minor	Cope, 1885	LC	High (14)	Wilson et al. 2013
Sceloporus mucronatus	Cope, 1885	LC	Medium (13)	Wilson et al. 2013
Sceloporus nelsoni	Cochran, 1923	LC	Medium (13)	Wilson et al. 2013
Sceloporus oberon	Smith and Brown, 1941	V	High (14)	Wilson et al. 2013
Sceloporus occidentalis	Baird and Girard, 1852	LC	Medium (12)	Wilson et al. 2013
Sceloporus ochoterenae	Smith, 1934	LC	Medium (12)	Wilson et al. 2013
Sceloporus olivaceus	Smith, 1934	LC	Medium (13)	Wilson et al. 2013
Sceloporus olloporus	Smith, 1937	NE	Low (9)	García-Padilla et al. 2020
Sceloporus omiltemanus	Günther, 1890	NE	High (16)	Johnson et al. 2017
Sceloporus orcutti	Stejneger, 1893	LC	Low (7)	Wilson et al. 2013
Sceloporus ornatus	Baird, 1859	NT	High (16)	Wilson et al. 2013
Sceloporus palaciosi	Lara-Gongora, 1983	LC	High (15)	Wilson et al. 2013
Sceloporus parvus	Smith, 1934	LC	High (15)	Wilson et al. 2013
Sceloporus poinsettii	Baird and Girard, 1852	LC	Medium (12)	Wilson et al. 2013
Sceloporus prezygus	Smith, 1939	NE	High (15)	Wilson et al. 2013
Sceloporus pyrocephalus	Cope, 1864	LC	Medium (12)	Wilson et al. 2013
Sceloporus salvini	Günther, 1890	DD	High (15)	Wilson et al. 2013
Sceloporus samcolemani	Smith and Hall, 1974	LC	High (15)	Wilson et al. 2013
Sceloporus scalaris	Wiegmann, 1828	LC	Medium (12)	Wilson et al. 2013
Sceloporus schmidti	Jones, 1927	NE	Medium (11)	McCranie 2018
Sceloporus serrifer	Cope, 1866	NE	Low (6)	Wilson et al. 2013
Sceloporus shannonorum	Langebartel, 1959	NE	High (15)	Wilson et al. 2013
Sceloporus siniferus	Cope, 1870	LC	Medium (11)	Wilson et al. 2013
Sceloporus slevini	Smith, 1937	LC	Medium (11)	Wilson et al. 2013
Sceloporus smaragdinus	Bocourt, 1873	LC	Medium (12)	Wilson et al. 2013
Sceloporus smithi	Hartweg and Oliver, 1937	LC	High (15)	Wilson et al. 2013
Sceloporus spinosus	Wiegmann, 1828	LC	Medium (12)	Wilson et al. 2013
Sceloporus squamosus	Bocourt, 1874	LC	Medium (11)	Wilson et al. 2013
Sceloporus stejnegeri	Smith, 1942	LC	Medium (13)	Wilson et al. 2013
Sceloporus subniger	Poglayen and Smith, 1958	NE	High (15)	Johnson et al. 2017
Sceloporus subpictus	Lynch and Smith, 1965	DD	High (16)	Wilson et al. 2013
Sceloporus sugillatus	Smith, 1942	LC	High (16)	Wilson et al. 2013
Sceloporus taeniocnemis	Cope, 1885	LC	Medium (12)	Wilson et al. 2013
Sceloporus tanneri	Smith and Larsen, 1975	DD	High (16)	Wilson et al. 2013
Sceloporus teapensis	Günther, 1890	LC	Medium (13)	Wilson et al. 2013
Sceloporus torquatus	Wiegmann, 1828	NE	High (16)*	This study
Sceloporus tristichus	Cope, 1875	NE	Medium (11)	This study
Sceloporus undulatus	(Bosc and Daudin, 1801)	LC	Low (9)	This study
Sceloporus unicanthalis	Smith, 1937	NE	High (16)	Johnson et al. 2017
Sceloporus uniformis	Phelan and Brattstrom, 1955	NE	Medium (13)	Wilson et al. 2013
Sceloporus utiformis	Cope, 1864	LC	High (15)	Wilson et al. 2013
Sceloporus vandenburgianus	Cope, 1896	LC	High (14)	Wilson et al. 2013
Sceloporus variabilis	Wiegmann, 1834	LC	Low (9)*	This study
Sceloporus virgatus	Smith, 1938	LC	High (15)	Wilson et al. 2013
Sceloporus woodi	Stejneger, 1918	NT	High (16)	This study
Sceloporus zosteromus	Cope, 1863	LC	Medium (12)	Wilson et al. 2013

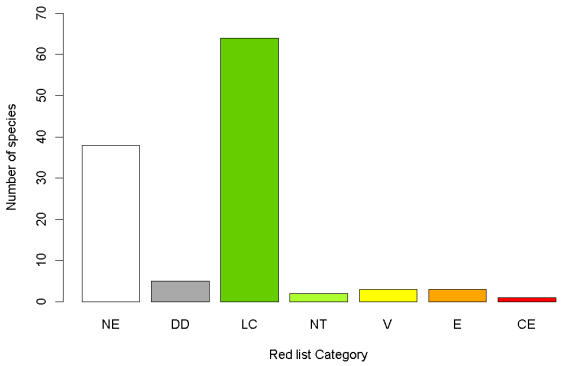

Fig. 1. Number of *Sceloporus* species assigned to each IUCN Red List category: Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), and Critically Endangered (CE).

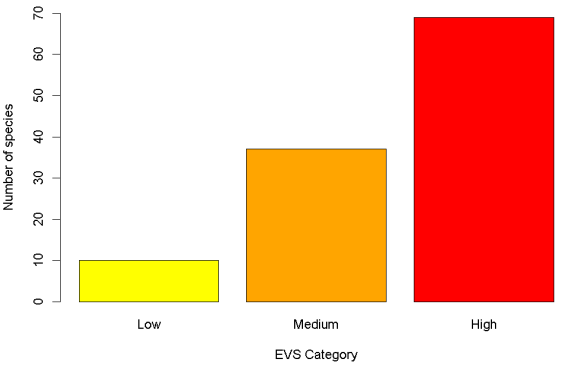

Fig. 2. Number of *Sceloporus* species assigned to each Environmental Vulnerability Score (EVS) category.

three are Vulnerable, three are Endangered, and one is Critically Endangered (Table 1, Fig. 1). In contrast, using the EVS system, ten species of *Sceloporus* are at the low level, 37 at the medium level, and 69 at the high level (Table 1, Fig. 2). Most of the species in the high EVS category were categorized as either Not Evaluated, Data Deficient, or Least Concern in the IUCN Red List (Fig. 3). This discrepancy between the EVS system and the IUCN Red List is consistent with the findings of other studies (e.g., Böhm et al. 2013, Wilson et al. 2013; Meiri and Chapple 2016; Caetano et al. 2022).

Although the IUCN Red List has been the leading authority on global species extinction risk for five decades (Betts et al. 2019), the assessments of reptiles in general (Böhm et al. 2013; Wilson et al. 2013; Caetano et al. 2022) and lizards in particular (Meiri and Chapple 2016) have lagged behind other groups. Meiri and Chapple (2016) evaluated the biases of the lizards assessed by the IUCN and found that most lizard species (64%) had not been assessed by the IUCN Red List at that time (see also Tingley et al. 2016). In this study, we found that 38 species of *Sceloporus* had not been evaluated for the Red List, or 32% of species in the genus *Sceloporus*. The higher level of assessment of *Sceloporus* could be related

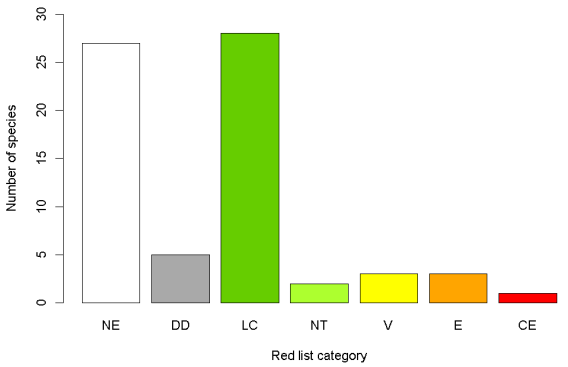

Fig. 3. Number of *Sceloporus species* with high vulnerability in its corresponding IUCN Red List category.

to the fact that *Sceloporus* is one of the most widely studied genera of lizards (Sites et al. 1992). Wilson et al. (2013) developed their EVS system specifically to overcome the "assessment gap" (Meiri and Chapple 2016) in reptiles. According to the EVS system, most of the *Sceloporus* species (59%) have high vulnerability, which is consistent with the evaluations made by Wilson et al. (2013), Johnson et al. (2017), and Mata-Silva et al. (2019) for the Mesoamerican herpetofauna.

Conservation Priority and Endemism of *Sceloporus* Lizards

Conservation priority levels were proposed by Johnson et al. (2017) and Mata-Silva et al. (2019) to recognize the species in need of conservation actions due to their high vulnerability and restricted ecological distributions. Our assessment found that 46 species of *Sceloporus* (39%) were assigned to conservation priority level I, the highest priority category (Table 2, Fig. 4). In addition, 84 of the 116 *Sceloporus* species are country endemics (72%). Of these endemic species, 77% are in the first three levels of conservation priority (i.e., 45 in level 1, 13 in level 2, and seven in level 3). Mexico is the country with most endemic species (73 of 84; 86.9%), followed by the USA with seven endemic species (seven of 84; 8.3%), Honduras with three (three of 84; 3.5%), and Guatemala with one (one of 84; 1.2%). These results are consistent with those reported by Johnson et al (2017), since Mexico is the country with most endemic species of reptiles in North America.

Conclusions

Reptiles have been historically neglected by conservation assessments, and *Sceloporus* lizards are no exception. Even though *Sceloporus* is a widely studied genus of reptiles, a gap in conservation biology studies remains, and this is reflected in the underestimation of conservation

Table 2. Priority conservation level and endemism of *Sceloporus* species. The country abbreviations are: MX = Mexico, USA = United States of America, HND = Honduras, GT = Guatemala, and ne= Not endemic.

Priority 1			
	Endemism		**Endemism**
Sceloporus adleri	MX	*Sceloporus huichol*	MX
Sceloporus aeneus	MX	*Sceloporus hunsakeri*	MX
Sceloporus anahuacus	MX	*Sceloporus insignis*	MX
Sceloporus angustus	MX	*Sceloporus lemosespinali*	MX
Sceloporus aurantius	MX	*Sceloporus lineatulus*	MX
Sceloporus aureolus	MX	*Sceloporus macdougalli*	MX
Sceloporus becki	USA	*Sceloporus maculosus*	MX
Sceloporus binocularis	MX	*Sceloporus madrensis*	MX
Sceloporus caeruleus	MX	*Sceloporus mikeprestoni*	MX
Sceloporus chaneyi	MX	*Sceloporus omiltemanus*	MX
Sceloporus cozumelae	MX	*Sceloporus ornatus*	MX
Sceloporus cryptus	MX	*Sceloporus palaciosi*	MX
Sceloporus cupreus	MX	*Sceloporus prezygus*	ne
Sceloporus cyanostictus	MX	*Sceloporus samcolemani*	MX
Sceloporus dixoni	MX	*Sceloporus schmidti*	HND
Sceloporus druckercolini	MX	*Sceloporus shannonorum*	MX
Sceloporus esperanzae	HND	*Sceloporus subniger*	MX
Sceloporus exsul	MX	*Sceloporus subpictus*	MX
Sceloporus gadsdeni	MX	*Sceloporus sugillatus*	MX
Sceloporus geminus	MX	*Sceloporus tanneri*	MX
Sceloporus goldmani	MX	*Sceloporus torquatus*	MX
Sceloporus grandaevus	MX	*Sceloporus unicanthalis*	MX
Sceloporus halli	MX		
Sceloporus hesperus	MX		
Priority 2		**Priority 3**	
	Endemism		**Endemism**
Sceloporus albiventris	MX	*Sceloporus formosus*	MX
Sceloporus arenicolus	USA	*Sceloporus malachiticus*	ne
Sceloporus asper	MX	*Sceloporus megalepidurus*	MX
Sceloporus brownorum	MX	*Sceloporus melanogaster*	MX
Sceloporus bulleri	MX	*Sceloporus oberon*	MX
Sceloporus cautus	MX	*Sceloporus parvus*	MX
Sceloporus couchii	MX	*Sceloporus smithi*	MX
Sceloporus cyanogenys	ne	*Sceloporus utiformis*	MX
Sceloporus edwardtaylori	MX		
Sceloporus heterolepis	MX		
Sceloporus lunae	GT		
Sceloporus lundelli	ne		
Sceloporus minor	MX		
Sceloporus salvini	MX		
Sceloporus vandenburgianus	ne		
Sceloporus virgatus	ne		
Sceloporus woodi	USA		

Table 2 (continued). Priority conservation level and endemism of *Sceloporus* species. The country abbreviations are: MX = Mexico, USA = United States of America, HND = Honduras, GT = Guatemala, and ne= Not endemic.

Priority 7		**Priority 8**	
	Endemism		**Endemism**
Sceloporus licki	MX	*Sceloporus bicanthalis*	MX
Sceloporus zosteromus	MX	*Sceloporus dugesii*	MX
		Sceloporus hondurensis	HND
		Sceloporus ochoterenae	MX
		Sceloporus stejnegeri	MX
		Sceloporus uniformis	ne
Priority 9		**Priority 10**	
	Endemism		**Endemism**
Sceloporus chrysostictus	ne	*Sceloporus carinatus*	ne
Sceloporus cowlesi	ne	*Sceloporus clarkii*	ne
Sceloporus gadoviae	MX	*Sceloporus horridus*	MX
Sceloporus jalapae	MX	*Sceloporus nelsoni*	MX
Sceloporus jarrovii	ne	*Sceloporus poinsettii*	ne
Sceloporus marmoratus	ne	*Sceloporus smaragdinus*	ne
Sceloporus merriami	ne	*Sceloporus spinosus*	MX
Sceloporus mucronatus	MX	*Sceloporus squamosus*	ne
Sceloporus occidentalis	ne	*Sceloporus taeniocnemis*	ne
Sceloporus olivaceus	ne		
Sceloporus pyrocephalus	MX		
Sceloporus scalaris	MX		
Sceloporus siniferus	ne		
Sceloporus slevini	ne		
Sceloporus teapensis	ne		
Priority 11		**Priority 12**	
	Endemism		**Endemism**
Sceloporus internasalis	ne	*Sceloporus tristichus*	USA
Priority 13		**Priority 17**	
	Endemism		**Endemism**
Sceloporus acanthinus	ne	*Sceloporus grammicus*	ne
		Sceloporus magister	ne
		Sceloporus melanorhinus	ne
		Sceloporus olloporus	ne
Priority 18			
	Endemism		
Sceloporus consobrinus	USA		
Sceloporus graciosus	USA		
Sceloporus orcutti	ne		

risk assessments by the IUCN Red List. In this study, we found that 31% of *Sceloporus* species have not been evaluated by IUCN. Also, ~80% of species with high vulnerability based on the EVS (69 species) are either Not Evaluated (38%) or listed as Least Concern (41%) on the IUCN Red List. This underestimation could be related to the cryptic nature of most *Sceloporus* lizards, which have narrow distribution ranges and highly specific ecological requirements, and are usually inconspicuous. In contrast to the IUCN Red List, the EVS system can easily evaluate less well studied species and considers three important aspects of species conservation risk assessment: distribution range, ecological versatility, and anthropogenic pressures. Implementing conservation risk assessments such as the EVS system is imperative for rapid evaluations and timely conservation actions for *Sceloporus* lizards. The results of this survey also emphasize that greater efforts need to be expended to fully understand the true conservation status of species in the genus *Sceloporus*, as well as the specific threats

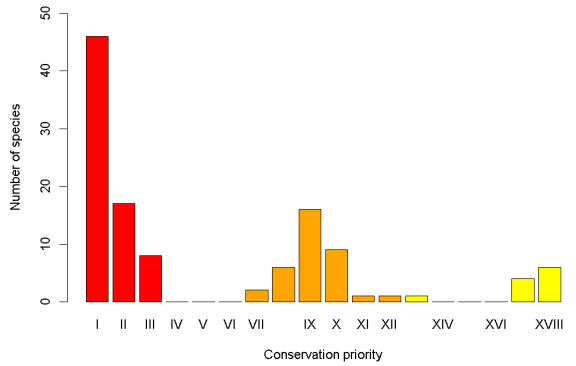

Fig. 4. Number of *Sceloporus* species assigned to each conservation priority level. Red bars indicate priority levels with high Environmental Vulnerability Score (EVS) species, orange bars represent priority levels with medium EVS species, and yellow bars indicate priority levels with low EVS species.

that they face.

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Literature Cited

Barve N, Barve V, Jiménez-Valverde A, Lira-Noriega A, Maher SP, Peterson AT, Soberón J, Villalobos F. 2011. The crucial role of the accessible area in ecological niche modeling and species distribution modeling. *Ecological Modelling* 222: 1,810–1,819.

Betts J, Young RP, Hilton-Taylor C, Hoffmann M, Rodríguez JP, Stuart SN, Milner-Gulland EJ. 2019. A framework for evaluating the impact of the IUCN Red List of Threatened Species. *Conservation Biology* 34: 632–643.

Böhm M, Collen B, Baillie JEM, Bowles P, Chanson J, Cox N, Hammerson G, Hoffmann M, Livingstone SR, Ram M, et al. 2013. The conservation status of the world's reptiles. *Biological Conservation* 157: 372–385.

Böhm M, Williams R, Bramhall HR, McMillan KM, Davidson AD, Garcia A, Bland LM, Bielby J, Collen B. 2016. Extinction risk correlates in squamate reptiles. *Global Ecology and Biogeography* 25: 391–405.

Bryson RW, Grummer JA, Connors EM, Tirpak J, McCormack JE, Klicka J. 2021. Cryptic diversity across the Trans-Mexican Volcanic Belt of Mexico in the Montane Bunchgrass Lizard *Sceloporus subniger* (Squamata: Phrynosomatidae). *Zootaxa* 4963(2): 335–353.

Caetano GHdO, Chapple DG, Grenyer R, Raz T, Rosenblatt J, Tingley R, Böhm M, Meiri S, Roll U. 2022. Automated assessment reveals that the extinction risk of reptiles is widely underestimated across space and phylogeny. *PLoS Biology* 20(5): e3001544.

Campillo-García G, Flores-Villela O, Butler BO, Velasco Vinasco JA, Ramírez Corona F. 2021. Hidden diversity within a polytypic species: the enigmatic *Sceloporus torquatus* Wiegmann, 1828 (Reptilia, Squamata, Phrynosomatidae). *Vertebrate Zoology* 71: 781–798.

Campillo-García G, Flores-Villela O, Butler BO, Benabib M, Castiglia R. 2023. More cryptic diversity among spiny lizards of the *Sceloporus torquatus* complex discovered through a multilocus approach. *Amphibia-Reptilia* 45: 21–35.

Ceballos G, Ehrlich PR, Barnosky AD, García A, Pringle RM, Palmer TM. 2015. Accelerated modern human-induced species losses: entering the sixth mass extinction. *Science Advances* 1: e1400253.

Chan LM, Archie JW, Yoder AD, Fitzgerald LA. 2013. Review of the systematic status of *Sceloporus arenicolus* Degenhardt and Jones, 1972, with an estimate of divergence time. *Zootaxa* 3664(3): 312–320.

Dirzo R, Young HS, Galetti M, Ceballos G, Isaac NJB, Collen B. 2014. Defaunation in the Anthropocene. *Science* 345(6195): 401–406.

Ernst JA, Branch LC, Clark AM, Hokit DG. 2004. Polymorphic microsatellite markers for the Florida Scrub Lizard (*Sceloporus woodi*). *Molecular Ecology Notes* 4: 364–365.

Fitzgerald LA, Walkup D, Chyn K, Buchholtz E, Angeli N, Parker M. 2018. The future for reptiles: advances and challenges in the Anthropocene. Pp. 163–174 In: *Encyclopedia of the Anthropocene*. Editors, DellaSala D, Goldstein M. Elsevier Science, Oxford, United Kingdom. 2,280 p.

Flores-Villela O, Smith EN, Campillo-García G, Martínez-Méndez N, Campbell JA. 2022. A new species of *Sceloporus* of the torquatus group (Reptilia: Phrynosomatidae) from West Mexico. *Zootaxa* 5134(2): 286–296.

Gadsden H, Castañeda G, Huitrón-Ramírez RA, Zapata-Aguilera SA, Ruíz S, Smith GR. 2018. Ecology of *Sceloporus gadsdeni* (Squamata: Phrynosomatidae) from the central Chihuahuan Desert, Mexico. *Phyllomedusa: Journal of Herpetology* 17(2): 181–193.

García-Padilla E, DeSantis DL, Rocha A, Mata-Silva V, Johnson JD, Wilson LD. 2020. Conserving the Mesoamerican herpetofauna: the most critical case of the priority level one endemic species. *Amphibian & Reptile Conservation* 14(2) [General Section]: 73–132 (e240).

Gibbons JW, Scott DE, Ryan TJ, Buhlmann KA, Tuberville TD, Metts BS, Greene JL, Mills T, Leiden Y, Poppy S, et al. 2000. The global decline of reptiles, déjà vu amphibians. *BioScience* 50(8): 653–666.

Guisan A, Zimmermann NE. 2000. Predictive habitat distribution models in ecology. *Ecological Modelling* 135: 147–186.

Hall WP. 2009. Chromosome variation, genomics, speciation, and evolution in *Sceloporus* lizards. *Cytogenetic and Genome Research* 127(2–4): 143–165.

Hokit DG, Branch LC. 2003. Habitat patch size affects demographics of the Florida Scrub Lizard (*Sceloporus woodi*). *Journal of Herpetology* 37(2): 257–265.

IPBES. 2019. *Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Editors, Brondizio ES, Settele J, Díaz S, Ngo HT. IPBES Secretariat, Bonn, Germany. 1,148 p.

Johnson JD, Mata-Silva V, Wilson LD. 2015. A conservation reassessment of the Central American herpetofauna based on the EVS measure. *Amphibian & Reptile Conservation* 9(2) [General Section]: 1–94 (e100).

Johnson JD, Wilson LD, Mata-Silva V, García-Padilla E, DeSantis DL. 2017. The endemic herpetofauna of Mexico: organisms of global significance in severe peril. *Mesoamerican Herpetology* 4: 544–620.

Kass JM, Pinilla-Buitrag GE, Paz A, Johnson BA, Grisales-Betancur V, Meenan SI, Attali D, Broennimann O, Galante PJ, Maitner BS, et al. 2023. Wallace 2: a shiny app for modeling species niches and distributions redesigned to facilitate expansion via module contributions. *Ecography* 2023: e06547.

Lance SL, Hagen C, Glenn TC, Freidenfelds NA, Langkilde T. 2009. Development and characterization of 17 polymorphic microsatellite loci in the eastern fence lizard, *Sceloporus undulatus*. *Conservation Genetics Resources* 1(1): 233–236.

Lawing AM, Polly PD, Hews DK, Martins EP. 2016. Including fossils in phylogenetic climate reconstructions: a deep time perspective on the climatic niche evolution and diversification of spiny lizards (*Sceloporus*). *American Naturalist* 188: 133–148.

Leaché AD, Banbury BL, Linkem CW, Nieto-Montes de Oca A. 2016. Phylogenomics of a rapid radiation: Is chromosomal evolution linked to increased diversification in North American spiny lizards (genus *Sceloporus*)? *BMC Evolutionary Biology* 16: 63.

Martínez-Méndez N, Mejía O, Rocha-Gómez A, Méndez-De La Cruz FR. 2012. Morphological convergence and molecular divergence: the taxonomic status of *Sceloporus serrifer* (Squamata, Phrynosomatidae) subspecies. *Zoologica Scripta* 41: 97–108.

Mata-Silva V, DeSantis DL, García-Padilla E, Johnson JD, Wilson LD. 2019. The endemic herpetofauna of Central America: a casualty of anthropocentrism. *Amphibian & Reptile Conservation* 13(1) [General Section]: 1–64 (e168).

Mayani-Parás F, Botello F, Castañeda S, Munguía-Carrara M, Sánchez-Cordero V. 2022. Extinction risk assessment of the endemic terrestrial vertebrates in Mexico. *Biological Conservation* 270: 109562.

Meiri S, Chapple DG. 2016. Biases in the current knowledge of threat status in lizards, and bridging the 'assessment gap.' *Biological Conservation* 204: 6–15.

Phillips S, Anderson RH, Schapire RE. 2006. Maximum entropy modeling of species geographic distributions. *Ecological Modelling* 190: 231–259.

R Development Core Team. 2015. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Rurik AJ, Wilmoth SC, Dayton KE, Sparkman AM. 2022. Rock refuges are strongly associated with increased urban occupancy in the Western Fence Lizard, *Sceloporus occidentalis*. *Diversity* 14(8): 655.

Saha A, McRae L, Dodd Jr CK, Gadsden H, Hare KM, Lukoschek V, Böhm M. 2018. Tracking population trends: population time-series data and living planet index for reptiles. *Journal of Herpetology*. 52(3): 259–268.

Sinervo B, Mendez de la Cruz F, Miles DDB, Heulin B, Sites Jr JW, et al. 2010. Erosion of lizard diversity by climate change and altered thermal niches. *Science* 328(5980): 894–899.

Sites Jr. JW, Archie JW, Cole CJ, Villela OF. 1992. A review of phylogenetic hypotheses for lizards of the genus *Sceloporus* (Phrynosomatidae): implications for ecological and evolutionary studies. *Bulletin of the American Museum of Natural History* 213: 1–110.

Solis-Zurita C, De Luna E, González D. 2019. Phylogenetic relationships in the *Sceloporus variabilis* (Squamata: Phrynosomatidae) complex based on three molecular markers, continuous characters, and geometric morphometric data. *Zoologica Scripta* 48: 419–439.

Thawley CJ, Langkilde T. 2016. Invasive Fire Ant (*Solenopsis invicta*) predation of Eastern Fence Lizard (*Sceloporus undulatus*) eggs. *Journal of Herpetology* 50(2): 284–288.

Tingley R, Meiri S, Chapple DG. 2016. Addressing knowledge gaps in reptile conservation. *Biological Conservation* 204: 1–5.

Todd BD, Willson JD, Gibbons JW. 2010. The global status of reptiles and causes of their decline. Pp. 47–67 In: *Ecotoxicology of Amphibians and Reptiles*. Editors, Sparling DW, Bishop CA, Krest S. CRC Press, Boca Raton, Florida, USA. 944 p.

Trumbo DR, Funk WC, Pauly GB, Robertson JM. 2021. Conservation genetics of an island-endemic lizard: low Ne and the critical role of intermediate temperatures for genetic connectivity. *Conservation Genetics* 22: 783–797.

Uetz P, Freed P, Aguilar R, Reyes F, Hošek J. 2022. The Reptile Database. Available: http://www.reptile-database.org [Accessed: 30 January 2022].

VanDerWal J, Shoo LP, Graham C, Williams E. 2009. Selecting pseudo-absence data for presence-only distribution modeling: How far should you stray from what you know? *Ecological Modelling* 220: 589–594.

Walkup DK, Ryberg WA, Fitzgerald LA, Hibbitts TJ. 2018. Occupancy and detection of an endemic habitat specialist, the Dunes Sagebrush Lizard (*Sceloporus arenicolus*). *Herpetological Conservation and Biology* 13(3): 497–506.

Wiken E, Jiménez Nava F, Griffith G. 2011. *North American Terrestrial Ecoregions-Level III*. Commission for Environmental Cooperation, Montreal, Canada. 149 p.

Wilson LD, Mata-Silva V, Johnson JD. 2013. A conservation reassessment of the reptiles of Mexico based on the EVS measure. *Amphibian & Reptile Conservation* 7(1): 1–47 (e61).

Wilson LD, McCranie JR. 2004. The conservation status of the herpetofauna of Honduras. *Amphibian & Reptile Conservation* 3(1): 6–33 (e12).

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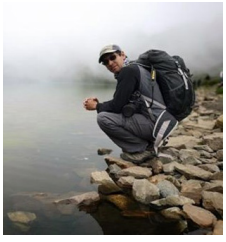

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Héctor Gadsden Esparza is a retired senior researcher at Instituto de Ecología, A.C., who worked at that institution for 32 years. He completed his Bachelor's, Master's, and Ph.D. at Facultad de Ciencias-UNAM (finishing in 1998), in addition to a Master's degree in Filosofía de las Ciencias at Universidad Autónoma Metropolitana (UAM), finishing in 1987; and a post-doctoral appointment at Instituto de Biología-UNAM (1996–1997). He has been a member of Sistema Nacional de Investigadores from 1996–2019, Director of "La Michilía" Biosphere Reserve in the state of Durango (1989–1991), and Director of INECOL-Centro Regional Chihuahua (1999–2003). He taught on the subjects of evolution, population genetics, population ecology, and taxonomy at Facultad de Ciencias-UNAM, UAM, and INECOL. Héctor has published about 150 papers and scientific notes, four books, and 14 book chapters. He has coordinated various projects financed by CONACYT and CONABIO, and he has served as the thesis advisor for 55 Bachelor, Master, and Ph.D. students. His research has focused on the ecology of reptile populations and assemblages in arid northern México, and the effects of global climate change on them. Due to his career and his contributions to the knowledge of Mexican herpetology, he was awarded national recognition by the Asociación para la Investigación y Conservación de Anfibios y Reptiles (AICAR) in October 2017. Due to his contributions to the study of ecology and conservation of herpetofauna in the Chihuahuan Desert, the description of a new species of lizard, *Sceloporus gadsdeni*, was dedicated to him in 2017. Finally, in November 2019, the Universidad Juárez del Estado de Durango (UJED) dedicated its 3rd Congress on Biological Diversity to him, and gave him special recognition.