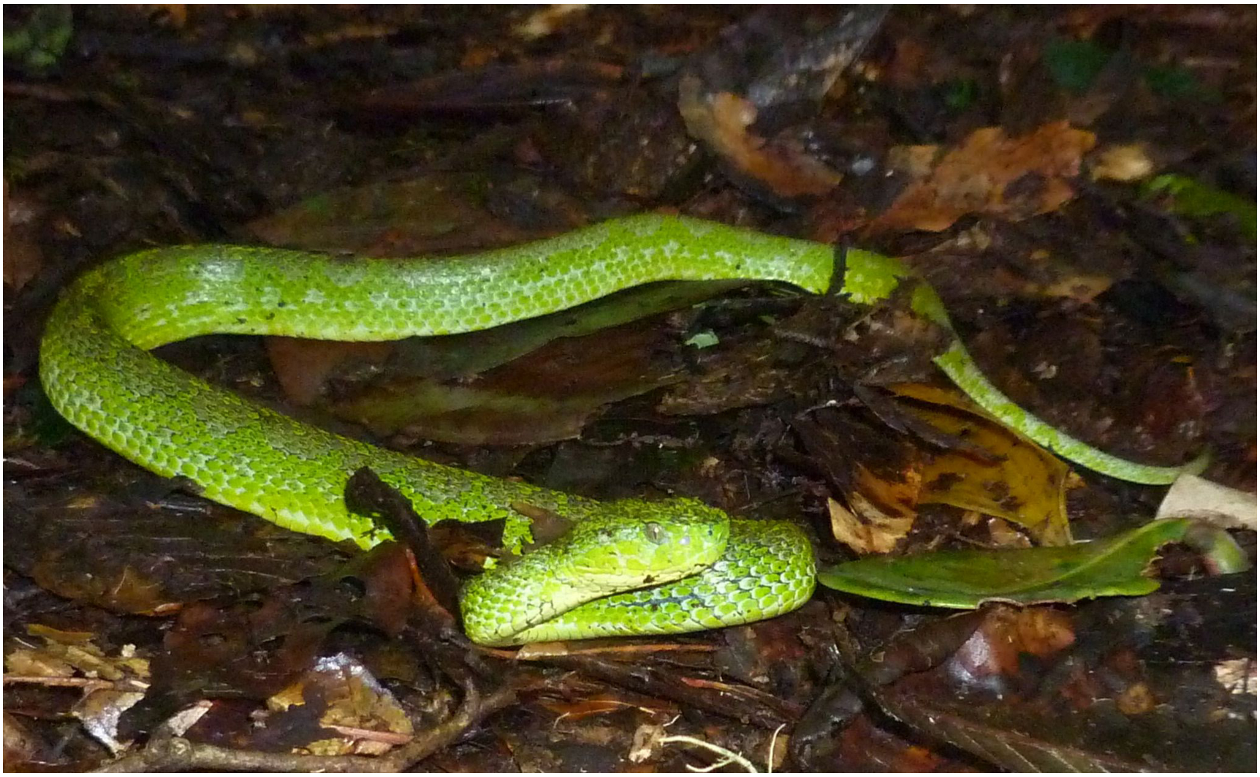
*Ecnomiohyla rabborum.* Rabb's Fringe-limbed Treefrog is one of the most significantly threatened amphibians in Central America. This species is one of the most unusual anurans in the region because of its highly specialized reproductive mode, in which the eggs are laid in water-containing tree cavities and are attached to the interior of the cavity just above the water line. Females depart the tree cavity after oviposition, leaving the males to brood the eggs and the developing tadpoles, and parental care apparently extends to feeding the tadpoles flecks of skin from the male's body (AmphibiaWeb site: accessed 24 July 2014). Mendelson et al. (2008) described this tree canopy treefrog from "montane cloudforest in the immediate vicinity of the town of El Valle de Antón" (AmphibiaWeb site: accessed 24 July 2014) in central Panama, at elevations from 900 to 1,150 m. This mode of reproduction is typical of the members of the genus *Ecnomiohyla*, which now comprises 14 species (Batista et al. 2014) with a collective distribution extending from southern Mexico to northwestern South America (Colombia and Ecuador). This treefrog appears to be one of the many casualties of a sweep-through of Panama by the fungal pathogen *Batrachochytrium dendrobatidis* in 2006. The arrival of this pathogen was anticipated by a team of amphibian biologists, who observed the disastrous effects of *B. dendrobatidis* on the populations of anurans in the El Valle de Antón region. Individuals of *E. rabbororum* were taken into captivity and housed at Zoo Atlanta, but only a single male remains alive. We determined its EVS as 20, placing it at the upper end of the high vulnerability category, and its IUCN status is Critically Endangered. Since the species is known to survive only in captivity, its IUCN status should be considered as Extinct in the Wild. Additionally, since the animal now is known from a single male, its IUCN status should change to Extinct once it dies. This individual is from the type locality. *Photo by Brad Wilson.*



*Bothriechis guifarroi.* This green palm-pitviper is known only from the type locality in the Refugio de Vida Silvestre Texíguat in north-central Honduras, where it occurs in Premontane Wet Forest at elevations of 1,015 to 1,450 m. We calculated its EVS as 19, placing it in the upper portion of the high vulnerability category, but its IUCN status has not been determined. Its EVS is the highest for any snake in Central America. Molecular analysis of this species indicates that it is part of a clade containing the Lower Central American taxa *B. lateralis* and *B. nigroviridis*. Two pattern phases are seen in juveniles, of which one resembles the juveniles of its apparent closest relative, *B. lateralis*, which is distributed in the chain of mountains in the central portions of Costa Rica and western Panama. This snake was named in honor of the Honduran environmental leader Mario Guifarro, who was slain by unknown assailants while heading grassroots attempts to stop illegal logging in the indigenous Tawahka territory in the Mosquitia of eastern Honduras. Don Mario was the guide on several herpetological expeditions undertaken in the Mosquitia by Wilson and co-researchers during the last decade. This individual is from the type locality. *Photo by Josiah H. Townsend.*

# DEDICATION

We are pleased to dedicate this contribution to our friend and colleague Louis W. Porras, for the many ways he has supported our efforts to conserve the rich herpetodiversity of Mesoamerica. As editor, publisher, and contributor to *Conservation of Mesoamerican Amphibians and Reptiles* (2010), he remained solidly behind this multi-year project. In addition, his amazing skills as a copy-editor and knowledge of graphic design were extremely important in the production of the *Amphibian & Reptile Conservation* Special Mexico Issue, published in 2013. Most recently, he has become the force behind the journal *Mesoamerican Herpetology* in which a number of our contributions have appeared. In general, we continually find it worthwhile to seek his counsel on a broad range of matters relating to herpetology and conservation. Most importantly, however, we consider it an honor to call him friend.

*Porthidium porrasi.* The White-tailed Hog-nosed Pitviper is endemic to the region of the Osa Peninsula of southwestern Costa Rica, where it occurs in Lowland Moist Forest at elevations from near sea level to 200 m. We assessed its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Least Concern. This individual is from Rincón, province of Puntarenas. *Photo by Alejandro Solórzano.*

Louis W. Porras photographed on 19 April 2014 with a pair of Mormon Racers (*Coluber mormon*) in the Lake Shore Mountains in Utah County, Utah. Louis said the following: "I've been monitoring a den in these mountains for about 25 years. In the spring I often hike up there with my grandson and other family members. This was an unusually productive day, because we found 25 snakes of four species." *Photo by Robbie Eagleston.*

Official journal website:
amphibian-reptile-conservation.org

*Amphibian & Reptile Conservation*
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# A conservation reassessment of the Central American herpetofauna based on the EVS measure

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***Abstract.*—Mesoamerica, the area composed of Mexico and Central America, is the third largest of the world's biodiversity hotspots. The Central American herpetofauna currently consists of 493 species of amphibians and 559 species of crocodylians, squamates, and turtles. In this paper, we use a revised EVS measure to reexamine the conservation status of the native herpetofauna of this region, utilize the General Lineage Concept of Species to recognize species-level taxa, and employ phylogenetic concepts to determine evolutionary relationships among the taxa. Since the publication of *Conservation of Mesoamerican Amphibians and Reptiles*, in 2010, 92 species of amphibians and squamates have been described, resurrected, or elevated from subspecies to species level, and one species of anuran has been synonymized. The herpetofaunal diversity of Central America is comparable to that of Mexico, an especially significant finding because the land area of Mexico is 3.75 times larger. The number of amphibian species is 1.3 times greater in Central America, whereas the number of species of turtles, crocodylians, and squamates is 1.5 times greater in Mexico. Endemicity also is significant in Central America (65.6% among amphibians, 46.5% among turtles, crocodylians, and squamates), with a combined average of 55.6%. We regard the IUCN system as expensive, time-consuming, tending to fall behind systematic advances, and over-dependent on the Data Deficient and Least Concern categories. Conversely, the EVS measure is economical, can be applied when species are described, is predictive, simple to calculate, and does not "penalize" poorly known species. Our EVS analysis of amphibians demonstrates that on average salamanders are more susceptible to environmental deterioration, followed by caecilians, and anurans. Among the remainder of the herpetofauna, crocodylians are the most susceptible and snakes the least, with turtles and lizards in between. We compared the EVS results for the Central American herpetofauna with those reported for Mexico; the results from those regions show an increase in numbers and percentages from low through medium to high. Arguably, attempting to conserve biodiversity is one of the most important and intransigent issues facing humanity, a situation partially due to humanity's lack of appreciation for its most serious concerns, and brought about by its anthropocentric focus.**

**Key words.** EVS, anurans, salamanders, caecilians, crocodylians, turtles, lizards, snakes, IUCN categorizations, survival prospects

***Resumen.*—Mesoamérica, el área comprendida por México y Centroamérica, es el centro de biodiversidad más grande del planeta. La herpetofauna de Centroamérica actualmente consiste de 493 especies de anfibios y 559 especies de crocodílidos, esquamados, y tortugas. En este artículo, usamos la medida de EVS revisada para reexaminar el estado de conservación de la herpetofauna nativa de esta región, usamos el Concepto del Linaje General de Especie para reconocer taxones al nivel de especie, y empleamos conceptos filogenéticos para determinar relaciones evolutivas entre taxones. Desde la publicación del libro *Conservation of Mesoamerican Amphibians and Reptiles*, en 2010, 92 especies de anfibios y esquamados han sido descritas, resucitadas, o elevadas de subespecie al nivel de especie y una especie de anuro ha sido sinonimizada. La diversidad herpetofaunística en Centroamérica es comparable a la de México, un resultado especialmente significativo dado que la superficie de México es 3.75 veces más grande. El número de especies de anfibios es 1.3 veces mayor en Centroamérica, mientras que el número de especies de tortugas, cocodrílidos y esquamados es 1.5 veces mayor en México. El endemismo es también significativo en Centroamérica (65.6% entre anfibios, 46.5% entre tortugas, cocodrílidos y esquamados), con un**

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**promedio combinado de 55.6%. Consideramos el sistema de UICN como costoso, consume mucho tiempo, con una tendencia a quedarse rebasado por los avances sistemáticos, y sobre dependiente de las categorías de Datos Deficientes y de Preocupación Menor. Inversamente, la medida de EVS es económica, puede ser aplicada cuando una especie es descrita, es predictiva, es fácil de calcular y no "penaliza" especies por ser pobremente conocidas. Nuestro análisis del EVS en anfibios demuestra que en promedio las salamandras son las más susceptibles al deterioro ambiental, seguidas por las cecilias y los anuros. Entre el resto de la herpetofauna, los cocodrílidos son los más susceptibles y las serpientes las menos susceptibles, con las tortugas y las lagartijas en medio. Comparamos los resultados del EVS de la herpetofauna de Centroamérica con la herpetofauna de México; los resultados para ambas regiones muestran un incremento en los números y porcentajes de baja a mediana, a alta vulnerabilidad. Posiblemente, intentar conservar la biodiversidad es uno de los problemas más importantes y arduos que enfrenta la humanidad, una situación parcialmente debida a la falta de apreciación de las preocupaciones más serias por parte de la humanidad, y exacerbada por su enfoque antropocéntrico.**

**Palabras claves.** EVS, anuros, salamandras, cecilias, cocodrílidos, tortugas, lagartijas, culebras, categorías de UICN, perspectivas de supervivencia

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> *Currently, the global extinction rate far exceeds the rate of speciation, and consequently, loss of species is the primary driver of changes in global biodiversity…Since the advent of the Anthropocene, humans have increased the rate of species extinction by 100–1,000 times the background rates that were typical over Earth's history … Until recently, most extinctions (since 1500) occurred on oceanic islands. In the last 20 years, however, about half of the recorded extinctions have occurred on continents, primarily due to land-use change, species introductions, and increasingly climate change, indicating that biodiversity is now broadly at risk throughout the planet.*
>
> Rockström et al. 2009: 14

## Introduction

The most significant problem facing humanity is biodiversity decline. Our attempts to estimate the total number of species and our knowledge and appreciation of environmental relationships within and among the large planetary spheres are woefully inadequate. Strangely enough, given the immense diversity of life on our planet and the endless intellectual fulfillment its study can foster, humans have become increasingly focused on their own activities and become increasingly removed from the rest of the living world. In spite of this loss of perspective, we are beginning to learn that our existence as a species depends on our understanding of how life on this planet operates, and the role we play in this process.

In a Special Mexico Issue of the journal *Amphibian & Reptile Conservation*, we conducted a conservation reassessment of the reptiles (Wilson et al. 2013a) and amphibians (Wilson et al. 2013b) of Mexico based on the use of the Environmental Vulnerability Score (EVS). These works allowed us to examine the results obtained by the International Union for Conservation of Nature (IUCN) and published in the Red List website (www.iucnredlist.org), and compare them to our EVS results. In total, we assayed 1,227 species (378 amphibians, 849 reptiles) of the Mexican herpetofauna. Our conclusions from those studies were that, "both groups are highly imperiled, especially the salamanders, lizards, and turtles" (Wilson et al. 2013b: 98). Because the term "reptile" has been demonstrated increasingly to have a paraphyletic standing in phylogenetic systematics (www.iflscience.com/plants-and-animals/there-s-no-such-thing-reptiles-any-more-and-here-s-why), instead we use the names "crocodylians, squamates, and turtles" when referring to these groups.

The purpose of this paper is to reexamine the conservation status of the herpetofauna of Central America, updating and broadening the treatments that appeared in *Conservation of Mesoamerican Amphibians and Reptiles* (CMAR; Wilson et al. 2010). A substantial amount of systematic work has been published since the cutoff point of 31 December 2008 used by Wilson and Johnson (2010); our cutoff date for the present paper was 1 March 2015. In the interim, 92 species-level taxa have been described, resurrected, or elevated, and one species was synonymized. In addition, 30 species have undergone status changes (usually placement in another genus). In this study, therefore, we treat 1,052 species (493 amphibians; 559 crocodylians, squamates and turtles) and use a revised EVS designed to encompass all of Central America.

## Our Taxonomic Positions

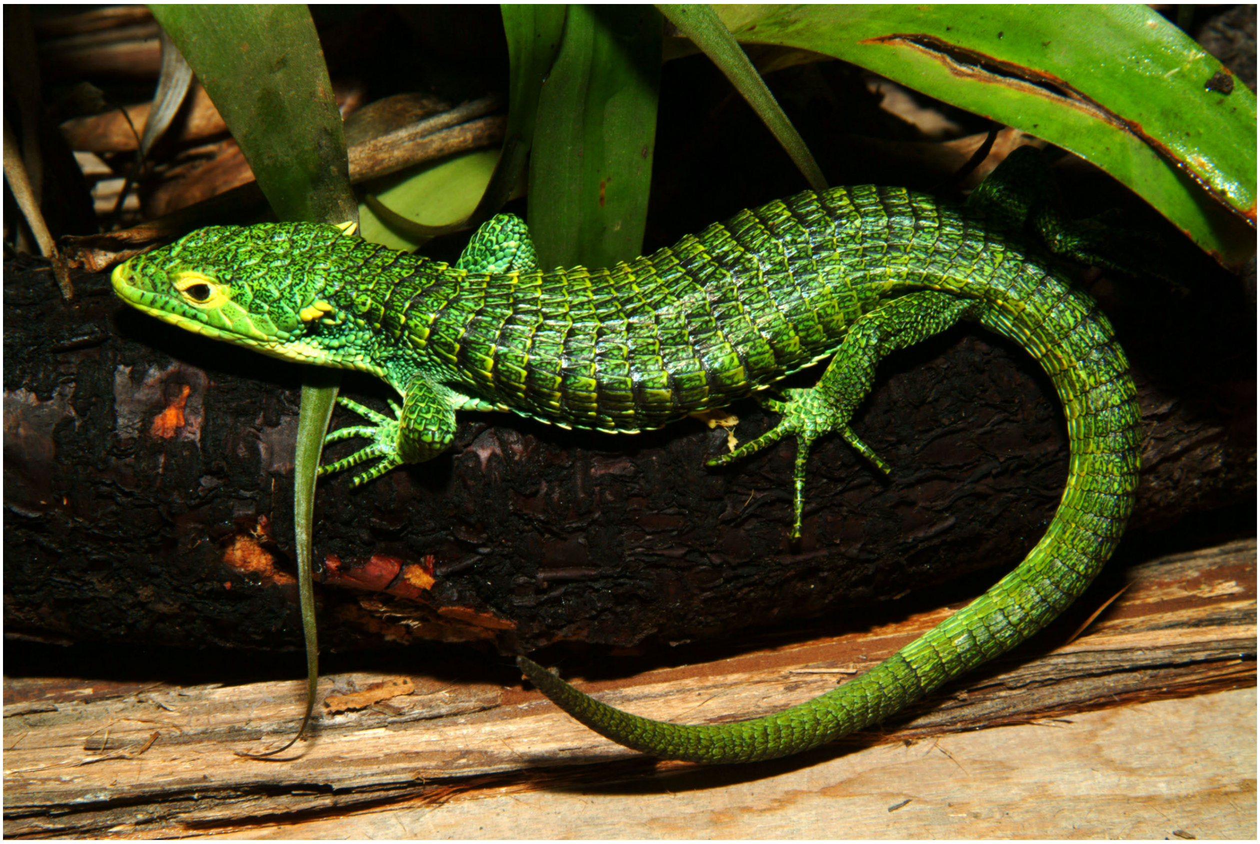
**Transitions in systematics.** — For herpetologists working in Mesoamerica, these are interesting times. We live in a period of transition, from conditions characterizing the past to those we envision will come in the future. The element of transition is evident in much of what we present in this paper and in our taxonomic positions, which we deliberate below.

In trying to understand the biological aspects of the Mesoamerican herpetofauna, we must be interested in systematics, the study of the pattern of relationships among living taxa (www.ucmp.berkeley.edu/clad/clad4.html). Most systematists today practice phylogenetic systematics, defined as "the way that biologists reconstruct the pattern of events that has led to the distribution and diversity of life" (www.ucmp.berkeley.edu/clad/clad4.html). The word "phylogenetic" refers to a system based on evolutionary relationships, in this case among members of biotic groups that commonly are depicted as segments on a phylogeny (an evolutionary tree). As with any reasoned system that has developed over time, today's phylogenetic systematics represents our current understanding of the way life has diversified and changed over time (www.ucmp.berkeley.edu/clad/clad4.html). The degree that phylogenetic systematics has influenced our present understanding of Mesoamerican herpetofaunal diversity has depended on the group of amphibians, crocodylians, squamates, or turtles studied, and by the level of acceptance of modern philosophical ideas and techniques by taxonomists. Thus, our understanding of phylogenetic systematics is in a state of transition, as we keep moving from the ideas and techniques of the past into those of the present and future.

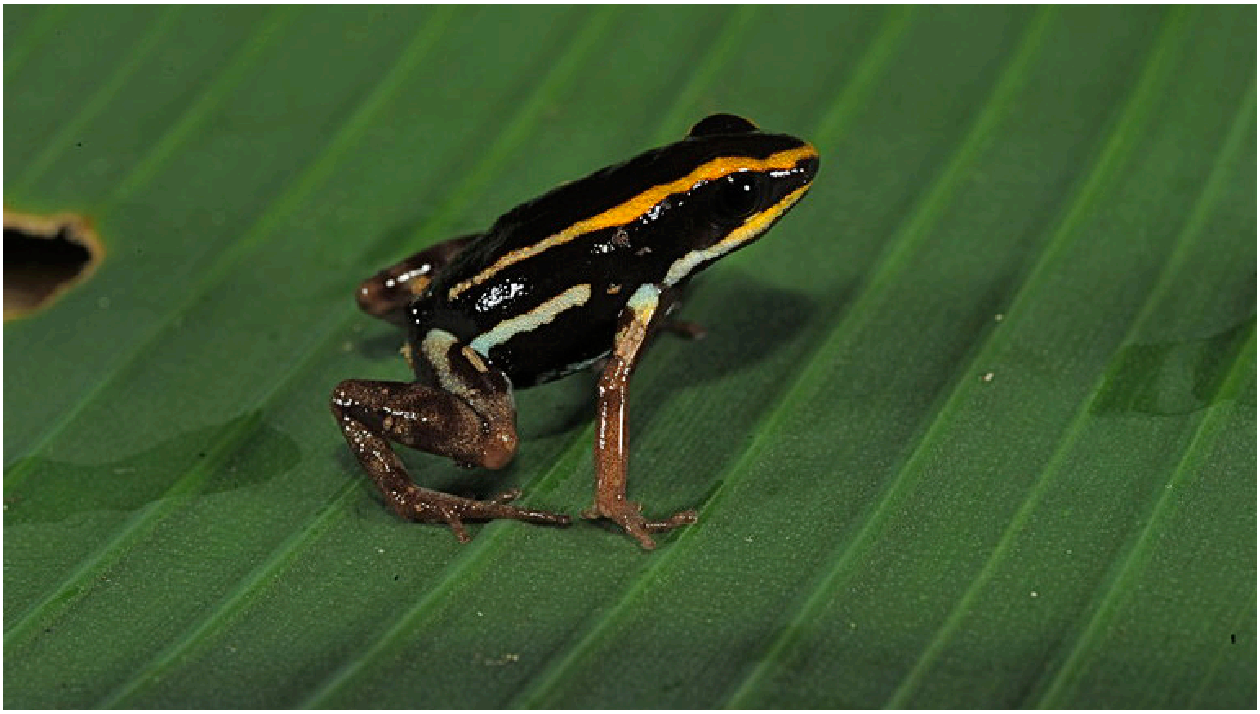
Our predecessors attempted to catalogue all life, and from Carolus Linnaeus we received a system of binomial nomenclature that provided a means for biologists to communicate. Under the Linnaean system of nomenclature, first and second names (generic and specific epithets) are provided for living organisms. A system for the placement of organisms into a set of hierarchically positioned taxonomic categories followed. Another idea that nearly all biologists embrace is that life changes over time. Charles Darwin delivered his theories of biotic evolution, of which some still constitute fundamental themes of modern-day biology. Presently, we combine the ideas of Linnaeus and Darwin and recognize the species category as the fundamental starting point of taxonomic inquiry. Anything systematically linked to populations, below the species level, is consigned to the ecologically regulated expression of individual and geographic variation within a species' genotypic and related phenotypic characters; geographic variation is how individual variation within a species fluctuates in space. Genera and all other higher taxonomic categories are not applicable until species are recognized. Once recognized, species are named, and in doing so must be placed within an existing genus or a new one erected to incorporate the newly named species. According to the rules of zoological nomenclature, named taxa also are placed into a specified set of higher taxonomic categories; major ones are genera, families, orders, classes, phyla, kingdoms, and domains.

**Species concepts and their evolution.** — Biologists also have inherited the part of systematics that deals with understanding how species come to exist and how they can be defined, and throughout history have provided a suite of species concepts. Within the context of these conceptions, the Biological Species Concept (BSC) proposed ideas of definitive reproductive isolation and the use of subspecies as a formal taxonomic category. The BSC gained primacy as a means of objectively defining and recognizing a species during the early to mid 20th century. In those days, the modern synthesis of evolutionary thought established genetic background as the source for evolutionary processes, through the early works of groundbreaking geneticists like Thomas H. Morgan and Wilhelm Johannsen, and later by the systematists Theodosius Dobzhansky and especially Ernst Mayr, whose book *Systematics and the Origin of Species from the Viewpoint of a Zoologist* (1942) served as a turning point for views about what constitutes a species. Together with like-minded biologists, such as the herpetologist and anatomist Hobart M. Smith, Mayr viewed a species as a group of populations of organisms that are capable of reproducing with each other and are reproductively isolated from other species. This species concept enjoyed great popularity among biologists who worked with sexually reproducing organisms, such as Mayr, who was an ornithologist. Nonetheless, the BSC never appealed much to biologists who focused on asexually reproducing organisms, because these creatures do not enjoy sexual reproductive compatibility. Although the BSC still holds sway in some corners of the biological world, it has gradually been replaced by species concepts that purport to work for all organisms, irrespective of their means of reproduction, and which are part of an overarching view of how life has changed over time.

These efforts gained remarkable focus and became part of the modern theory and practice of phylogenetic systematics, which rests on a foundation of cladistic theory pioneered by Willi Hennig in the 1930's. Cladistic analysis provided a means of erecting testable hypotheses about evolutionary initiated connections among organisms, and currently is considered by many as the best means for phylogenetic analysis (www.ucmp.berkeley.edu/clad/clad1.html), which now we recognize predomi-



*Abronia vasconcelosii.* This arboreal alligator lizard is endemic to the Guatemalan Plateau in the south-central portion of the country, where occurs in Lower Montane Wet Forest at elevations from 2,000 to 2,100 m. We assessed its EVS as 16, placing it in the middle portion of the high vulnerability category, and its IUCN status is Vulnerable. This individual is from Cerro Alux, department of Sacatepéquez, Guatemala. *Photo by Gunther Köhler.*



*Andinobates claudiae.* This poison dart frog is endemic to islands on the Atlantic side of Panama, where occurs in Lowland Moist Forest at elevations from 5 to 140 m. We gauged its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Data Deficient. This individual is from Isla Colón, province of Bocas del Toro. *Photo by Brian Freiermuth.*

nantly among groups at higher taxonomic categories (see below). Most importantly, cladistic analysis gives biologists a way to use scientific methodology to study how organisms are related to one another on an accepted ancestor-descendent evolutionary basis. Cladistic protocols recognize synapomorphies, namely shared derived homologous characteristics, which uniquely distinguish the related groups in which they are present from all other such groups, most specifically by sharing the derived traits that originated during evolutionary modification of the direct ancestor to the descendants comprising phylogenetic segments of an evolutionary lineage. Therefore, cladistic systematics does not use reproductive capacity as a universal character to identify sister species on a phylogeny.

Reproduction is a characteristic of life, and sexual reproduction is common to a large portion of living species. Today, however, speciation in bisexual organisms is properly recognized to arise by cladogenesis, which is the splitting of a single lineage into two new genetically separate lineage segments. This idea, in part, dates to at least Darwin and his supporters, and was expanded upon by more modern phylogenetically-based species concepts, like the Evolutionary and Phylogenetic Species Concepts of George G. Simpson and Edward O. Wiley for the former, and Niles Eldridge and Joel Craycraft for the latter, among others. It was Kevin de Queiroz, in a series of papers dating from the late 1990s (e.g., de Queiroz 2005, 2007) that proposed a General Lineage Concept of Species (GLCS) that reiterated species to be genetically separated lineages, but uniquely embraced both clonal (asexual) and bisexual reproductive systems. We interprete the GLCS and its inclusive phylogenetically based principles to falsify some traditionally used doctrines that are deemed unusable in a modern phylogenetically assembled taxonomic system; below we identify the major ones associated with bisexual species.

As a consequence of modern phylogenetic theory, the BSC as a universal definition for bisexual species essentially was relegated to the systematics of the past, because reproductive capability is not a synapomorphic state but rather a plesiomorphic one, which is the ancestral state before the feature evolved into the derived condition in groups making up separate lineage segments found on a phylogeny. Plesiomorphic characters cannot be used to show sister relationships among other members of a phylogeny, because they can remain in that primitive condition in some or all taxa making up lineage segments of the phylogeny. The demise of the BSC to depict phylogenetic relationships among related taxa because of its reliance on an unusable trait (reproductive isolation) to show sister relationships also led to the finale for the short-lived impact of numerical taxonomy (Sneath and Sokal 1973). Numerical taxonomy used the overall similarity of many unweighted phenetic traits to cluster sister taxa together on a supposed phylogeny (actually a similarity phenogram). The high number of plesiomorphic traits shared among closely related species, however, makes the phenograms untenable for depicting phylogenetic sister relationships because such primitive traits cannot reflect evolutionary sister relationships among them.

Taxonomic processes at the species-lineage level usually do not follow cladistic principles, because speciation regularly does not rely on shared synapomorphies to specify sister relationships. In many of those cases evolutionary relationships were established when new evolutionary lineage segments were formed during allopatric speciation (geographic separation of ancestor into two separate evolutionary lineage segments), so features identifying separate sister species at that level can be an assortment of traits that were present in the ancestor to the two new lineage segments. Allopatric speciation typically is not due to genetic changes, but rather to spatial separation that eliminates gene flow. In other words, newly defined sister species can be very similar (if not identical) in genotypic structure and phenotypic expression during early periods of their lineage diversification. Still, a synapomorphy could define sister species if its attainment in the ancestral lineage is the reason for speciation, which generally would be expected in a sympatric situation. The primary function of taxonomists working at the species level is to determine if gene flow has ceased or not, and then decide what suite of taxonomic characters will define the taxon as a new separate evolutionary lineage segment.

A lineage is "any series of organisms connected by reproduction by parent of offspring" (www.ucmp.berkeley.edu/glossary/gloss1phylo.html). Thus, in bisexual organisms, speciation occurs as soon as an ancestral gene pool splits into two genetically isolated gene pools (lineage segments), as depicted at the nodes of a phylogeny. Consequently, there are no "stages of speciation," other than the initial complete separation of an ancestral lineage into two new sister lineages, which can be rapid or prolonged depending on the source of separation. Evolutionary character divergences are not stages of speciation, but rather changes within a single lineage's gene pool during its evolutionary lifespan. Some people consider stages of speciation alongside some speculative rule when they report that their sampled population has not changed adequately in genetic distance or morphological divergence to be considered a full species, as though some indefinable amount of evolutionary change is necessary to be considered a different species. Frost and Hillis (1990) correctly pointed out that "invoking a particular arbitrary level of genetic distance or morphological divergence as a species criterion is neither appropriate nor fruitful." This means that a species currently is defined only as a separate evolutionary lineage and not by some subjective amount of evolutionary change. Because a single lineage, say a species, does not develop into a new taxon without a genetic split, the idea of anagenesis (development of a new taxon without a genetic split) is negated, along with the related idea that stages of speciation occur

*Agkistrodon howardgloydi.* The Southern Cantil is distributed from southern Honduras to northwestern Costa Rica, where it occurs in Lowland Arid and Dry forests at elevations from near sea level to 470 m. We determined its EVS as 17, placing it in the middle portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from Volcán Masaya, Nicaragua. *Photo by Javier Sunyer.*

within a single lineage. Anagenesis has been considered a valid concept in the past, but in order to form a new species gene pool separation must exist.

**The demise of the subspecies category.** — Even though the subspecies category has been associated with taxonomically recognized geographic variants within a species that are connected by gene flow (intergradation), some tend to consider a subspecies as a stage of speciation, even in light of clinal intergradation (gene-flow between members of the same species along a geographic cline). Thus, the subspecies category no longer is useful in systematics as a formal taxon, because by definition it does not constitute a separate evolutionary lineage, nor is it a stage of speciation. Disposing with this category also eliminates the conundrum created with another definition of a subspecies, as an entity consisting of organisms capable of interbreeding and producing fertile offspring with other subspecies of the same species, but cannot do so in nature because of geographic isolation or other factors. This "they can but they don't" paradox remains because it is not a testable hypothesis through scientific methodology. This definition also is misleading because allopatric populations, by definition, are separate evolutionary lineages due to genetic isolation and should be considered full species, not subspecies. If supposedly allopatric populations do not exhibit distinct genetic or morphological differences at a particular point in time, the only reasonable conclusion is that their gene pools are not incontrovertibly separated, so those populations should continue to be considered the same species until empirical data reverse that conclusion. So again, a foremost issue for taxonomists is to determine if gene pool separation has transpired or not.

Our understanding of the lowest-level phylogenetic relationships is that only species are separate evolutionary lineages and, thus, only species can be depicted appropriately on phylogenetic trees as lineage segments diverging from the nodes. Inserting subspecies as a lineage segment branching at nodes might seem to give subspecies a legitimate position as a formal taxonomic category, but it does not because a population that is not a separate evolutionaly lineage legitimately cannot be placed onto a resolved phylogeny.

In summary, our position is that subspecies, as formerly defined, are not separate evolutionary lineages and cannot be placed into a phylogeny. Furthermore, subspecies do not conform to an anagenetic stage of speciation because those stages do not exist. The focus of phylogenetic systematics, therefore, including its association with conservation biology, requires species to be the fundamental unit of diversification as identified by their binomial scientific name.

In addition, hybridization between two species in a contact zone should not be a factor in determining the presence of one or two species, because the ability to successfully reproduce is a plesiomorphic characer that cannot be used to identify phylogenetic sister relationships among the species being investigated. Hybridization in contact zones often is observed in natural situations; hybrids have no taxonomic status unless they lead to a separate lineage segment.

**Persistent issues in publication of systematic results.** — Another aspect of this discussion is our need to comment on the GLCS theory and its practice in modern systematics, because of its scientific relevance in officially published and unpublished literature. With the focus of modern phylogenetic systematics being centered on evolutionary divergence at the species level, our recognition of amphibians, crocodylians, squamates, and turtles in Central America is based on our interpretation of the information available in peer-reviewed scientific literature. With continued advances in communication, especially through the Internet, recognition of taxa should not be founded on what one might find on a Facebook page, in a blog, from someone's tweet, or in a private non-peer-reviewed journal (see Kaiser et al. 2013), no matter what attempts are made to masquerade them as legitimate scientific contributions. Thus, in documenting the makeup of the Cental American herpetofauna, we cite our sources as in Wilson et al. (2013a, b). Unfortunately, problems in scientific publication still persist, which are identified to clarify our position, as follows: (a) a lack of appropriate taxon representation; (b) a lack of appropriate taxonomic follow-through; and (c) taxon recognition based on non-phylogenetic grounds. We discuss some of these problems below and in the section entitled "Controversial Taxonomic Issues."

An example of lack of appropriate taxon representation is evident in the manner in which recognition of the genus *Masticophis* has been treated in recent literature. We believe efforts to synonymize *Masticophis* with *Coluber* have been hampered by a serious lack of appropriate taxon representation by previous investigators (e.g., Utiger et al. 2005; Pyron et al. 2013; and others). As traditionally recognized (e.g., Wallach et al. 2014), *Masticophis* contains at least 11 species, and no taxonomic analysis to date has included more than a small sample of those. In addition, little effort has been made to examine the phylogenetic relationships of the 11 species to more than a handful of the other genera and their constituent species that likely are close relatives of *Masticophis* and *Coluber* (for elaboration, see section on Controversial Taxonomic Issues).

Another example of a lack of appropriate taxon representation regarding racers in the Burbrink et al. (2008) study is the absence of samples of *C. constrictor* from Mexico, Belize, or Guatemala, where the "subspecies" *C. c. oaxaca* has been recognized (Köhler 2008). Lack of appropriate taxon representation is a common inconsistency in taxonomic studies of the herpetofauna that occur in the United States and neighboring Latin America, where taxon sampling often stops at or near the United States and Mexico border.

The single species recognized in the genus *Coluber* (*C. constrictor*) is what used to be recognized as the generotype of a much larger constellation of species that mostly occur in the Old World, which now have been segregated into seven genera (including the six listed in Wallach et al. 2014, and another genus, *Argyrogena*, resurrected by Wilson 1967, to contain the species *A. fasciolatus*). Wallach et al. (2014) noted that Burbrink et al. (2008) studied *C. constrictor* from a phylogenetic perspective and recognized "six unnamed clades." The clades or lineages they recognized are reminiscent of the "subspecies" arrangement held prior to the publication of their study (e.g., Conant and Collins 1998; Stebbins 2003). Burbrink et al. (2008) concluded that, "according to the general lineage concept of species, the racer may not be a single taxon, particularly since several lineages are well-defined geographically and are of very ancient origin." So, our questions to these authors are: (1) what happened to the taxonomic follow-through; (2) what is the taxonomic status of the six recognized but unnamed lineages; and (3) given that the lineages are noticeably not named in Burbrink et al. (2008), is there somewhere else where they are, or will be named? The logical place to find this information would be at the Center for North American Herpetology website, but the standard complement of 11 subspecies is listed there (accessed 1 March 2015). Nonetheless, it would be simple to figure out the names of the six lineages recognized in Burbrink et al. (2008), but it is not our responsibility to second-guess the authors and apply the designations to their recognized lineages. We believe, however, that the authors of this study and others like it are responsible for providing the necessary taxonomic follow-through and place some binomial on the lineages in question, at least until someone else reports different conclusions.

The last issue is taxon recognition based on non-phylogenetic grounds. Recognition of taxa must be founded on conclusions reached in phylogenetic studies using evidence-based data published in peer-reviewed scientific outlets. Once published, the information can be applied to resolve a variety of problems, such as determining conservation status. Importantly, such resolutions must be founded entirely on solid phylogenetic grounds. We cite a perplexing recent example to the contrary. Sanders et al. (2013) studied the phylogeny of the viviparous

*Bolitoglossa cerroensis.* This web-footed salamander is distributed in the Cordillera de Talamanca in central Costa Rica, where it occurs Lower Montane and Montane Wet forests at elevations from 2,530 to 2,990 m. We determined its EVS as 16, placing it in the middle portion of the high vulnerability category, and its IUCN status is Least Concern. This individual is from near Cerro de la Muerte. *Photo by Tobias Eisenberg.*

*Bolitoglossa diaphora.* This Cusuco web-footed salamander is known only from Parque Nacional Cusuco, Sierra de Omoa, in northwestern Honduras, where it occurs in Lower Montane Wet Forest at elevations from 1,450 to 2,200 m. We calculated its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Critically Endangered. This individual is from the vicinity of the type locality. *Photo by Todd Pierson.*

*Bolitoglossa centenorum.* This web-footed salamander is only known from the type locality on Cerro Bobic in west-central Guatemala, in the Sierra de Cuchumatanes, department of Huehuetenango, where it occurs in Montane Wet Forest at en elevation of 3,250 m. We gauged its EVS as 18, placing it in the upper portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from near San Mateo Ixtatán. *Photo by Todd Pierson.*

*Bolitoglossa aureogularis.* The Yellow-throated Web-footed Salamander is known only from two localities in Costa Rica, of which one is the vicinity of the type locality on the Atlantic versant of the Cordillera de Talamanca; it occurs in Lower Montane Wet forest (cloud forest) at elevations from 1,680 to 2,100 m. We estimated its EVS as 18, placing it in the upper portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from the headwaters of the Río Coén, province of Limón. *Photo by Roney Santiago and Eduardo Boza Oviedo.*

seasnakes using both mitochondrial and nuclear markers from 39 of 62 species and 15 of 16 genera. We found one of their conclusions of particular interest because they allocated the long-recognized genus *Pelamis*, with its single species, to the genus *Hydrophis* (the name thus became *Hydrophis platurus*). This view later was supported by the broader study of Pyron et al. (2013), so we accept it based on the suggestions presented in both studies. We take issue, however, with the last sentence in Sanders et al. (2013), which reads: "The taxon *Hydrophis* is well known as comprising dangerously venomous sea snakes; hence, retaining this name (instead of adding multiple new genera) will create less confusion for conservationists, medical professionals, and fishing industries/communities as well as herpetologists." The level of confusion agonized over by the types of people indicated, including those compiling taxonomic lists (taxonomic inflation - Isaac et al. 2004; Will et al. 2005) is not a valid reason for reaching taxonomic conclusions, in this case whether one genus (*Hydrophis*) should be recognized or multiple genera (including, according to the authors, five new genera). Making life easier for persons not evolutionarily driven is not a valid motive for disregarding phylogenetic conclusions.

We also contend that recognizing subspecies as a formal taxonomic category, or placing them as separate evolutionary lineage segments on a phylogeny, are examples of taxon recognition based on non-phylogenetic grounds. Unfortunately, many studies continue this practice and sometimes unnessessarily confound taxonomic issues. In particular, the wrongful use of subspecies as a formal taxonomic category can obscure the issue when geographic pattern classes (Grismer 2002) of the same species are acknowledged with official taxonomic names. Such variation can be erratic when it expresses vastly inconsistent spatial features in ecological conditions and in the size of intergrade zones, and is a non-phylogenetic and speculative concept without basis in authenticity. In a similar context, Uetz et al. (2014) unfairly criticized Wallach et al. (2014) for not recognizing subspecies in their Snakes of the World, which in our opinion was the correct thing for the latter authors to do because of the invalid status of subspecies in modern phylogenetically based taxononmy. Identifying subspecies today only has relevance in historical perspectives.

## Controversial Taxonomic Issues

Our work deals with over one thousand species of amphibians, crocodylians, squamates, and turtles occurring in Central America. Thus, differences in taxonomic opinion are expected between our position and those held by other systematic herpetologists. We discussed some of these differences above in Our Taxonomic Positions section, and discuss others below.

***Trachemys* in Central America.** — In recent years, the taxonomy of the turtle genus *Trachemys* in Mesoamerica has been examined numerous times with inconsistent results. Seidel and Smith (1986) transferred the taxon *Pseudemys scripta* and its subspecies into the genus *Trachemys*. Legler (1990) continued recognizing *Pseudemys* as the genus containing *T. scripta* and acknowledged the Central American forms as *P. s. venusta* (Caribbean versant of southern Mexico and the Yucatan Peninsula), *P. s. grayi* (Pacific side from the Isthmus of Tehuantepec to western Guatemala), and *P. s. emolli* (Nicaraguan lakes and Costa Rica). Ernst (1990) accepted the genus *Trachemys* and similarly recognized the subspecies *T. s. venusta* and *T. s. grayi*, but considered *T. s. ornata* as occurring from Honduras to Panama. Seidel (2002) later elevated two of the Central American forms to *T. emolli* and *T. venusta*. Bonin et al. (2006) considered *T. ornata* to be a Mexican Pacific versant endemic, *T. venusta* as occurring on the Atlantic slopes from Veracruz, Mexico, to Panama and on the Pacific side from southeastern Oaxaca, Mexico, to Guatemala, and *T. emolli* as restricted to Nicaragua and adjacent Costa Rica. Köhler (2008) reviewed the most recent literature on this species complex, but preferred to take a "conservative approach" and relegated all Central American populations to indeterminate status as part of the wide-ranging *Trachemys scripta*, but commented that he expected the taxonomy to be revised.

Fritz et al. (2011) examined the molecular phylogeny of the slider turtles of Mexico, Central America, and South America and determined previous allocations to be incorrect, therein identifying two species in Central America: *T. grayi* and *T. ornata*. Their evidence indicated that *T. grayi* occurred intermittently on the Pacific lowlands of Oaxaca, Mexico, through Panama and included species or subspecies of taxa previously considered as *T. venusta panamensis*, *T. v. grayi*, and *T. emolli*. Their information also specified that *T. ornata* ranged sporadically on the Pacific versant from Sinaloa, Mexico (type locality, Mazatlan), to a depicted allopatric population in the vicinity of Acapulco, Guerrero, the only locality in western Mexico from which they had samples. *Trachemys ornata* also was reported to occur from Tamaulipas, Mexico, on the Atlantic versant into South America. Populations of *T. ornata* from that area previously were listed as comprised of *T. venusta cataspila*, *T. v. venusta*, *T. v. uhrigi*, and two subspecies of *T. callirostris* in South America. In a paper associated primarily with Antillean *Trachemys*, Parham et al. (2013) continued to recognize *T. venusta* for Atlantic versant turtles without analyzing any *T. ornata* from western Mexico (except from the supposed isolated population around Acapulco), and *T. emolli* on the Pacific vesant of middle Central America because of its supposed allopatric distribution. McCranie et al. (2013), in reporting the taxon *T. g. emolli* in southern Honduras, added new data that corroborated the taxonomy of Fritz et al. (2011), although they cited the publication date of that paper as 2012. The main problem with both Fritz et al. (2011) and McCranie et al. (2013), as with most recent sources, is that these authors continued to utilize subspecies as a formal taxonomic category.

The question arises as to what these recent studies demonstrate regarding which species-level taxa of slider turtles should be recognized in Central America. In our effort to arrive at a decision, we examined the latest version of the world turtle checklist published by the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group (van Dijk et al. 2014). These authors adopted a position that allows users of the checklist to arrive at their own conclusion on what taxa at what level can or should be recognized, which leads to a curious situation. They recognized three taxa of slider turtles in Central America. One was *T. venusta*, which supposedly was distributed principally along the Atlantic versant from Tamaulipas, Mexico, to extreme northwestern Colombia, but also on the Pacific versant in Panama. van Dijk et al. (2014), however, suggested that this taxon also could be called, in addition to *T. venusta*, *T. ornata venusta*, or *T. venusta venusta*. They also listed *T. grayi* (Pacific versant of Oaxaca, Mexico, to eastern El Salvador), but indicated that it could also be called *T. venusta grayi*. Finally, they included *T. emolli* (Pacific versant from eastern El Salva-

*Bolitoglossa indio.* This web-footed salamander is known from the lowlands of the Río San Juan area in extreme southeastern Nicaragua and north-central Costa Rica, where it occurs in Lowland Moist Forest at elevations from 25 to 68 m. We evaluated its EVS as 17, placing it in the middle portion of the high vulnerability category, and its IUCN status is Data Deficient. This individual is from the type locality, Dos Bocas de Río Indio, department of Río San Juan, Nicaragua. *Photo by Javier Sunyer.*

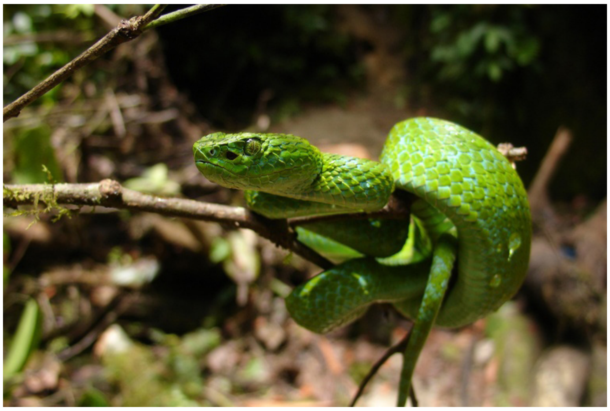
dor to northwestern Costa Rica), but also listed the taxon as *T. grayi emolli*. So, the reader could make a choice among three species and/or subspecies (*grayi*, *ornata*, and *venusta*) into which to place the three Central American populations of slider turtles under a total of seven preferred names.

We then examined Legler and Vogt's (2013) book on Mexican turtles to see how they handled the issue, and quickly realized that their taxonomic arrangements were permeated with subspecies, and that they continued to treat all populations as subspecies of *T. scripta*. When we ignored the trinomials and just concentrated on the subspecific names as potential species names, Legler and Vogt's (2013) scheme would recognize the following: *T. ornata* as occurring on the Pacific side of Mexico from Sinaloa southwestward to the area around Acapulco, Guerrero, the latter location depicted as a broadly allopatric population (also illustrated that way by Legler 1990, and Seidel 2002); *T. venusta* as ranging on the Atlantic versant from southeastern Veracruz through Central America into Colombia, and on the Pacific side in western Panama and adjacent Costa Rica; and *T. grayi* as occurring on the Pacific versant from south-central Oaxaca into El Salvador. They did not recognize the taxon *emolli* that had been considered a subspecies of *P. scripta* by Legler (1990) and *T. scripta* by Iverson (1992), as a full species by Seidel (2002) and Jackson et al. (2008), and as *T. grayi* by Fritz et al. (2011).

McCranie et al. (2013) also produced a subspecies infused phylogeny, so again if their trinomials are ignored, their taxa as based on distributional information found on their phylogeny, included the following potential Central American forms: *T. ornata* ranging from Sinaloa, Mexico, on the Pacific versant to Acapulco, Guerrero, and on the Atlantic slope from Tamaulipas, Mexico, southward and eastward through Central America to Venezuela; and *T. grayi* occurring on the Pacific slope from southeastern Oaxaca, Mexico, to Panama. A major difference of Fritz et al. (2011) and McCranie et al. (2013), when compared to the other papers, was that of all the species of *Trachemys* in Central America, only *T. ornata* occurred on both Atlantic and Pacific versants of Mexico above the Isthmus of Tehuantepec and on the Atlantic slope of Central America. Below the Isthmus, however, only *T. grayi* was present on the Pacific side, from southwestern Mexico to Panama. The pattern of species distributed on the Pacific and Atlantic sides connected near the Isthmus of Tehuantepec, as in *T. ornata*, also is found among crocodylians, squamates, and other turtles (see maps in Köhler 2008).

Seidel (2002) and Legler and Vogt (2013) regarded the population of *Trachemys* located on the Pacific side of Panama and Costa Rica as *T. venusta*, a species that almost everywhere else in Mesoamerica was an Atlantic versant form. Parham et al. (2013) thought that *T. venusta* and *T. emolli* probably intergraded in southern Nicaragua and northern Costa Rica, although they apparently had no access to the information in McCranie et al. (2013). Fritz et al. (2011) and McCranie et al. (2013) both reported that *T. grayi* was the species present from Pacific Costa Rica and Panama, which was conspecific with other populations to the northwest on the Pacific slopes, and not to those on the Atlantic side. The question of what species name to use for the Atlantic versant population occurring from Tamaulipas into South America tentatively is answered by recognizing the conclusions of the published positions of Fritz et al. (2011) and McCranie (2013) that *T. ornata* is the valid name, because it has publication date priority over *T. venusta*. The decision by Parham et

*Bothrops punctatus.* This semiarboreal pitviper is distributed from extreme eastern Panama to northwestern Ecuador, where it occurs in Lowland Wet, Premontane Wet, and Lower Montane Wet forests at elevations from near sea level to 2,300 m. We evaluated its EVS as 16, placing it in the middle portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from the Serranía de Pirre, province of Darién, Panama. *Photo by Abel Batista.*



*Bothriechis marchi.* The Honduran Emerald Tree Viper is endemic to northwestern and north-central Honduras, where it occurs in Premontane Wet and Lower Montane Wet forests at elevations from 500 to 1,840 m. We calculated its EVS as 16, placing it in the middle portion of the high vulnerability category, and its IUCN status is Endangered. This individual is from Parque Nacional Cusuco, Sierra de Omoa, department of Cortés. *Photo by Silviu Petrovan.*

*Bradytriton silus.* This salamander, the sole member of its genus, is endemic to the Sierra de Cuchumatanes in northwestern Guatemala, where it is known only from two localities in Premontane and Lower Montane Wet forests at elevations of 1,310 and 1,640 m. We established its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Critically Endangered. This individual is from San José Maxbal, department of Huehuetenango. *Photo by Sean Michael Rovito.*

*Bolitoglossa insularis.* This web-footed salamander is endemic to Volcán Maderas on Ometepe Island in southwestern Nicaragua, where it occurs in Premontane Moist Forest at elevations from 800 to 1,050 m. We assessed its EVS as 18, and its IUCN status is Vulnerable. This individual is from Volcán Maderas, Isla de Ometepe, department of Rivas. *Photo by Javier Sunyer.*

al. (2013) to revert to calling the Atlantic versant turtles *T. venusta* is curious. These authors admitted that Atlantic and Pacific Mexico populations probably were conspecific and that the valid name would be *T. ornata*. Still, they decided to maintain the name *T. venusta* because they had no data from Mexican west coast *T. ornata* other than samples from the supposed allopatric population in the vicinity of Acapulco, which they thought might have been introductions, and speculated that genetic introgression was the reason for their alliance with *T. ornata*; to us, this indicates that wild *T. ornata* probably were present in the area. We also question the allopatric nature of the Acapulco population because another Guerrero locality for *T. ornata* was reported by Mertz et al. (2015) from 200 km NW of Acapulco, which bridges a portion of the distributional gap between Cabo Corrientes, Jalisco, and Acapulco (Legler and Vogt 2013).

For our purposes in this paper and to try to reduce the confusion created in the van Dijk et al. (2014) checklist and other papers, we consider that the equivalent data in Fritz et al. (2011) and McCranie (2013) best explain the present knowledge of the taxonomic status of *Trachemys* in Central America, so we recognize two species-level taxa of slider turtles: *T. grayi* on the Pacific lowlands and *T. ornata* on the Atlantic side, with their ranges as indicated above. Nonetheless, we reject all reference to subspecies due to taxonomic recognition based on non-phylogenetic grounds.

**Taxonomy of *Chelonia mydas*.** — The Green Turtle, *Chelonia mydas*, is a cosmopolitan species of marine turtle that occurs in all the tropical to temperate oceans, and has been regarded as showing considerable individual and geographic variation in morphological and genetic characters (see discussion in Ernst and Lovich 2009). *Chelonia agassizii*, a supposedly Pacific Ocean form, was named by Bocourt (1868) for an individual from the Pacific coast of Guatemala, which some authorities have determined to be a local variant of *C. mydas* (Karl and Bowen 1999), others have considered it a subspecies of *C. mydas* (Kamezaki and Matsui 1995), and still others as a full species (Iverson 1992; Pritchard 1999; Savage 2002; Bonin et al. 2006). In a morphological study of *C. mydas* from coastal waters around Japan, Okamoto and Kamezaki (2014) found differences between two samples of turtles that appeared to validate *C. mydas* and *C. agassizii* as separate species (at least around Japan), and they commented on other studies in the Pacific Ocean that agreed with their findings (e.g., Parker et al. 2011). We consider that the possibility of the two species arrangement eventually might stand or even expand. We also feel, however, that accepting the two species scenario is premature because of a serious lack of appropriate taxon representation, especially in the Atlantic and Indian Oceans, as well as the need for using more relevant phylogenetic criteria to decipher species-level taxonomic status within the composite of populations associated with *C. mydas*.

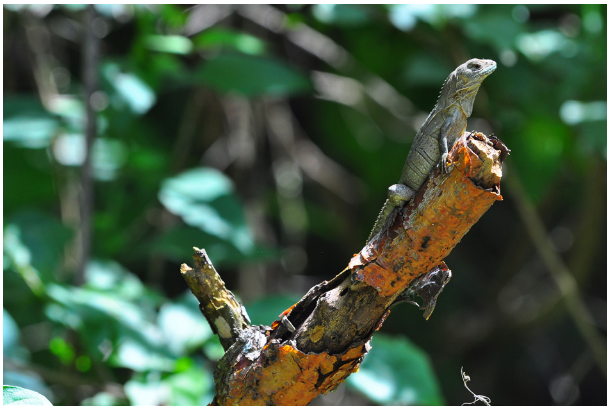
**Status of *Cryptochelys*.** — Taxon delimitation among the turtles historically placed in the family Kinosternidae has been challenging at all taxonomic levels, and this controversy continues to the present. Two recent studies are relevant to the status of members of this group in Central America. As noted in van Dijk et al. (2014), "Iverson et al. (2013) sequenced three mtDNA and three nuclear markers for every recognized species and most subspecies of kinosternids. Their analyses revealed three well-resolved clades within the Kinosternidae, corresponding to *Sternotherus*, a previously unnamed clade that they described as the new genus *Cryptochelys*, and *Kinosternon sensu stricto*. Their molecular data support for *Cryptochelys* was strong, but data support for non-monophyly of *Kinosternon* with respect to *Sternotherus* was weak. The identified groups are broadly consistent with morphological and biogeographical features. Their new genus *Cryptochelys* was diagnosed based on an extensive set of morphological and molecular characters, and contains the designated type species *leucostoma*, as well as *acuta*, *angustipons*, *creaseri*, *dunni*, and *herrerai*." van Dijk et al (2014) referenced "a parallel study of kinosternid phylogenetics … that reaches different taxonomic conclusions." The title of this paper by Spinks et al. (2014), "Multilocus phylogeny of the New-World mud turtles (Kinosternidae) supports the traditional classification of the group," indicated the principal conclusion of this paper, i.e., a rebuttal of the Iverson et al. (2013) classification, as well as an argument for maintaining stability in organismic classifications. Their abstract provides a good statement of their position, as follows: "A goal of modern taxonomy is to develop classifications that reflect current phylogenetic relationships and are as stable as possible given the inherent uncertainties in much of the tree of life. Here, we provide an in-depth phylogenetic analysis, based on 14 nuclear loci comprising 10,305 base pairs of aligned sequence data from all but two species of the turtle family Kinosternidae, to determine whether recent proposed changes to the group's classification are justified and necessary. We conclude that those proposed changes were based on (1) mtDNA gene tree anomalies, (2) preliminary analyses that do not fully capture the breadth of geographic variation necessary to motivate taxonomic changes, and (3) changes in rank that are not motivated by non-monophyletic groups. Our recommendation, for this and other similar cases, is that taxonomic changes be made only when phylogenetic results that are statistically well-supported and corroborated by multiple independent lines of genetic evidence indicate that non-phylogenetic groups are currently recognized and need to be corrected. We hope that other members of the phylogenetics community will join us in proposing taxonomic changes only when the strongest phylogenetic data demand such changes, and in so doing that we can move toward stable, phylogenetically informed classifications of lasting value." Operating on this basis, Spinks et al. (2014) rejected the Iverson et al. (2013) genus *Cryptochelys*, moved the six above-mentioned species back into the genus *Kinosternon*, and maintained recognition of the genus *Sternotherus*. The Spinks et al. (2014) arrangement appears to rest on a more secure basis, does not support recognition of *Cryptochelys*, and is the approach we tentatively adopted. Nonetheless, we wish to caution those same "members of the phylogenetics community" that attempting stability of organismic classification is only desirable if it does not limit scientific discourse. Given that humans will always be dealing with the inherent uncertainties in much of the tree of life, and that their scientific toolbox can only hope to recover phylogenies of organisms about which we are aware, systematic biologists must have the freedom to attempt such recovery in a spirit of cooperative enlightenment. After all, we are guided in this effort by the conventions of peer review in scientific publications and the principles of zoological nomenclature. Even with these conventions, it will never be possible for systematists to locate a comfortable armchair from which to reflect on stable, phylogenetically informed classifications of lasting value.

**Staurotypinae vs. Staurotypidae.** — Divergent approaches to the family-level classification of the genera *Claudius* and *Staurotypus* were taken in the Iverson et al. (2013) and Spinks et al. (2014) papers discussed above, with the former arguing for the placement of these genera

*Craugastor laevissimus.* This species is distributed from western and east-central Honduras to northern and southwestern Nicaragua, where it occurs in Lowland Moist, Lowland Dry, Premontane Wet, Premontane Moist, Premontane Dry, and Lower Montane Moist forests at elevations from near sea level to 2,000 m. We assessed its EVS as 12, placing it in the upper portion of the medium vulnerability category, and its IUCN status is Endangered. This individual is from Cerro Kilambé, department of Jinotega, Nicaragua. *Photo by Javier Sunyer.*

*Craugastor chingopetaca.* This rainfrog is known only from the type locality along the Río San Juan in extreme southeastern Nicaragua, department of Río San Juan, where it occurs in Lowland Wet Forest at an elevation of 40 m. We evaluated its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Data Deficient. This individual is from Reserva de Vida Silvestre Río San Juan. *Photo by Javier Sunyer.*

*Craugastor nefrens.* The distribution of this ranita de hojarasca (little litter frog) is restricted to a narrow elevational band (800–1,000 m) of Premontane Wet Forest in the Sierra de Caral of eastern Guatemala, near the border with Honduras. We established its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Data Deficient. This individual is from Finca la Firmeza, Morales, department of Izabal. *Photo by Sean Michael Rovito.*



*Ctenosaura palearis.* This Guatemalan spiny-tailed iguana is endemic to the Motagua Valley in eastern Guatemala, where it occurs in Lowland Arid and Premontane Dry forests at elevations from 150 to 700 m. We calculated its EVS as 19, placing it in the upper portion of the high vulnerability category, and its IUCN status is Endangered. This individual is from Zacapa, Motagua River Valley, department of Zacapa. *Photo by Antonia Pachmann.*

in the family Staurotypidae and the latter in the subfamily Staurotypinae. Iverson et al. (2013) followed Bickham and Carr (1983) in recognizing two clades, one consisting of *Claudius* and *Staurotypus* and another of *Kinosternon* and *Sternotherus*, as separate families, based on the estimated age of the clades and their unambiguously distinct morphologies and sex-determining mechanisms (genetic sex determination in the former clade and temperature-dependent sex determination in the latter), as well as the concatenated sequences of three nuclear and three mitochondrial genes. Spinks et al. (2014: 258), however, argued that, "in the interest of maintaining taxonomic stability … we suggest that the community maintain the historical treatment of Staurotypinae as a subfamily as has been done for decades." We briefly explained our position on this matter above, and in this case follow the recommendations of Iverson et al. (2013) and recognize the genera *Claudius* and *Staurotypus* in the family Staurotypidae, distinct from the family Kinosternidae that includes the genera *Kinosternon* and *Sternotherus*.

**Single-genus vs. multiple-genera approaches to anole classification.** — A sizeable number of herpetologists are interested in anoles and their classification. Over the years, many herpetologists have tried to make sense of a group of lizards that presently contains 395 species

(Reptile Database website; accessed 28 February 2015), with more added each year (e.g., see our listing of presently added taxa to the Central American herpetofauna, in which we document the recognition of 15 additional species-level taxa since the publication of Wilson et al., 2010). Gunther Köhler and his colleagues undertook most of this work and with one exception (*Dactyloa ginaelisae*) described or resurrected the remainder under the genus *Anolis*. In our present work, we list 95 species of anoles in Central America, and Wilson et al. (2013a) recorded 50 species from Mexico; presently 129 species comprise the anole fauna of Mesoamerica (16 species occupy both regions; www.mesoamericanherpetology.com; accessed 28 February 2015). In Wilson et al. (2013a), we listed all 50 Mexican species under the genus *Anolis*. We took that position because a controversy was brewing over the classification proposed by Nicholson et al. (2012), especially with the harsh rebuttal of this paper by Poe (2013), and we were uncertain where the controversy would go. Since that time, however, Nicholson et al. (2014) provided a detailed response addressing Poe's concerns. Most anyone with an interest in anole systematics knows the backstory, beginning with Guyer and Savage's (1986) revolutionary cladistic analysis of the anoles. The effect of that study was to segment the huge and unwieldy genus *Anolis* into a series of eight genera. Subsequently, Williams (1989) authored a scathing critique of the Guyer-Savage approach, asking if the data were available to reclassify the anoles; herpetologists varied in their opinions. During the ensuing years, students of tropical American herpetology basically fell into two camps, those who supported or opposed the Guyer-Savage scheme. In recent years, we sided with the latter camp (Wilson and Johnson 2010; Johnson et al. 2010; Wilson et al. 2013a), but did not undertake an exhaustive study of the matter. Nonetheless, after the publication of Poe's (2013) critique of the Nicholson et al. (2012) paper and the Nicholson et al. (2014) rebuttal, we decided to take a fresh look at this issue. Principally, the controversy that developed over the last two years results from two approaches to the classification of anoles. The Nicholson et al. (2012, 2014) approach was to recognize eight genera of these lizards. Poe's (2013) tactic was to jettison entirely the Nicholson et al. (2012) approach and to recognize a single genus that contained 391 species, the largest genus of squamates. Fundamentally, Poe's criticism of the eight-genus approach was two-fold, i.e., that "some of the proposed genera are not monophyletic" and that Nicholson et al. (2012) did not study enough taxa or enough characters. Nicholson et al. (2014) presented their rebuttal "to explain how Poe erred in characterizing our work, and missed the opportunity to present an alternative comprehensive taxonomy to replace the one against which he argues so strenuously. In this contribution we explain, and correct, Poe's errors and misrepresentations, and argue that our taxonomy is likely to be adopted because it (1) eliminates the obvious problem that will arise if the family Dactyloidae contains only a single large genus (i.e., that a single genus obscures the evolution and diversity within the group and misrepresents or cloaks it), (2) it conforms with the long historical trend of dissecting large, cumbersome groups into smaller sub-units, (3) is consistent with all recent phylogenetic studies for anoles in membership within clades we recognize as genera, and (4) aids in associating these lizards with the ancient land masses that shaped their history." We consider that Nicholson and her coauthors adequately responded to Poe's criticisms and we are confident in adopting the portion of their scheme relevant to the situation in Central America, and Mesoamerica as a whole. So, what impact does the Nicholson et al. approach have on the taxonomy of anoles in Mesoamerica? As it turns out, only three of the eight genera Nicholson et al. (2012, 2014) recognized contain Mesoamerican species as follows: *Anolis* (one species), *Dactyloa* (10 species), and *Norops* (118 species). The distribution of the genus *Anolis* is stated by Nicholson et al. (2012) to be in "the Bahamas, Cuba, and adjacent islands, Navassa Island, Little Cayman [I]sland, Hispaniola, and the southeastern United States west to Oklahoma and Texas." They further indicated that, "one Cuban species (*A. allisoni*) occurs on Isla Cozumel, Mexico and Islas de la Bahía, Honduras, and on coastal islands off Belize." Distribution of the genus *Dactyloa* is indicated by Nicholson et al. (2012) to be on the "Atlantic and Pacific slopes of Costa Rica and Panama, then south through the Chocó region of Colombia and Ecuador, including Malpelo Island; highlands of Colombia, Ecuador, Peru, and Venezuela; Caribbean slope of Colombia and Venezuela; Bonaire and Blanquilla Islands and the southern Lesser Antilles; south on the Atlantic versant through the Guayanas to Espiritu Santo State in eastern Brazil, and throughout the Orinoco and Amazon Basins in Colombia, Ecuador, Peru, Venezuela, Bolivia, and Brazil." The remainder of the anoles in Central America (as well as all of the species in Mexico except for *Anolis allisoni*) are placed in the genus *Norops*, which Nicholson et al. (2012) reported to occur in "Cuba, Jamaica, Bahamas, Grand and Little Cayman, Cayman Brac, Mexico, Central America, and many adjacent islands, including Cozumel, the Bay Islands, the Corn Islands, Swan Island, San Andres and Providencia (Caribbean) and Isla del Coco (Pacific); south to western Ecuador, northern South America (Colombia and Venezuela), including Isla Gorgona (Pacific), the islands of Aruba, Curaçao, and Margarita (Caribbean), Trinidad and Tobago; then south through the Guyanas to southeastern and southern Brazil, and Paraguay, and throughout the Orinoco and Amazon Basins (Colombia, Venezuela, Ecuador, Peru, Brazil, and Bolivia)." We agree that Nicholson and her coauthors provided a perceptive set of reasons why their classification will be accepted in time, just as with other classifications that sought to

*Cryptotriton nasalis.* This small salamander is endemic to the Sierra de Omoa in northwestern Honduras, where it occurs in Premontane and Lower Montane Wet forests at elevations from 1,220 to 2,200 m. We estimated its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Endangered. This individual is from the Sierra de Omoa, department of Cortés. *Photo by Sean Michael Rovito.*

make sense of formerly unmanageable genera, such as *Eleutherodactylus*, which now not only is segmented into a number of genera, but also a number of families.

***Coluber* versus *Masticophis*.** — We base most of this commentary on information discussed in Wilson and Johnson (2010), along with a fresh look at the available data and on our reliance on the proper use of phylogenetic systematics to produce accurate conclusions. The major issue is: should the genus *Masticophis* be synonymized with the genus *Coluber* based on the information available today? This question has been contentious for many years, and the disagreement stems from a number of factors, including overall molecular, morphological, and ontogenetic similarities between the two genera; a prodigious lack of appropriate taxon representation in seminal papers of recent vintage (see Our Taxonomic Position section), especially those that reflected molecular comparisons; and the overt continuation of recognizing groups at the subspecies level.

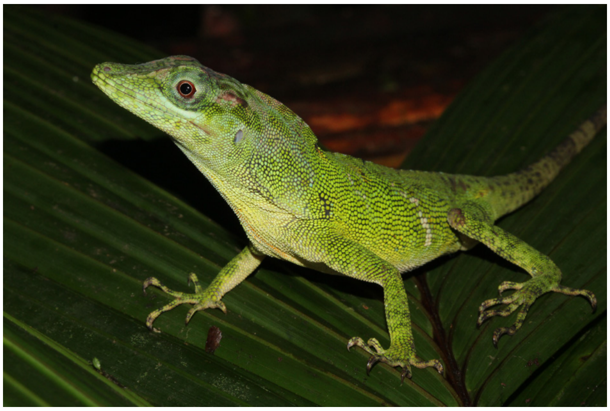
Nagy et al. (2004), in a molecular study using mitochondrial and nuclear genes, agreed with Schätti's (1987) morphogical investigation that the genus *Coluber* (*sensu stricto*) should be restricted to the New World; both declined to synonymize *Masticophis* with *Coluber* based on their own data. Utiger et al. (2005), with low support, found *Masticophis flagellum* to be nested within *Coluber constrictor*, with *M. taeniatus* as the sister to the *C. constrictor-M. flagellum* clade, which made *Masticophis* paraphyletic, therein recommending the placement of *Masticophis* into *Coluber* (the older generic name). Burbrink et al. (2008) examined *C. constrictor* from throughout upper North America and concluded the species to be monophyletic and composed of six unnamed lineages; they also considered *M. flagellum* the sister species to *C. constrictor*, thus negating Utiger et al.'s. (2005) verdict that a population of *C. flagellum* was more closely related to *C. constrictor* than to other populations of *C. flagellum*. The Burbrink et al. (2008) treatment also is afflicted with a lack of taxonomic follow-through, inasmuch as the separate lineages within the *C. constrictor* complex they disclosed are not named. In addition, they did not indicate the species to which *M. flagellum* is the sister taxon. Collins and Taggart (2008) correctly noted that because of incomplete taxon sampling by Utiger et al. (2005), the generic status of certain taxa could not be addressed adequately. Wilson and Johnson (2010) also presented summary information on this debate, and commented that Utiger et al. (2005) did not provide adequate samples from throughout the range of the respective taxa (e.g., at least nine other species of *Masticophis* were not included in their study). Both Collins and Taggart (2008) and Wilson and Johnson (2010) recommended the continued recognition of both genera as separate taxa, although some publications have continued to use *Coluber* for all the species of *Masticophis*, most notedly *C. flagellum* and *C. taeniatus*, species occurring sympatrically in the southwestern United States.

Importantly, no comparison has been made between *M. flagellum* and the wide-ranging *M. mentovarius*, as presently envisioned, which long were thought to be sister species (e.g., Wilson 1970; Johnson 1977). Also, only a small amount of genetic material has been available to examine and compare the relationships of *Coluber* and *Masticophis* to other genera of North American racer-like colubrids (e.g., *Dendrophidion*, *Drymobius*, *Leptodrymus*, *Leptophis*, *Mastigodryas*, *Salvadora*), of which most do not occur northward outside of Mexico.

*Craugastor polyptychus*. This frog is distributed along the lowlands of the Atlantic versant from extreme southeastern Nicaragua to extreme northwestern Panama, where it occurs in Lowland Moist Forest at elevations from near sea level to 260 m. We estimated its EVS as 17, placing it in the middle portion of the high vulnerability category, and its IUCN status is Least Concern. This individual is from the Refugio Nacional de Vida Silvestre Gandoca-Manzanillo, province of Limón, Costa Rica. *Photo by Maciej Pabijan.*

*Crocodylus acutus*. The American Crocodile is broadly distributed in the Caribbean Basin from southern Florida and the Yucatan Peninsula south to Colombia and Venezuela, and on the Pacific coast of Latin America from Sinaloa in Mexico to Peru in South America. We evaluated its EVS as 14, at the lower end of the high vulnerability category, and its IUCN status is Vulnerable. This individual is from Isla Juan Venado, a barrier island constituting a nature reserve, department of León, Nicaragua. *Photo by Javier Sunyer.*

*Dactyloa ibanezi*. This anole is distributed on the Caribbean versant from southeastern Costa Rica to western Panama, where it occurs in Lowland Moist and Premontane Wet forests at elevations from 400 to 1,070 m. We established its EVS as 15, placing it in the lower portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from Donoso, province of Colón, Panama. *Photo by Abel Batista.*



*Dactyloa kunayalae*. This anole is distributed in western and central Panama, where it occurs in Lowland Moist and Premontane Wet forests at elevations from 320 to 1,050 m. We estimated its EVS as 15, placing it in the lower portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from the Río Tuquesa, province of Darién, Panama. *Photo by Abel Batista.*

In an extensive review of squamates, Pyron et al. (2013) also showed *C. constrictor* and *C. flagellum* as sister species and *C. taeniatus* as the sister to that clade, but didn't mention the overt lack of appropriate taxon representation when producing their phylogeny. Pyron et al. (2013) included some samples of other racer-like genera in their phylogeny, but still maintained a lack of sufficient taxon sampling in those genera, of which most have not undergone recent phylogenetic analyses. After all, if the phylogenetic interpretation is not accurate or based on inadequate taxonomic representation, it could lead to erroneous conclusions.

Another germane question about the generic status of *Masticophis* could be resolved by determining the phylogenetic position of *M. taeniatus* compared with that of the above-mentioned genera of racer-like species. After an all-encompasing phylogenetic comparison, the possibility exists that a monophyletic *M. taeniatus* group (eight species), could be assigned to a genus other than *Masticophis* or *Coluber*; which would remove the paraphyletic status of *Masticophis*, and make its inclusion into *Coluber* inconsequential.

In conclusion, because pertinent phylogenetic studies on the issue of *Coluber* versus *Masticophis* have not included appropriate taxonomic representation of members of the genera *Masticophis* and *Coluber* or genera of other Western Hemisphere racer-like colubrids, we accept the recommendations of Collins and Taggart (2008) and Wilson and Johnson (2010) and use the name *Masticophis* for the 11 species traditionally included in this genus, including *M. mentovarius* in Central America.

## A Revised Environmental Vulnerability Measure

Wilson et al. (2013a, b) adapted the Environmental Vulnerability Score developed by Wilson and McCranie (2004) for use in Mexico. The Mexican EVS only differed from that used for Honduras by Wilson and McCranie (2004) in the design of the geographic component (considering, however, that the third component of the measure differed between amphibians and the remainder of the herpetofauna). Herein, we revised the same component for use with the Central American herpetofauna, as follows:

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

The second component of the EVS measure, for ecological distribution based on occurrence in different vegetaion formations, is the same for Central America as for Mexico, 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 component, for amphibians, deals with the type of reproductive mode, as follows:

1 = both eggs and tadpoles are found in large to small bodies of lentic or lotic water
2 = eggs are deposited in foam nests, and tadpoles are found in small bodies of lentic or lotic water
3 = tadpoles are found in small bodies of lentic or lotic water, and eggs elsewhere
4 = eggs are laid in moist situations on land or in moist arboreal situations, and tadpoles (larvae) are carried (or move) to water or undergo direct development
5 = eggs and/or tadpoles are carried in the dorsal pouch of the female or are imbedded in the dorsum of female, larval or direct development, or viviparous
6 = eggs and tadpoles are found in water-retaining arboreal bromeliads or in water-filled tree cavities

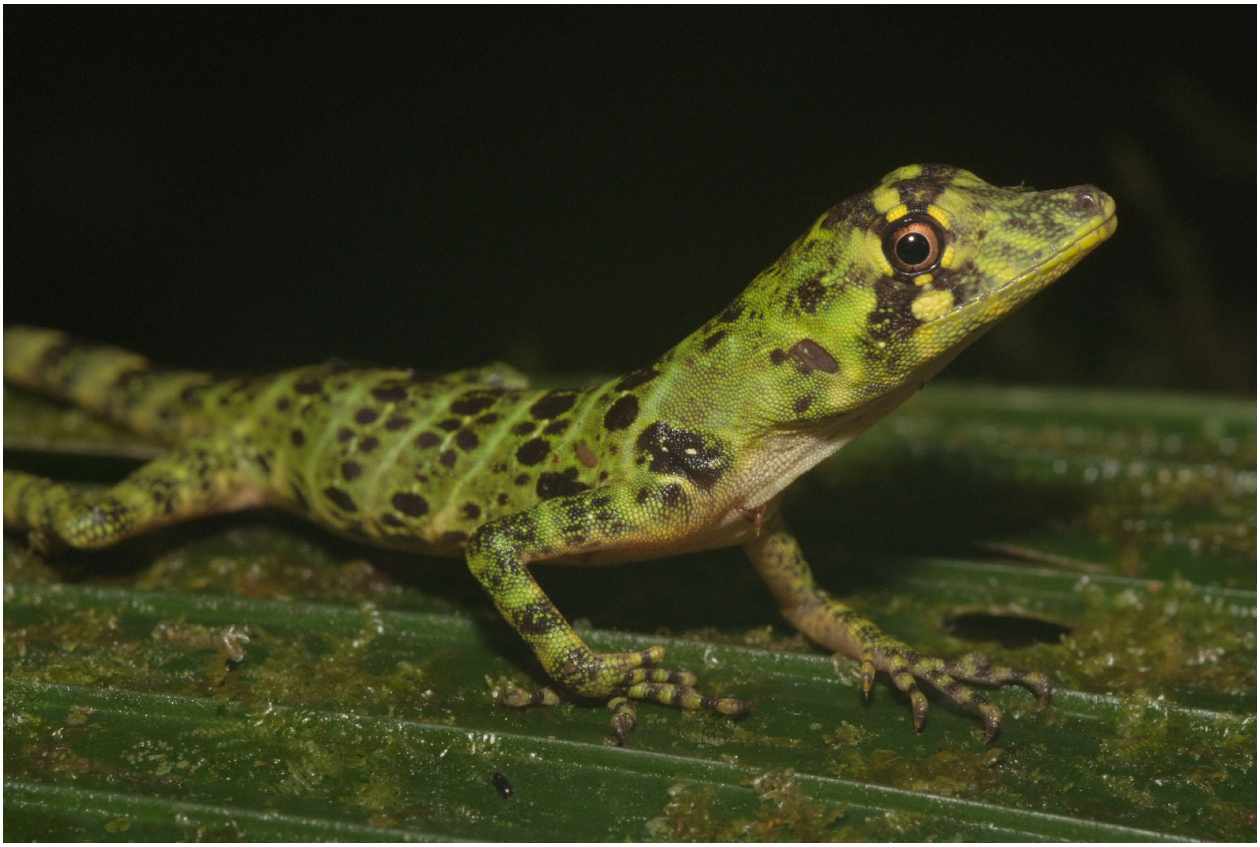
The third component, for crocodylians, squamates, and turtles, deals with the degree of human persecution, as follows:

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

Once these three components are added, the EVS can range from 3 to 20 in both groups. Wilson and McCranie (2004) placed the range of scores for Honduran amphibians into three categories of vulnerability to environmental degradation, as follows: low (3–9); medium (10–13); and high (14–19). The categories for the rest of the herpetofauna were similar, with the high category encompassing values of 14–20. Herein, we employ the same categorizations: low (3–9); medium (10–13); and high (14–20). In Appendices 1 and 2, these categories are signified by the abbreviations L (low), M (medium), and H (high).

## Recent Changes to the Central American Herpetofauna

Due to ongoing fieldwork in Central America by a number of herpetologists from around the globe, and the systematic research emanating from their fieldwork, the composition of the region's herpetofauna constantly is being updated. In most cases, the number of recognized taxa increases. These changes add or subtract from the taxonomic lists that appeared in Wilson et al. (2010);



*Dactyloa latifrons.* This anole is distributed from eastern Panama to northwestern Ecuador, where it occurs in Premontane Wet Forest at elevations from 665 to 780 m. We gauged its EVS as 13, placing it at the upper end of the medium vulnerability category, but its IUCN status has not been determined. This individual is from the Serranía de Pirre, province of Darién, Panama. *Photo by Abel Batista.*

since that work appeared, the following 92 species have been described, resurrected, or elevated to species level:

*Anomaloglossus astralogaster*: Myers et al. 2012. *American Museum Novitates* 3,763: 1–19. New species.

*Anomaloglossus isthminus*: Myers et al. 2012. *American Museum Novitates* 3763: 1–19. New species.

*Atelopus chirripoensis*: Savage and Bolaños. 2009. *Revista Biologia Tropical* 57: 381–386. New species.

*Incilius aurarius*: Mendelson et al. 2012. *Journal of Herpetology* 46: 473–479. New species.

*Incilius karenlipsae*: Mendelson and Mulcahy. 2010. *Zootaxa* 2396: 61–68. New species.

*Craugastor evanesco*: Ryan et al. 2010b. *Copeia* 2010: 405–409. New species.

*Andinobates geminisae*: Batista et al. 2014b. *Zootaxa* 3866: 333–352. New species.

*Diasporus citrinobapheus*: Hertz et al. 2012. *ZooKeys* 196: 23–46. New species.

*Diasporus igneus*: Batista et al. 2012. *Zootaxa* 3410: 51–60. New species.

*Ecnomiohyla bailarina*: Batista et al. 2014c. *Zootaxa* 3826: 449–474. New species.

*Ecnomiohyla sukia*: Savage and Kubicki. 2010. *Zootaxa* 2719: 21–34. New species.

*Ecnomiohyla veraguensis*: Batista et al. 2014c. *Zootaxa* 3826: 449–474. New species.

*Pristimantis adnus*: Crawford et al. 2010. *Herpetologica* 66: 171–185. New species.

*Bolitoglossa aureogularis*: Boza-Oviedo et al. 2012. *Zootaxa* 3309: 36–61. New species.

*Bolitoglossa centenorum*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa chucantiensis*: Batista et al. 2014d. *Mesoamerican Herpetology* 1: 96–121. New species.

*Bolitoglossa daryorum*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa eremia*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa huehuetenanguensis*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa jugivagans*: Hertz et al. 2013. *Zootaxa* 3636: 463–475. New species.

*Bolitoglossa kamuk*: Boza-Oviedo et al. 2012. *Zootaxa* 3309: 36–61. New species.

*Bolitoglossa kaqchikelorum*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa la*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa ninadormida*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa nussbaumi*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa nympha*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa omniumsanctorum*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. Resurrection from synonymy.

*Bolitoglossa pacaya*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa psephena*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa pygmaea*: Bolaños and Wake. 2009. *Zootaxa* 1981: 57–68. New species.

*Bolitoglossa robinsoni*: Bolaños and Wake. 2009. *Zootaxa* 1981: 57–68. New species.

*Bolitoglossa splendida*: Boza-Oviedo et al. 2012. *Zootaxa* 3309: 36–61. New species.

*Bolitoglossa suchitanensis*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa tenebrosa*: Vásquez-Almazán and Rovito. 2014. *Journal of Herpetology* 48: 518–524. New species.

*Bolitoglossa tzultacaj*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa xibalba*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Bolitoglossa zacapensis*: Rovito et al. 2010. *Journal of Herpetology* 44: 516–525. New species.

*Cryptotriton necopinus*: McCranie and Rovito. 2014. Zootaxa 3795: 61–70. New species.

*Cryptotriton sierraminensis*: Vásquez-Almazán et al. 2009. *Copeia* 2009: 313–319. New species.

*Dendrotriton chujorum*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Dendrotriton kekchiorum*: Campbell et al. 2010. *Miscellaneous Publications, Museum of Zoology, University of Michigan* (200): i–iv, 1–60. New species.

*Nototriton matama*: Boza-Oviedo et al. 2012. *Zootaxa* 3309: 36–61. New species.

*Nototriton mime*: Townsend et al. 2013c. *Zootaxa* 3666: 359–368. New species.

*Nototriton picucha*: Townsend et al. 2011. *Systematics and Biodiversity* 9: 275–287. New species.

*Oedipina chortiorum*: Brodie et al. 2012. *Journal of Herpetology* 46: 233–240. New species.

*Oedipina koehleri*: Sunyer et al. 2011. *Breviora* 526: 1–16. New species.

*Oedipina motaguae*: Brodie et al. 2012. *Journal of Herpetology* 46: 233–240. New species.

*Oedipina nica*: Sunyer et al. 2010. *Zootaxa* 2613: 29–39. New species.

*Oedipina nimaso*: Boza-Oviedo et al. 2012. *Zootaxa* 3309: 36–61. New species.

*Oedipina petiola*: McCranie and Townsend. 2011. *Zootaxa* 2990: 59–68. New species.

*Oedipina tzutujilorum*: Brodie et al. 2012. *Journal of Herpetology* 46: 233–240. New species.

*Dactyloa ginaelisae*: Lotzkat et al. 2013. *Zootaxa* 3626: 1–54. New species.

*Dactyloa ibanezi*: Poe et al. 2009. *Phyllomedusa* 8: 81–87. New species.

*Norops alocomyos*: Köhler et al. 2014. *Zootaxa* 3915: 111–122. New species.

*Norops beckeri*: Köhler. 2010. *Zootaxa* 2354: 1–8. Resurrection from the synonymy of *A. pentaprion*.

*Norops benedikti*: Lotzkat et al. 2011. *Zootaxa* 3125: 1–21. New species.

*Norops charlesmyersi*: Köhler. 2010. *Zootaxa* 2354: 1–8. New species.

*Norops gaigei*: Köhler et al. 2012. *Zootaxa* 3348: 1–23. Resurrection of *A. gaigei* from the synonymy of *A. tropidogaster*.

*Norops leditzigorum*: Köhler et al. 2014. *Zootaxa* 3915: 111–122. New species.

*Norops marsupialis*: Köhler et al. 2015. *Zootaxa* 3915: 111–122. Resurrection of *A. marsupialis* from the synonymy of *A. humilis*. Previously recognized at the species level without comment by Bolaños et al. (2011).

*Norops monteverde*: Köhler. 2009. *Journal of Herpetology* 43: 11–20. New species.

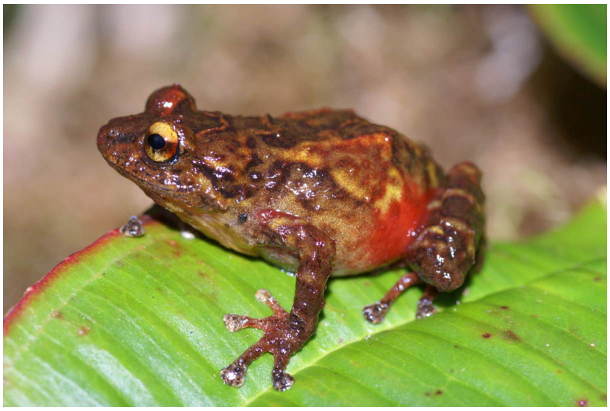
*Norops osa*: Köhler et al. 2010a. *Zootaxa* 2718: 23–38. New species.

*Norops tenorioensis*: Köhler 2011. *Zootaxa* 3120: 29–42. New species.

*Norops triumphalis*: Nicholson and Köhler. 2014. *Zootaxa* 3895: 225–237. New species.

*Norops unilobatus*: Köhler and Vesely. 2010. *Herpetologica* 66: 186–207. New species.

*Dendrotriton chujorum.* This salamander is endemic to the northern portion of the Sierra de Cuchumatanes in northwestern Guatemala, where occurs in the lower extent of Montane Wet Forest at elevations from 2,697 to 2,792 m in. We gauged its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Critically Endangered. This individual is from near San Mateo Ixtatán, Sierra de los Cuchumatanes, Guatemala. *Photo by Todd Pierson.*



*Diasporus igneus.* The Fiery Rainfrog is known only from the eastern and western slopes of Cerro Santiago in the Serranía de Tabasará in central Panama, where it occurs in Lower Montane Wet Forest at elevations from 1,699 to 1,815 m. We determined its EVS as 18, placing it in the upper portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from Llano Tugri, in the Comarca Ngöbe Buglé. *Photo by Abel Batista.*

*Diploglossus bilobatus.* This anguid lizard is distributed along the Atlantic lowlands and premontane slopes of Costa Rica and northwestern Panama, where it occurs in Lowland Moist and Wet forests, Premontane Wet Forest and Premontane Rainforest at elevations from near sea level to 1,360 m. We determined its EVS as 16, placing in the middle of the high vulnerability category, and its IUCN status is Least Concern. This individual is from Isla Bopa, province of Bocas del Toro, Panama. *Photo by Abel Batista.*

*Dipsas articulata.* This slug-eating snake is found along the Atlantic versant from southeastern Nicaragua to western Panama, where it occurs in Lowland Moist and Wet forests at elevations from near sea level to 500 m. We assessed its EVS as 15, placing it in the lower portion of the high vulnerability category, and its IUCN status is Least Concern. This individual is from Greytown, department of Río San Juan, Nicaragua. *Photo by Javier Sunyer.*

*Norops wellbornae*: Köhler and Vesely. 2010. *Herpetologica* 66: 186–207. Resurrection from the synonymy of *A. sericeus*.

*Ctenosaura praeocularis*: Hasbún and Köhler. 2009. *Journal of Herpetology* 43: 192–204. New species.

*Marisora magnacornae*: Hedges and Conn. 2012. *Zootaxa* 3288: 1–244. New species.

*Marisora roatanae*: Hedges and Conn. 2012. *Zootaxa* 3288: 1–244. New species.

*Phyllodactylus paralepis*: McCranie and Hedges. 2013b. *Zootaxa* 3694: 51–58. New species.

*Sphaerodactylus alphus*: McCranie and Hedges. 2013a. *Zootaxa* 3694: 40–50. New species.

*Sphaerodactylus continentalis*: McCranie and Hedges. 2012. *Zootaxa* 3492: 65–76. Resurrection from synonymy.

*Sphaerodactylus guanajae*: McCranie and Hedges. 2012. *Zootaxa* 3492: 65–76. New species.

*Sphaerodactylus leonardovaldesi*: McCranie and Hedges. 2012. *Zootaxa* 3,492: 65–76. New species.

*Sphaerodactylus poindexteri*: McCranie and Hedges. 2013. *Zootaxa* 3694: 40–50. New species.

*Ameiva praesignis*: Ugueto and Harvey. 2011. *Herpetological Monographs* 25: 113–170. Elevation to species level from within *A. ameiva*.

*Cnemidophorus duellmani*: McCranie and Hedges. 2013c. *Zootaxa* 3722: 301–316. New species.

*Dermophis occidentalis.* This caecilian is endemic to the southern Pacific versant of Costa Rica, where it occurs in Lowland Moist and Premontane Wet forests at elevations from 50 to 970 m. We determined its EVS as 17, placing it in the middle portion of the high vulnerability category, and its IUCN status is Data Deficient. This individual is from Río Piro, province of Puntarenas. *Photo by Eduardo Boza Oviedo.*

*Cnemidophorus ruatanus*: McCranie and Hedges. 2013c. *Zootaxa* 3722: 301–316. Resurrection from the synonymy of *C. lemniscatus*.

*Boa imperator*: Hynková et al. 2009. *Zoological Science* 26: 623–631. Elevation to species level from within *B. constrictor*.

*Dendrophidion apharocybe*: Cadle 2012. *Bulletin of the Museum of Comparative Zoology* 160: 183–240. New species.

*Dendrophidion crybelum*: Cadle 2012. *Bulletin of the Museum of Comparative Zoology* 160: 183–240. New species.

*Dendrophidion rufiterminorum*: Cadle and Savage. 2012. *Zootaxa* 3513: 1–50. New species.

*Tantilla olympia*: Townsend et al. 2013a. *Journal of Herpetology* 47: 191–200. New species.

*Tantilla psittaca*: McCranie 2011b. *Zootaxa* 3037: 37–44. New species.

*Omoadiphas cannula*: McCranie and Cruz Díaz. 2010. *Zootaxa* 2690: 53–58. New species.

*Sibon merendonensis*: Rovito et al. 2012. *Zootaxa* 3266: 62–68. New species.

*Sibon noalamina*: Lotzkat et al. 2012. *Zootaxa* 3485: 26–40. New species.

*Sibon perissostichon*: Köhler et al. 2010b. *Herpetologica* 66: 80–85. New species.

*Epictia magnamaculata*: Adalsteinnsson et al. 2009. *Zootaxa* 2244: 1–50. Transfer from genus *Leptotyphlops* and resurrection from the synonymy of *E. goudotii.*

*Bothriechis guifarroi*: Townsend et al. 2013b. *ZooKeys* 298: 77–105. New species.

*Cerrophidion sasai*: Jadin et al. 2012. *Zoological Scripta* doi: 10.1111/j.1463-6409.2012.00547.x. New species.

*Cerrophidion wilsoni*: Jadin et al. 2012. *Zoological Scripta* doi: 10.1111/j.1463-6409.2012.00547.x. New species.

These 92 species represent an increase of 9.7% over the 952 species listed for Central America by Wilson and Johnson (2010: Appendix 1).

The following species has undergone synonymization:

*Pristimantis educatoris*: Ryan et al. 2010a. *Journal of Herpetology* 44: 193–200. Synonymized with *P. caryophyllaceus* (Batista et al. 2014).

The following 29 species have undergone status changes:

*Incilius chompipe*: Mendelson et al. 2011. *Zootaxa* 3138: 1–34. Transfer from genus *Crepidophryne*.

*Incilius epioticus*: Mendelson et al. 2011. *Zootaxa* 3138: 1–34. Transfer from genus *Crepidophryne*.

*Incilius guanacaste*: Mendelson et al. 2011. *Zootaxa* 3138: 1–34. Transfer from genus *Crepidophryne*.

*Andinobates claudiae*: Brown et al. 2011. *Zootaxa* 3083: 1–120. Transfer from genus *Ranitomeya*.

*Andinobates fulguritus*: Brown et al. 2011. *Zootaxa* 3083: 1–120. Transfer from genus *Ranitomeya*.

*Andinobates minutus*: Brown et al. 2011. *Zootaxa* 3083: 1–120. Transfer from genus *Ranitomeya*.

*Agalychnis lemur*: Faivovich et al. 2010. *Cladistics* 26: 227–261. Transfer from genus *Hylomantis*.

*Trachycephalus typhonius*: Lavilla et al. 2010. *Zootaxa* 2671: 17–30. New name for *T. venulosus*.

*Leptodactylus insularum*: Heyer and de Sá. 2011. Smithsonian Contributions to *Zoology* 635: i–vii, 1–58. Name *L. insularum* applied to populations in Costa Rica and Panama, as well as Colombia, Venezuela, and Trinidad. Called *L. bolivianus* in Wilson et al. (2010).

*Ctenophryne aterrima*: de Sá et al. 2012. BMC *Evolutionary Biology* 12: 241 (21 pp.). Formerly placed in the genus *Nelsonophryne*, now placed in synonymy of *Ctenophryne*.

*Elachistocleis panamensis*: de Sá et al. 2012. *BMC Evolutionary Biology* 12: 241 (21 pp.). Transfer from genus *Chiasmocleis*.

*Elachistocleis pearsei*: de Sá et al. 2012. *BMC Evolutionary Biology* 12: 241 (21 pp.). Return to genus *Elachistocleis* from *Relictivomer*. This species was not considered in Wilson et al. (2010), but was shown to occur in Panama by Köhler (2011b).

*Hypopachus pictiventris*: Streicher et al. 2012. *Molecular Phylogenetics and Evolution* 64: 645–653. Tentative transfer from genus *Gastrophryne*. Transfer supported by de Sá et al. 2012. *BMC Evolutionary Biology* 12: 241 (21 pp.).

*Hypopachus ustus*: Streicher et al. 2012. *Molecular Phylogenetics and Evolution* 64: 645–653. Tentative transfer from genus *Gastrophryne*. Spelling of specific epithet corrected by Frost (2013). Transfer supported by de Sá et al. 2012. *BMC Evolutionary Biology* 12: 241 (21 pp.).

*Marisora alliacea*: Hedges and Conn. 2012. *Zootaxa* 3288: 1–244. Transfer from the genus *Mabuya*.

*Marisora brachypoda*: Hedges and Conn. 2012. *Zootaxa* 3288: 1–244. Transfer from the genus *Mabuya*.

*Marisora unimarginata*: Hedges and Conn. 2012. *Zootaxa* 3288: 1–244. Transfer from the genus *Mabuya*.

*Holcosus chaitzami*: Harvey et al. 2012. *Zootaxa* 3459: 1–156. Transfer from the genus *Ameiva*.

*Holcosus festivus*: Harvey et al. 2012. *Zootaxa* 3459: 1–156. Transfer from the genus *Ameiva*.

*Holcosus leptophrys*: Harvey et al. 2012. *Zootaxa* 3459: 1–156. Transfer from the genus *Ameiva*.

*Holcosus quadrilineatus*: Harvey et al. 2012. *Zootaxa* 3459: 1–156. Transfer from the genus *Ameiva*.

*Holcosus undulatus*: Harvey et al. 2012. *Zootaxa* 3459: 1–156. Transfer from the genus *Ameiva*.

*Epictia magnamaculata*: Adalsteinnsson et al. 2009. *Zootaxa* 2244: 1–50. Resurrection from the synonymy of *E. goudotii*.

*Trichellostoma macrolepis*: Adalsteinnsson et al. 2009. *Zootaxa* 2244: 1–50. Transfer from the genus *Leptotyphlops*. Later established as the type species of a new leptotyphlopid genus *Trilepida* by Hedges (2011).

*Amerotyphlops costaricensis*: Hedges et al. 2014. *Caribbean Herpetology* 49: 1–61. Transfer from the genus *Typhlops*.

*Amerotyphlops microstomus*: Hedges et al. 2014. *Caribbean Herpetology* 49: 1–61. Transfer from the genus *Typhlops*.

*Amerotyphlops stadelmani*: Hedges et al. 2014. *Caribbean Herpetology* 49: 1–61. Transfer from the genus *Typhlops*.

*Amerotyphlops tenuis*: Hedges et al. 2014. *Caribbean Herpetology* 49: 1–61. Transfer from the genus *Typhlops*.

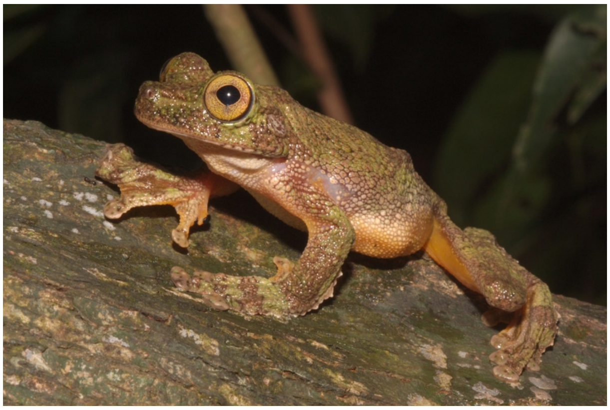
*Amerotyphlops tycherus*: Hedges et al. 2014. *Caribbean Herpetology* 49: 1–61. Transfer from the genus *Typhlops*.

Streicher et al. (2014) examined evolutionary relationships among some members of the *Craugastor rhodopis* species group and recognized four major clades, including one identified as *C. occidentalis*, which required its movement from the *C. mexicanus* species series to the *C. rhodopis* species group. A clade in eastern Mexico corresponds to *C. rhodopis* and one on both the Pacific and Atlantic versants of southeastern Mexico, Guatemala, and El Salvador to *C. loki*. Further, they identified a haplotype from Volcán San Martín in southern Veracruz, Mexico, which might correspond to a separate evolutionary lineage. The authors also indicated that, "a small group of specimens was reported from the northern department of Cortés in Honduras [that report appeared in McCranie and Wilson, 2002], but the actual occurrence of *C. loki* in Honduras is questionable given the abundance of the morphologically similar *C. chac*, *C. gollmeri*, and *C. laticeps*, in this region …" The authors left the identity of the Honduran material and the status of other populations in the *rhodopis* species group to future work.

In a broad-scale paper on blindsnake taxonomy, Hedges et al. (2014) transferred five Central American typhlopid species from *Typhlops* to a new genus, *Amerotyphlops*. This study, based on morphological and molecular data, supported the recognition of four subfamilies, of which three were described anew, and contains essentially geographically cohesive groups of genera and species. Recognition of the three new subfamilies restricts the remaining subfamily, the Typhlopinae, to genera and species in the New World. The authors recognized four genera, of which *Amerotyphlops*, *Antillotyphlops*, and *Cubatyphlops* were described as new. Interestingly, the first of these genera is composed of 14 species distributed "primarily on the mainland, ranging from eastern Mexico (Veracruz) to southern South America (Bolivia and Argentina), and includes a West Indian species, *A. tasymicris* in Grenada and the Grenadines" (Hedges et al. 2014: 44). Five of the 14 species are distributed in Central America (Appendix 2).

Torres et al. (2013) reported *Abronia lythrochila*, formerly a Mexican endemic, from northwestern Guatemala, thus adding this species to the Central American herpetofauna.

Griffin and Powell (2014) reported *Tropidodipsas fasciata*, formerly a Mexican endemic, from Guatemala, thus adding this species to the Central American herpetofauna.



*Ecnomiohyla bailarina.* The Golden-eyed Fringe-limbed Treefrog is known only from the type locality in extreme southwestern Panama near the border with Colombia (but, see Addendum), where it occurs in Premontane Wet Forest at an elevation of 750 m. We calculated its EVS as 20, placing it at the upper end of the high vulnerability category, but its IUCN status has not been determined. This individual is from the northern slope of the Jingurudó mountain range in the Comarca Emberá-Wounaan, in the Darién region. *Photo by Abel Batista.*

*Heloderma charlesbogerti.* The Motagua Valley Beaded Lizard is restricted to the Motagua Valley in eastern Guatemala, where it occurs in Lowland Arid and Premontane Dry forests at elevations from 300 to 900 m. We assessed its EVS as 18, placing it in the upper portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from the Motagua River Valley in Guatemala. *Photo by Antonia Pachmann.*

Olson and David (2014) changed the spelling of the specific name of the single species of *Chelonoidis* occurring in Central America to *carbonarius*, given the ICZN requirement (ICZN 1999; Article 30,2.4) to treat the generic name as masculine since the original author (Fitzinger 1835) did not state it explicitly to be feminine.

Some other qualifications concerning the taxonomic status of certain species to which we adhere are found in the above Controversial Taxonomic Issues section.

## Diversity and Endemism in the Central American Herpetofauna

Mesoamerica is one of the world's most important biodiversity reservoirs, and Central America contains a substantial component of that region's herpetofauna (Wilson and Johnson 2010). The Central American herpetofauna presently consists of 1,052 species (319 anurans, 159 salamanders, 15 caecilians, 3 crocodylians, 532 squamates, and 24 turtles; Table 1). Compared to the herpetofauna of Mexico, which currently consists of 1,252 species (239 anurans, 141 salamanders, 3 caecilians, 3 crocodylians, 818 squamates, and 48 turtles; J. D. Johnson, unpublished data), the number of species in Central America is significant given that the area of Mexico is about 3.75 times larger than that of Central America (www.cia.gov; accessed 14 December 2013). Compared to Mexico, Central America also is a haven for anurans, salamanders, and caecilians, as it contains 1.3 times more species. In contrast, however, Mexico contains 1.6 times more crocodylians, squamates, and turtles than Central America. Evidently, these differences are related to the environmental requirements for these two groups of vertebrates, and the variety of ecosystems in the two regions.

The 493 species amphibians in Central America are classified in 16 families and 69 genera (Table 1). The Hylidae contains the most genera (21); the remaining 15 families contain 1–8 genera. The Dendrobatidae and Plethodontidae contain eight genera each; the remaining anuran and caecilian families five or fewer (Table 1). The number of species per family ranges from one (Pipidae and Rhinophrynidae) to 159 (Plethodontidae). Three families (Craugastoridae, Hylidae, and Plethodontidae) contain close to or considerably more than 100 species each, and collectively total 358 (72.6%) of all the amphibian species. The remaining 13 families contain 1–39 species (the latter number is for the Bufonidae). In total, there are 13 families and 57 genera of anurans, one family and eight genera of salamanders, and two families and four genera of caecilians.

The 559 species of crocodylians, squamates, and turtles in Central America are classified in 42 families and 145 genera (Table 1). The Colubridae and Dipsadidae are the largest, with 24 and 35 genera, respectively; the remaining families contain 1–8 genera. Two families contain eight genera (Gymnophthalmidae and Viperidae), and the others contain five or fewer (Table 1). The number of species per family ranges from one (seven families) to 144 (Dipsadidae). Two families (Dactyloidae and Dipsadidae) contain close to or considerably more than 100 species (Table 1), collectively 239 (42.8%) of all the squamate species. The remaining 40 families contain 1–32 species (the latter number is for Viperidae). In total, there are two families and two genera of crocodylians, nine families and 14 genera of turtles, and 31 families and 129 genera of squamates.

The herpetofauna of Central America also is characterized by a high degree of endemism (Table 1). Of the 493 species of anurans, salamanders, and caecilians in

**Table 1.** Family composition and endemicity of the Central American herpetofauna.

| Families | Genera | Species | Endemic Species | Percentage of Endemicity |
|---|---|---|---|---|
| Aromobatidae | 2 | 3 | 2 | 66.7 |
| Bufonidae | 4 | 39 | 23 | 59.0 |
| Centrolenidae | 5 | 14 | 3 | 21.4 |
| Craugastoridae | 3 | 101 | 77 | 76.2 |
| Dendrobatidae | 8 | 19 | 12 | 63.2 |
| Eleutherodactylidae | 2 | 11 | 6 | 54.5 |
| Hemiphractidae | 2 | 3 | 0 | 0 |
| Hylidae | 21 | 98 | 53 | 54.1 |
| Leptodactylidae | 3 | 9 | 1 | 11.1 |
| Microhylidae | 4 | 9 | 1 | 11.1 |
| Pipidae | 1 | 1 | 1 | 100 |
| Ranidae | 1 | 11 | 5 | 45.5 |
| Rhinophrynidae | 1 | 1 | 0 | 0 |
| **Total Anurans** | **57** | **319** | **184** | **57.5** |
| Plethodontidae | 8 | 159 | 133 | 83.6 |
| **Total Salamanders** | **8** | **159** | **133** | **83.6** |
| Caeciliidae | 2 | 7 | 3 | 42.9 |
| Dermophiidae | 2 | 8 | 4 | 50.0 |
| **Total Caecilians** | **4** | **15** | **7** | **46.7** |
| **Total Amphibians** | **69** | **493** | **324** | **65.7** |
| Alligatoridae | 1 | 1 | 0 | 0 |
| Crocodylidae | 1 | 2 | 0 | 0 |
| **Total Crocodylians** | **2** | **3** | **0** | **0** |
| Amphisbaenidae | 1 | 2 | 0 | 0 |
| Anguidae | 5 | 28 | 22 | 78.6 |
| Corytophanidae | 3 | 9 | 0 | 0 |
| Dactyloidae | 3 | 95 | 67 | 70.5 |
| Eublepharidae | 1 | 2 | 0 | 0 |
| Gymnophthalmidae | 8 | 14 | 5 | 35.7 |
| Helodermatidae | 1 | 2 | 1 | 50.0 |
| Hoplocercidae | 2 | 2 | 0 | 0 |
| Iguanidae | 2 | 11 | 7 | 63.6 |
| Mabuyidae | 1 | 5 | 4 | 80.0 |
| Phrynosomatidae | 2 | 17 | 2 | 11.8 |
| Phyllodactylidae | 2 | 5 | 3 | 60.0 |
| Polychrotidae | 1 | 1 | 0 | 0 |
| Scincidae | 2 | 3 | 0 | 0 |
| Sphaerodactylidae | 4 | 19 | 10 | 52.6 |
| Sphenomorphidae | 1 | 4 | 1 | 25.0 |
| Teiidae | 4 | 12 | 4 | 33.3 |
| Xantusiidae | 1 | 4 | 1 | 25.0 |
| Xenosauridae | 1 | 1 | 0 | 0 |
| Anomalepididae | 3 | 3 | 1 | 33.3 |
| Boidae | 3 | 4 | 0 | 0 |
| Charinidae | 1 | 2 | 0 | 0 |

**Table 1 (continued).** Family composition and endemicity of the Central American herpetofauna.

| Families | Genera | Species | Endemic Species | Percentage of Endemicity |
|---|---|---|---|---|
| Colubridae | 24 | 74 | 26 | 35.1 |
| Dipsadidae | 35 | 144 | 78 | 54.2 |
| Elapidae | 2 | 18 | 8 | 44.4 |
| Leptotyphlopidae | 2 | 5 | 1 | 20.0 |
| Loxocemidae | 1 | 1 | 0 | 0 |
| Natricidae | 2 | 5 | 0 | 0 |
| Sibynophiidae | 1 | 2 | 0 | 0 |
| Tropidophiidae | 1 | 1 | 0 | 0 |
| Typhlopidae | 1 | 5 | 3 | 60.0 |
| Viperidae | 8 | 32 | 15 | 46.9 |
| **Total Squamates** | **129** | **532** | **259** | **48.7** |
| Cheloniidae | 4 | 5 | 0 | 0 |
| Chelydridae | 1 | 2 | 0 | 0 |
| Dermatemydidae | 1 | 1 | 0 | 0 |
| Dermochelyidae | 1 | 1 | 0 | 0 |
| Emydidae | 1 | 2 | 0 | 0 |
| Geoemydidae | 1 | 5 | 1 | 20.0 |
| Kinosternidae | 1 | 4 | 1 | 25.0 |
| Staurotypidae | 2 | 3 | 0 | 0 |
| Testudinidae | 1 | 1 | 0 | 0 |
| **Total Turtles** | **14** | **24** | **2** | **8.3** |
| **Total "Reptiles"** | **145** | **559** | **261** | **46.7** |
| **Total Herpetofauna** | **214** | **1,052** | **585** | **55.6** |

this region, 324 (65.7%) are endemic, and of the 559 species of crocodylians, squamates, and turtles, 261 (46.7%) are endemic. The percentage of endemicity for the entire herpetofauna is 55.6%. These figures are somewhat comparable to those for the Mexican herpetofauna (J.D. Johnson, unpublished data). Of the 383 Mexican amphibian species, 258 (67.4%) are endemic, and of the 869 species of crocodylians, squamates, and turtles, 499 (57.4%) are endemic. The percentage of endemicity for the entire herpetofauna is 60.5% (J.D. Johnson, unpublished data).

Among the Central American amphibians, the percentage of endemicity at the family level ranges from zero (Hemiphractidae and Rhinophrynidae) to 100 (Pipidae). Interestingly, each of these anuran families contains 1–3 species in Central America. The largest number of endemic species is in the family Plethodontidae (133); its percentage of endemicity is 83.6. The Bufonidae (23), Craugastoridae (77), and Hylidae (53) also contain sizable numbers of endemic species. Collectively, these four families contain 286 (88.3%) of all the amphibian endemic species.

Among the crocodylians, squamates, and turtles, the percentage of endemicity at the family level ranges from zero (in 21 families) to 80.0% (Mabuyidae). As with amphibians, the 21 families with no endemics contain relatively few species (nine or fewer). The largest number of endemic squamates is in the family Dipsadidae (78), with the next largest being the Dactyloidae (67). The next most sizable numbers of endemic species are in the families Colubridae (26) and Viperidae (15). Collectively, these four families contain 186 (71.8%) of all the squamate endemic species.

In summary, four amphibian and four squamate families contain the largest numbers of endemic species in Central America (472; 81.1%) of the 585 endemic species known from this region (Table 1). In total, these eight families contain 742 species, of which 63.6% are endemic to Central America (Table 1). With additional exploration and systematic research, the number and proportion of endemic species in Central America should continue to rise.

## IUCN Red List Assessment of the Central American Herpetofauna

In response to the emerging picture of global amphibian population decline, the IUCN began a conservation assessment of the world's amphibians (see Stuart et al. 2004). Consequently, in 2002, a workshop to assess the Mesoamerican amphibians was held at the La Selva Biological Station in Costa Rica, followed by one in Jalisco, Mexico, to assess the crocodylians, squamates,

**Table 2.** IUCN Red List categorizations for Central American herpetofaunal families.

| Families | Number of Species | IUCN Red List categorizations | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Extinct | Critically Endangered | Endangered | Vulnerable | Near Threatened | Least Concern | Data Deficient | Not Evaluated |
| Aromobatidae | 3 | — | — | — | — | — | 1 | — | 2 |
| Bufonidae | 39 | 1 | 9 | 7 | 3 | 1 | 12 | 4 | 2 |
| Centrolenidae | 14 | — | — | — | — | 1 | 12 | 1 | — |
| Craugastoridae | 101 | 2 | 23 | 16 | 10 | 8 | 26 | 14 | 2 |
| Dendrobatidae | 19 | — | — | 3 | 1 | 1 | 8 | 5 | 1 |
| Eleutherodactylidae | 11 | — | — | — | 3 | — | 5 | 1 | 2 |
| Hemiphractidae | 3 | — | — | 1 | — | 1 | 1 | — | — |
| Hylidae | 98 | — | 33 | 14 | 5 | 5 | 35 | 3 | 3 |
| Leptodactylidae | 9 | — | 1 | — | — | — | 8 | — | — |
| Microhylidae | 9 | — | — | — | 1 | — | 8 | — | — |
| Pipidae | 1 | — | — | 1 | — | — | — | — | — |
| Ranidae | 11 | — | — | — | 3 | 1 | 6 | — | 1 |
| Rhinophrynidae | 1 | — | — | — | — | — | 1 | — | — |
| **Total Anurans** | **319** | **3** | **66** | **42** | **26** | **18** | **123** | **28** | **13** |
| Plethodontidae | 159 | — | 25 | 33 | 17 | 8 | 19 | 18 | 39 |
| **Total Salamanders** | **159** | **—** | **25** | **33** | **17** | **8** | **19** | **18** | **39** |
| Caeciliidae | 7 | — | — | — | — | — | 3 | 4 | — |
| Dermophiidae | 8 | — | — | — | 1 | — | 2 | 5 | — |
| **Total Caecilians** | **15** | **—** | **—** | **—** | **1** | **—** | **5** | **9** | **—** |
| **Total Amphibians** | **493** | **3** | **91** | **75** | **44** | **26** | **147** | **55** | **52** |
| Alligatoridae | 1 | — | — | — | — | — | 1 | — | — |
| Crocodylidae | 2 | — | — | — | 1 | — | 1 | — | — |
| **Total Crocodylians** | **3** | **—** | **—** | **—** | **1** | **—** | **2** | **—** | **—** |
| Amphisbaenidae | 2 | — | — | — | — | — | 1 | — | 1 |
| Anguidae | 28 | — | 2 | 8 | 2 | 2 | 6 | 5 | 3 |
| Corytophanidae | 9 | — | — | — | — | — | 5 | — | 4 |
| Dactyloidae | 95 | — | — | 3 | 1 | — | 4 | 3 | 84 |
| Eublepharidae | 2 | — | — | — | — | — | 2 | — | — |
| Gymnophthalmidae | 14 | — | — | — | — | 1 | 4 | — | 9 |
| Helodermatidae | 2 | — | — | — | — | — | — | — | 2 |
| Hoplocercidae | 2 | — | — | — | — | — | — | — | 2 |
| Iguanidae | 11 | — | 1 | 4 | — | 1 | 1 | 1 | 3 |
| Mabuyidae | 5 | — | 1 | — | — | — | 3 | 1 | — |
| Phrynosomatidae | 17 | — | — | — | — | — | 17 | — | — |
| Phyllodactylidae | 5 | — | — | — | 1 | — | 1 | — | 3 |
| Polychrotidae | 1 | — | — | — | — | — | — | — | 1 |
| Scincidae | 3 | — | — | — | — | — | 3 | — | — |
| Sphaerodactylidae | 19 | — | — | — | — | — | 10 | — | 9 |
| Sphenomorphidae | 4 | — | — | — | — | — | 2 | 1 | 1 |
| Teiidae | 12 | — | — | — | — | | 6 | 1 | 5 |
| Xantusiidae | 4 | — | — | — | — | 1 | 3 | — | — |
| Xenosauridae | 1 | — | — | — | 1 | — | — | — | — |
| Anomalepididae | 3 | — | — | — | — | — | — | 2 | 1 |
| Boidae | 4 | — | — | — | — | — | — | — | 4 |

**Table 2 (continued).** IUCN Red List categorizations for Central American herpetofaunal families.

| Families | Number of Species | IUCN Red List categorizations | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Extinct | Critically Endangered | Endangered | Vulnerable | Near Threatened | Least Concern | Data Deficient | Not Evaluated |
| Charinidae | 2 | — | — | — | — | — | — | — | 2 |
| Colubridae | 74 | — | 1 | 2 | 3 | — | 37 | 5 | 26 |
| Dipsadidae | 144 | — | 7 | 11 | 5 | 8 | 66 | 15 | 32 |
| Elapidae | 18 | — | 1 | — | — | — | 12 | — | 5 |
| Leptotyphlopidae | 5 | — | — | — | — | — | 1 | — | 4 |
| Loxocemidae | 1 | — | — | — | — | — | 1 | — | — |
| Natricidae | 5 | — | — | — | — | — | 5 | — | — |
| Sibynophiidae | 2 | — | — | — | — | — | 1 | — | 1 |
| Tropidophiidae | 1 | — | — | — | — | — | — | — | 1 |
| Typhlopidae | 5 | — | — | — | 1 | — | 3 | — | 1 |
| Viperidae | 32 | — | — | 2 | 1 | 1 | 12 | 1 | 15 |
| **Total Squamates** | **532** | **—** | **13** | **30** | **15** | **14** | **206** | **35** | **219** |
| Cheloniidae | 5 | — | 2 | 2 | 1 | — | — | — | — |
| Chelydridae | 2 | — | — | — | 1 | — | — | — | 1 |
| Dermatemydidae | 1 | — | 1 | — | — | — | — | — | — |
| Dermochelyidae | 1 | — | 1 | — | — | — | — | — | — |
| Emydidae | 2 | — | — | — | — | — | — | — | 2 |
| Geoemydidae | 5 | — | — | — | — | 3 | — | — | 2 |
| Kinosternidae | 4 | — | — | — | 1 | 1 | — | — | 2 |
| Staurotypidae | 3 | — | — | — | — | 3 | — | — | — |
| Testudinidae | 1 | — | — | — | — | — | — | — | 1 |
| **Total Turtles** | **24** | **—** | **4** | **2** | **3** | **7** | **—** | **—** | **8** |
| **Total "Reptiles"** | **559** | **—** | **17** | **32** | **19** | **21** | **208** | **35** | **227** |
| **Total Herpetofauna** | **1,052** | **3** | **108** | **107** | **63** | **47** | **355** | **90** | **279** |

and turtles of that country. Several years later, in 2012, a workshop to assess the squamates of Central America was held at Parque Nacional Palo Verde in Costa Rica. The results of the first two workshops appeared on the IUCN Red List website, but to date those for the third remain incomplete. Wilson et al. (2013a, b) presented an overview and conclusions of these assessments for the Mexican herpetofauna.

We accessed the IUCN website (www.iucnredlist.org) to summarize the present situation for Central American amphibians (Table 2). The data in this table are somewhat more complete than for crocodylians, squamates, and turtles, given that the Global Reptile Assessment still is underway. Nonetheless, of 493 species of Central American amphibians, 52 species (10.5%) have not been evaluated as of this writing, so we placed them in the NE (Not Evaluated) category. The remaining categories are: Extinct (EX, 3 [0.6%]); Critically Endangered (CR, 91 [18.5%]); Endangered (EN, 75 [15.2%]); Vulnerable (VU, 44 [8.9%]); Near Threatened (NT, 26 [5.3%]); Least Concern (LC, 147 [29.8%]); and Data Deficient (DD, 55 [11.2%]). A total of 210 species (42.6%), therefore, have been assessed in one of the three threat categories (CR, EN, or VU), which is slightly more than 10% higher than what was reported for these categories on a global scale (32.3%) by Stuart et al. (2010). If the EX and DD species are added to those in the threat categories, then 268 (54.4%) species are extinct, threatened with extinction, or too poorly known to allow for an assessment; these results are similar to those reported for the global situation (EX+CR+EN+VU+DD = 3,181 [55.4%]; Stuart et al. 2010). This percentage, however, is about 10 points lower than that reported for the Mexican amphibians (Wilson et al. 2013b).

The families Craugastoridae (49 of 101 species; 48.5%), Hylidae (52 of 98 species; 53.1%), and Plethodontidae (75 of 159 species; 47.2%) contain the greatest number and proportion of threatened species. For the salamanders, if the numbers of DD and NE species are added to those considered threatened (18+39+75 = 132), then 83.0% of the 159 Central American species are threatened, poorly known, or have not been evaluated. Collectively, the 358 species in the three largest families comprise 72.6% of the amphibian taxa in Central America, and the 176 threatened species in these families make up 83.8% of the 210 total. A similar proportion is seen among the Mexican amphibians (88.6% of 211 totals).

As startling as the statistics for amphibian population decline are on a global scale (Stuart et al. 2010), on a regional scale for Central America they are more alarming. According to the IUCN criteria, about four out of every 10 species of amphibians are judged as threatened, and more than one-half of those are threatened or too poorly known to allow for an assessment, which is the case for the most speciose families in the region. Two factors are expected to keep increasing the severity of this decline, even without considering the rate of accelerating environmental deterioration. The first is that new species will continue to be described, as indicated above in the discussion on taxonomic changes since the publication of Wilson et al. (2010). The other factor is that advancing molecular studies, especially on broadly distributed taxa, will continue to reveal the presence of new species. Both of these factors will increase the number of threatened taxa. As an example, Ruane et al. (2014) studied the molecular systematics of *Lampropeltis triangulum*, a species that for many decades was considered one of the world's most broadly distributed terrestrial snakes (Williams 1988). These authors recognized seven species in what previously was considered a single species-level taxon, and noted that additional species in this complex likely will be recognized in the future.

## Critique of the IUCN Assessment

In conservation reassessments for the Mexican herpetofauna, we criticized the IUCN system of categorization and provided distinctions between this system and the EVS (Wilson et al. 2013a, b). Alvarado-Díaz et al. (2013) also criticized this system. The principal criticisms levied by these authors are as follows:

1. Using the IUCN system of conservation assessment is expensive and time-consuming. Stuart et al. (2010) provided a figure of $534.12 for the average cost of creating an IUCN threat assessment for a single species. If this figure were applied to the 1,052 species making up the Central American herpetofauna, the total expenditure would be $561,894.24. In comparison, costs for our EVS assessments were negligible because they were accomplished using the resources of the Internet and our own volunteered time. Creating the IUCN Global Amphibian Assessment, of which the results appeared in 2004 (Stuart et al. 2004) involved a number of years. For example, one of us (LDW) attended the Mesoamerican Amphibian Workshop undertaken at the La Selva Biological Station in Costa Rica in November 2002, so a period of close to two years elapsed before the global results were published (Stuart et al. 2004). Another example is that the complete results of the Central American Reptile Workshop, attended by two of us (JDJ and LDW), have not appeared two years and two months since this workshop was conducted at Palo Verde National Park in Costa Rica in May of 2012 (as of 1 March 2015). The delay primarily has been caused because evaluations for most of the anoles have not been completed, and because evaluations for a sizable number of species that occur in both Central America and South America will not be available until all of the relevant workshops for the latter region are completed. In contrast, we began working on the present paper in early October, 2013. We completed most of our EVS assessment of the Central American herpetofauna by the early portion of January, 2014, but the publication of this paper was delayed because we needed to wait until the entire results of the Palo Verde Workshop appeared at the IUCN Red List website (but see above). Accordingly, we consider it pertinent to quote the "important note" or proviso indicated on the Overview paper at the amphibians.org website, as follows: "Given the current quality control requirements needed for conservation assessments to be published on the IUCN Red List, and our very limited human resources, we are unable to process large numbers of assessments at this time. Country-level global reassessments may be possible if requests come with the funding and resources necessary to conduct such reassessments, or if the herpetological community of the country or region in question is willing to take over stewardship of its global assessments through its respective regional/national working group." Thus, the expense for such IUCN assessments has overwhelmed the ability of this organization to continue undertaking this work.

2. New herpetofaunal taxa are described more rapidly than the IUCN procedures can provide a conservation assessment. As noted in the previous section, 52 species of amphibians (13 anurans and 39 salamanders) remain unevaluated by the IUCN, which is 10.5% of the 493 species known from Central America as of this writing. Comparable figures are not available for the remainder of the herpetofauna, since the Global Reptile Assessment is ongoing, but we can state that 32 species of squamates (lizards and snakes) have been described since the publication of Wilson and Johnson (2010). This figure represents 6.0% of the 532 species of squamates now known from Central America. The data in Table 2 indicate that 227 species of crocodylians, squamates, and turtles (40.6% of the total of 559 species) have not been evaluated. Given the provisos indicated in the above paragraph and the consequences indicated, a much more rapid and cost-effective mode of conservation assessment is needed, not only for keeping up with the advances of systematic knowledge, but more importantly because of the increasing rate of environmental deterioration.

3. Once new herpetofaunal species are incorporated into the IUCN Red List, often they are placed in the Data Deficient category due to an expected lack of initial information on their population status. In particular, this situation occurs with taxa described from a single specimen and/or a single locality. Species in this category were termed “threat species in disguise” by Wilson et al. (2013b), because of the likelihood that such species, once evaluated, would fall into one of the three threat categories. One of our recommendations deals with this issue.

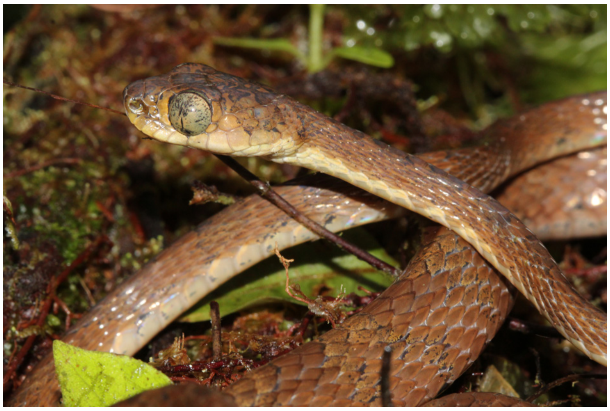
4. Typically, large numbers of taxa are assigned to the Least Concern (LC) category, described by Wilson et al. (2013b) as a “dumping ground” for species that might require “a more discerning look that would demonstrate that many of these species should be partitioned into IUCN categories other than LC,” such as the three threat categories and the Near Threatened one. This opinion was expressed after the authors examined the relationship between the IUCN categorizations and the EVS assessments for Mexican amphibians, and is corroborated here by the assessment

**Table 3.** Environmental Vulnerability Scores for Central American herpetofaunal species, arranged by family. Shaded area to the left encompasses low vulnerability scores, and to the right high vulnerability scores.

| Families | Number of species | Environmental Vulnerability Scores | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Aromabatidae | 3 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | 1 | — | 1 | — | — |
| Bufonidae | 39 | 1 | — | — | 1 | 1 | 2 | 3 | 1 | 3 | 3 | 8 | 9 | 4 | 2 | 1 | — | — | — |
| Centrolenidae | 14 | — | — | — | — | — | 1 | 1 | 2 | 2 | 4 | 1 | — | 1 | 2 | — | — | — | — |
| Craugastoridae | 101 | — | — | — | — | — | — | 1 | — | 1 | 6 | 2 | 6 | 15 | 35 | 17 | 18 | — | — |
| Dendrobatidae | 19 | — | — | — | — | — | — | — | — | — | — | — | 1 | 6 | 6 | 3 | 3 | — | — |
| Eleutherodactylidae | 11 | — | — | — | — | — | — | — | — | 1 | 1 | — | — | 3 | 1 | 2 | 3 | — | — |
| Hemiphractidae | 3 | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 2 | — | — | — | — |
| Hylidae | 98 | 1 | 2 | — | — | 3 | 4 | 2 | 6 | 9 | 11 | 18 | 18 | 8 | 1 | 2 | 4 | 3 | 6 |
| Leptodactylidae | 9 | — | — | 1 | 1 | 1 | — | 1 | — | — | 3 | 1 | 1 | — | — | — | — | — | — |
| Microhylidae | 9 | — | 1 | — | — | — | 2 | — | 1 | 1 | 3 | — | 1 | — | — | — | — | — | — |
| Pipidae | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — |
| Ranidae | 11 | 1 | — | 1 | — | — | 1 | 2 | 1 | — | 3 | — | 1 | 1 | — | — | — | — | — |
| Rhinophrynidae | 1 | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — |
| **Total Anurans** | **319** | **3** | **3** | **2** | **2** | **5** | **11** | **10** | **11** | **18** | **34** | **30** | **37** | **39** | **50** | **26** | **29** | **3** | **6** |
| **Total Anuran %** | **—** | **0.9** | **0.9** | **0.6** | **0.6** | **1.6** | **3.4** | **3.1** | **3.4** | **5.6** | **10.7** | **9.4** | **11.6** | **12.2** | **15.7** | **8.2** | **9.1** | **0.9** | **1.9** |
| Plethodontidae | 159 | — | — | — | — | — | 1 | 1 | — | 2 | 2 | 6 | 4 | 17 | 34 | 35 | 57 | — | — |
| **Total Salamanders** | **159** | **—** | **—** | **—** | **—** | **—** | **1** | **1** | **—** | **2** | **2** | **6** | **4** | **17** | **34** | **35** | **57** | **—** | **—** |
| **Total Salamander %** | **—** | **—** | **—** | **—** | **—** | **—** | **0.6** | **0.6** | **—** | **1.3** | **1.3** | **3.8** | **2.5** | **10.7** | **21.4** | **22.0** | **35.8** | **—** | **—** |
| Caeciliidae | 7 | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 2 | 1 | — | 2 | — |
| Dermophiidae | 8 | — | — | — | — | 1 | — | — | — | — | — | 2 | 1 | — | 1 | 1 | 2 | — | — |
| **Total Caecilians** | **15** | **—** | **—** | **—** | **—** | **1** | **—** | **—** | **—** | **—** | **—** | **2** | **1** | **2** | **3** | **2** | **2** | **2** | **—** |
| **Total Caecilian %** | **—** | **—** | **—** | **—** | **—** | **6.7** | **—** | **—** | **—** | **—** | **—** | **13.3** | **6.7** | **13.3** | **20.0** | **13.3** | **13.3** | **13.3** | **—** |
| **Total Amphibians** | **493** | **3** | **3** | **2** | **2** | **6** | **12** | **11** | **11** | **20** | **36** | **38** | **42** | **58** | **87** | **63** | **88** | **5** | **6** |
| **Total Amphibian %** | **—** | **0.6** | **0.6** | **0.4** | **0.4** | **1.2** | **2.4** | **2.2** | **2.2** | **4.1** | **7.3** | **7.7** | **8.5** | **11.8** | **17.6** | **12.8** | **17.8** | **1.0** | **1.2** |
| Alligatoridae | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — |
| Crocodylidae | 2 | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — |
| **Total Crocodylians** | **3** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **1** | **1** | **—** | **1** | **—** | **—** | **—** | **—** |
| **Total Crocodylian %** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **—** | **33.3** | **33.3** | **—** | **33.3** | **—** | **—** | **—** | **—** |
| Amphisbaenidae | 2 | — | — | — | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — |
| Anguidae | 28 | — | — | — | — | — | 1 | — | — | — | — | 1 | 2 | 7 | 9 | 3 | 5 | — | — |
| Corytophanidae | 9 | — | — | — | — | 1 | — | 2 | 1 | 2 | — | 2 | — | 1 | — | — | — | — | — |
| Dactyloidae | 95 | — | — | — | — | 2 | 2 | 4 | 1 | 1 | 4 | 12 | 11 | 23 | 13 | 22 | — | — | — |
| Eublepharidae | 2 | — | — | — | — | — | — | 1 | — | — | — | — | 1 | — | — | — | — | — | — |

**Table 3 (continued).** Environmental Vulnerability Scores for Central American herpetofaunal species, arranged by family. Shaded area to the left encompasses low vulnerability scores, and to the right high vulnerability scores.

| **Families** | **Number of species** | **Environmental Vulnerability Scores** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| Gymnophthalmidae | 14 | — | — | — | — | — | — | 1 | — | 1 | 1 | 1 | 5 | 3 | 2 | — | — | — | — |
| Helodermatidae | 2 | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | 1 | — | — |
| Hoplocercidae | 2 | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 | — | — | — | — | — |
| Iguanidae | 11 | — | — | — | — | — | 1 | — | 1 | — | — | 1 | — | 1 | — | — | 3 | 4 | — |
| Mabuyidae | 5 | — | — | — | 1 | — | — | — | — | — | — | — | — | 2 | 1 | 1 | — | — | — |
| Phrynosomatidae | 17 | — | — | 1 | — | — | — | — | 3 | 1 | 5 | 2 | 2 | 2 | — | 1 | — | — | — |
| Phyllodactylidae | 5 | — | — | — | — | — | 2 | — | — | — | — | — | — | — | 1 | 2 | — | — | — |
| Polychrotidae | 1 | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — |
| Scincidae | 3 | — | — | — | — | — | — | — | — | — | 1 | 1 | 1 | — | — | — | — | — | — |
| Sphaerodactylidae | 19 | — | — | — | — | — | 1 | 1 | — | — | 1 | 2 | 4 | 2 | 4 | 4 | — | — | — |
| Sphenomorphidae | 4 | — | — | — | — | 1 | 1 | — | — | — | — | — | — | 1 | — | 1 | — | — | — |
| Teiidae | 12 | — | — | — | 1 | — | 1 | — | 1 | — | 1 | 1 | 2 | 2 | 3 | — | — | — | — |
| Xantusiidae | 4 | — | — | — | — | — | — | 2 | — | — | — | 2 | — | — | — | — | — | — | — |
| Xenosauridae | 1 | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| **Total Lizards** | **236** | **—** | **—** | **1** | **2** | **5** | **9** | **11** | **7** | **6** | **15** | **26** | **29** | **45** | **33** | **34** | **9** | **4** | **—** |
| Anomalepididae | 3 | — | — | — | — | — | — | 1 | — | 1 | 1 | — | — | — | — | — | — | — | — |
| Boidae | 4 | — | — | — | — | — | 2 | — | — | 1 | — | 1 | — | — | — | — | — | — | — |
| Charinidae | 2 | — | — | — | — | — | — | 1 | — | — | 1 | — | — | — | — | — | — | — | — |
| Colubridae | 74 | — | — | 1 | 6 | 5 | 2 | 5 | 3 | 5 | 10 | 8 | 13 | 2 | 12 | 2 | — | — | — |
| Dipsadidae | 144 | — | 2 | 1 | 3 | 3 | 3 | 7 | 10 | 5 | 17 | 17 | 24 | 23 | 27 | 2 | — | — | — |
| Elapidae | 17 | — | — | — | — | — | — | 2 | 1 | — | — | 2 | — | 4 | 2 | 4 | 2 | — | — |
| Leptotyphlopidae | 5 | — | — | 2 | — | — | — | — | 1 | — | 2 | — | — | — | — | — | — | — | — |
| Loxocemidae | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — |
| Natricidae | 5 | — | — | — | — | — | 1 | 2 | 1 | — | — | 1 | — | — | — | — | — | — | — |
| Sibynophiidae | 2 | | | | | | | | | 1 | | 1 | | | | | | | |
| Tropidophiidae | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — |
| Typhlopidae | 5 | — | — | — | — | — | — | — | — | 2 | 2 | — | 1 | — | — | — | — | — | — |
| Viperidae | 32 | — | — | — | — | — | — | 1 | 1 | 2 | 2 | 1 | 3 | 6 | 6 | 6 | 3 | 1 | — |
| **Total Snakes** | **295** | **—** | **2** | **4** | **9** | **8** | **8** | **19** | **18** | **18** | **35** | **31** | **41** | **35** | **47** | **14** | **5** | **1** | **—** |
| **Total Squamates** | **531** | **—** | **2** | **5** | **11** | **13** | **17** | **30** | **25** | **24** | **50** | **57** | **70** | **80** | **80** | **48** | **14** | **5** | **—** |
| **Total Squamate %** | **—** | **—** | **0.4** | **0.9** | **2.1** | **2.4** | **3.2** | **5.6** | **4.7** | **4.5** | **9.4** | **10.7** | **13.2** | **15.1** | **15.1** | **9.0** | **2.6** | **0.9** | **—** |
| Chelydridae | 2 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 | — | — | — |
| Dermatemydidae | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — |
| Emydidae | 2 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | 1 | — |
| Geoemydidae | 5 | — | — | — | — | — | 1 | — | — | — | 1 | 1 | | 1 | 1 | — | — | — | — |
| Kinosternidae | 4 | — | — | — | — | — | 2 | — | — | — | — | — | 1 | — | 1 | — | — | — | — |
| Staurotypidae | 3 | — | — | — | — | — | — | — | — | — | — | 1 | 2 | — | — | — | — | — | — |
| Testudinidae | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — |
| **Total Turtles** | **18** | **—** | **—** | **—** | **—** | **—** | **3** | **—** | **—** | **2** | **1** | **2** | **3** | **1** | **2** | **3** | **—** | **1** | **—** |
| **Total Turtle %** | **—** | **—** | **—** | **—** | **—** | **—** | **16.7** | **—** | **—** | **11.1** | **5.5** | **11.1** | **16.7** | **5.5** | **11.1** | **16.7** | **—** | **5.5** | **—** |
| **Total “Reptiles”** | **552** | **—** | **2** | **5** | **11** | **13** | **20** | **30** | **25** | **26** | **51** | **60** | **74** | **81** | **83** | **51** | **14** | **6** | **—** |
| **Total “Reptile” %** | **—** | **—** | **0.4** | **0.9** | **2.0** | **2.4** | **3.6** | **5.4** | **4.5** | **4.7** | **9.2** | **10.9** | **13.4** | **14.7** | **15.0** | **9.2** | **2.5** | **1.1** | **—** |
| **Total Herpetofauna** | **1,045** | **3** | **5** | **7** | **13** | **19** | **32** | **41** | **36** | **46** | **87** | **98** | **116** | **139** | **170** | **114** | **102** | **11** | **6** |
| **Total Herpetofauna %** | **—** | **0.3** | **0.5** | **0.7** | **1.2** | **1.8** | **3.1** | **3.9** | **3.4** | **4.4** | **8.3** | **9.4** | **11.1** | **13.3** | **16.3** | **10.9** | **9.8** | **1.1** | **0.6** |



*Imantodes phantasma.* This blunt-headed treesnake is distributed in the Darién region of eastern Panama, where it occurs in Premontane Wet Forest at elevations from 1,000 to 1,100 m. We established its EVS as 16, placing in the middle portion of the high vulnerability category, and its IUCN status is Data Deficient. This individual is from the Serranía de Pirre, province of Darién, Panama. *Photo by Abel Batista.*

*Isthmohyla zeteki.* This treefrog is distributed from central Costa Rica to western Panama, where it occurs in Premontane Wet Forest and Rainforest on into Lower Montane Rainforest at elevations from 1,200 to 1,804 m. We evaluated its EVS as 13, placing it at the upper end of the middle vulnerability category, and its IUCN status is Critically Endangered. This individual is from the Cordillera de Tilarán, province of Alajuela, Costa Rica. *Photo by Brian Kubicki.*

*Isthmohyla picadoi.* This treefrog occurs in the Cordillera Central and Cordillera de Talamanca of Costa Rica and western Panama, where it occurs in Lower Montane and Montane rainforests at elevations from 1,920 to 2,770 m. We assessed its EVS as 19, placing it in the upper portion of the high vulnerability category, and its IUCN status is Near Threatened. This individual is from near Tres Colinas, Parque Internacional La Amistad, Cordillera de Talamanca, province of Puntarenas, Costa Rica. *Photo by Sean Michael Rovito.*

*Kinosternon angustipons.* The Narrow-bridged Mud Turtle is distributed along the Atlantic versant from southeastern Nicaragua to northwestern Panama, where it occurs in Tropical Moist Forest at elevations from near sea level to 260 m. We estimated its EVS as 16 in the middle portion of the high vulnerability category, and its IUCN status is Vulnerable. This individual is from the Río Papaturro, Los Guatuzos, department of Río San Juan, Nicaragua. *Photo by Javier Sunyer.*

for Central American species we provide in a following section.

Given our opinion about the nature of the IUCN system of conservation assessment, as in our assessments for the Mexican herpetofauna, we employ the EVS measure to conduct our own assessment of the conservation status of the Central American herpetofauna.

## EVS for the Central American Herpetofauna

In our prior conservation reassessments of the members of the Mexican herpetofauna (Wilson et al. 2013a, b), we specified a number of advantages for using the EVS system. Based on the information in Wilson et al. (2013b:107), we summarize these advantages below.

1. "This measure can be applied as soon as a species is described, because the information necessary for its application generally is known at that point." If the information is not entirely known (e.g., about amphibian reproductive mode), it can be estimated based on the phylogenetic relationships of the newly described species.

2. "The calculation of the EVS is an economical undertaking and does not require expensive, grant-supported workshops, such as those held in connection with the Global Reptile Assessment sponsored by the

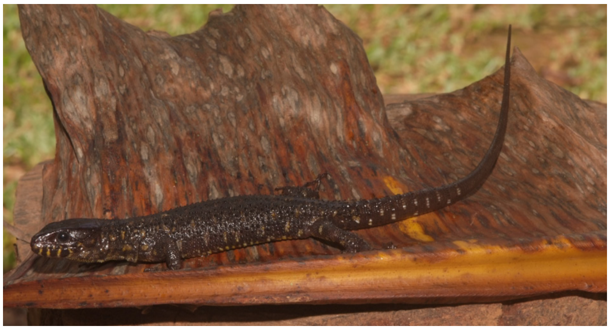
IUCN." Given that any conservation assessment is only an estimate of an organism's status in nature, it will always remain subject to modification based on additions to our knowledge. As an extreme example, conservation biologists might reach a point where they feel justified to report that a certain species is extinct (i.e., the creature no longer is in existence). This theoretical definition of the term can be problematical, however, because it can be difficult or impossible to determine if any individuals of the species remain in nature. Thus, a practical definition of the term extinction can be adopted to mean that no individuals of the species have been found by anyone qualified to make such a determination. Interestingly, on 30 December 2013 the AmphibiaWeb site indicated that an anuran from Sri Lanka (*Pseudophilautus hypomelas*) that had been declared extinct was rediscovered (Wickramasinghe et al. 2013). The authors suggested that its status be changed to Critically Endangered "under the IUCN Red List Categories and Criteria because of the extent of occurrence (EOO) is less than 100 km$^2$, the area of occupancy (AOO) is less than 10 km$^2$, and is recorded from a single location. The habitat is under severe anthropogenic activities such as overexploitation of natural resources for tea cultivation, forest fragmentation, use of agrochemicals, soil erosion, inadequately planned constructions and illegal constructions, mini-hydro power plants, forest die back, and discharge of pollutants to the environment." This familiar litany of reasons for organismic endangerment also applies to environments in Central America, where similar reports have been published (Abarca et al. 2010).

3. "The EVS is predictive, because it provides a measure of succeptibility to anthropogenic pressure, and can pinpoint taxa in need of immediate attention and continuing scrutiny." We provide an example of two recently described species of the hylid genus *Ecnomiohyla*. Batista et al. (2014) described *E. bailarina* and *E. veraguensis* from southeastern and west-central Panama, respectively. The authors noted that, "the secretive habits of *Ecnomiohyla bailarina*, as with other *Ecnomiohyla* species, make it difficult to obtain an assessment of its population size. Considering that the status of the *E. bailarina* population is unknown, the data deficient (DD) criterion, according to the IUCN … seems appropriate for this species, until data on its population trend become available. Moreover, due to the fact that *E. bailarina* and *E. thysanota* occur in a region affected by social problems and political conflicts along the border between Panama and Colombia, it is unlikely that there will be sufficient opportunity to visit the region to assess population sizes." With respect to their other new species, Batista et al. (2014) indicated that, "since *Ecnomiohyla veraguensis* occurs along with relatively widely distributed species, it is not suspected to be endemic to the Cerro Negro surroundings [the vicinity of the type locality]. However, all species in the genus are known to be very susceptible to habitat degradation and thus most are listed under a threatened category … So it is very likely that *E. veraguensis* also will qualify for a threatened category as soon as additional data are available." These authors implied that this species should be given a Data Deficient status based on the same sort of reasoning used for *E. bailarina*. We reviewed the Batista et al. (2014) paper and determined the EVS for the two species based on the information provided in the original descriptions. As a result, the EVS for both species are the highest possible (Appendix 1), i.e., 20 (6+8+6), based on being known only from the type locality in a single vegetation formation and having presumably a reproductive mode like other species of *Ecnomiohyla* (i.e., with eggs and tadpoles in water-filled tree cavities). This EVS is the same as that for the recently described and famously endangered *Ecnomiohyla rabborum* (Appendix 1; Mendelson 2011). As a consequence of our ability to calculate EVS for both of the newest *Ecnomiohyla* species, we can bring attention to their plight and their conservation status to the point that they can be used as flagship species, along with *E. rabborum*, to publicize the issues surrounding the conservation of the Panamanian herpetofauna as a whole (also see Jaramillo et al. 2010).

4. "Finally, this measure is simple to calculate and does not 'penalize' species that are poorly known." In our opinion, this penalizing comes when a species is designated as Data Deficient, because it then enters into a conservation status limbo until and unless information is available that will allow for the application of another IUCN category to be applied (most likely one of the three threat categories). For this reason, as previously discussed, we consider the DD species as "threat species in disguise." Given the pace at which organismic endangerment proceeds and the survival chances for many species, obviously they cannot afford such delays.

We calculated the EVS scores for each of the 1,045 species of amphibians, crocodylians, squamates, and turtles in Central America to which it can be applied (see Appendix 1). We placed these data alongside those for the IUCN categorizations we obtained from the IUCN Red List website (www.iucnredlist.org) and used the designation NE for those species presently not evaluated by the IUCN.

Theoretically, the EVS scores can range from 3 to 20 for amphibians, crocodylians, squamates, and turtles. A score of 3 would be assigned to broadly distributed species both inside and outside of Central America, which occurs in eight or more forest formations, and, if an amphibian has both its eggs and tadpoles in large to small bodies of lentic or lotic water or, if a squamate, if a spe-



*Lepidophyma reticulatum.* This night lizard is distributed on the Pacific versant of Costa Rica and western Panama, where it occurs in Lowland Moist and Wet and Premontane Moist and Wet forests at elevations from 10 to 1,250 m. We estimated its EVS as 13, placing it at the upper end of the medium vulnerability category, and its IUCN status is Least Concern. This individual is from Portón, province of Chiriquí, Panama. *Photo by Abel Batista.*

*Lithobates miadis.* This leopard frog is endemic to Little Corn Island off the Caribbean coast of Nicaragua, whose area consists of only 3 km2; it occurs in Lowland Moist Forest and breeds in permanent ponds. We established its EVS as 15, placing it in the lower portion of the high vulnerability category, and its IUCN status is Vulnerable. This individual is from the Región Autónoma del Atlántico Sur. *Photo by Javier Sunyer.*

cies is fossorial and thus usually escapes human notice. The amphibian species receiving an EVS score of 3 are the ranid *Lithobates forreri*, the bufonid *Rhinella marina*, and the hylid *Smilisca baudinii* (Appendix 1). We did not assign this score to any crocodylian, squamate, or turtle. At the other extreme, an EVS score of 20 would be assigned to a species known only from the vicinity of its type locality, is restricted to a single forest formation, and, if an amphibian, has both its eggs and tadpoles in water-retaining arboreal bromeliads or water-filled tree cavities, or, if a crocodylian, squamate, or turtle is commercially or non-commercially exploited for hides, meat, eggs and/or the pet trade. We assigned an EVS score of 20 to six species of hylid anurans, including four in the genus *Ecnomiohyla*, one in *Isthmohyla*, and one in *Ptychohyla* (Appendix 1). As with the lowest possible score, no crocodylian, squamate, or turtle received the highest possible score. The remaining EVS scores ranged from 4 to 19. We provide a summary of the EVS scores for the Central American herpetofaunal species in Table 3. The EVS range falls into the following three categories: low (3–9), medium (10–13), and high (14–19).

The range and mean EVS scores for the major herpetofaunal groups are as follows: anurans = 3–20 (13.8); caecilians = 7–19 (15.4); and salamanders = 8–18 (16.5); crocodylians = 13–16 (14.3); lizards = 5–19 (14.0); snakes = 4–19 (12.8); and turtles = 8–19 (13.5). We found that on average among amphibians, salamanders are more susceptible to environmental deterioration, and anurans are less susceptible than caecilians; among the remainder of the herpetofauna, crocodylians are the most susceptible and snakes the least susceptible, with turtles and lizards falling in between. The average scores fell into the upper portion of the medium category (anurans, snakes, and turtles), and the lower portion of the high category (caecilians, salamanders, and lizards). We found the average EVS scores for all amphibian species as 14.7, a value near the lower end of the high range of vulnerability, and that for crocodylians, squamates, and turtles as 13.3, a value slightly above the upper end of the medium range of vulnerability. Based on these average EVS values, amphibians are somewhat more vulnerable to environmental degradation than the rest of the herpetofauna.

Our results show an EVS score of 16, near the middle portion of the high vulnerability category, in the highest percentage (15.6) of anuran species, and an EVS score of 18, near the upper end of the high vulnerability category, in the highest percentage (35.8) of the salamander species. For caecilians, we found the same percentage of species (13.3) with EVS values ranging from 13 to 19. When organized by EVS category, the lowest number of species of amphibians (39 [7.9%]) fell into the low category, an intermediate number (105 [21.3%]) into the medium category, and the highest number (349 [70.8%]) into the high category. These figures are more alarming than those reported for the Mexican amphibian fauna; Wilson et al. (2013b) noted that of the 378 total taxa, 50 (13.2%) fell into the low vulnerability category, 106 (28.0%) into the medium category, and 222 (58.7%) into the high category.

We discovered that the EVS scores for crocodylians are too few and too scattered to confirm a pattern. With squamates, however, we found EVS scores of 15 and 16, in the lower portion of the high vulnerability category, in the highest percentage (14.9%) of the species. Overall, the frequency of EVS values for all crocodylians, squamates, and turtles increased to peak at the value of 16, and decreased steeply thereafter. When organized by EVS category, as with amphibians we found that the lowest number of species (81 [14.7%]) fell into the low category, an intermediate number (162 [29.3%]) into the medium category, and the highest number (309 [56.0%]) into the high category. These statistics differ only slightly from those reported for Mexican crocodylians, squamates, and turtles by Wilson et al. (2013a), who indicated that of the 841 total taxa that could be scored, 99 (11.8%)

fell into the low vulnerability category, 272 (32.3%) into the medium category, and 470 (55.9%) into the high category.

For the total Central American herpetofauna, our results show 120 species (11.5%) with EVS scores in the low category of vulnerability, 267 (25.6%) in the medium category, and 658 (63.0%) in the high category. For Mexico, the comparable figures are 149 (12.2%), 378 (31.0%), and 692 (56.8%). Amazingly, we found more than six of every 10 species in Central America in the high category of vulnerability to environmental deterioration. This figure is more elevated than that for the Mexican herpetofauna, although in both regions more than one-half of the herpetofauna has been judged to have the highest level of vulnerability to environmental damage. This statistic has astounding implications for efforts to conserve this hugely significant herpetofauna.

Given that our EVS results show such a high percentage of the Central American herpetofauna in the high vulnerability category, this situation needs to be examined more closely. Thus, we indicate the EVS categorizations of low, medium, and high in the last column in Appendices 1 and 2. We summarized these categorizations and compared them to the scores for each of the three components that contribute to the total EVS, as well as the total EVS itself, and organized these data according to the herpetofaunal families and orders (Table 4).

As noted above, amphibians generally are more environmentally vulnerable than the remainder of the herpetofauna (percentage of high EVS 70.8% vs. 55.8%). The relatively high figure for amphibians primarily is due to the extremely high number of salamander species placed in the high vulnerability category (92.4%) compared to the situation among anurans (59.6%). All salamanders in Central America are categorized in the family Plethodontidae. According to the accounting at the AmphibiaWeb site (accessed 9 December 2014), this family consists of 444 species; thus, the 159 Central American species comprise 35.8% of the total. This figure also represents 60.9% of the 261 species known from Mesoamerica (www.mesoamericanherpetology.com; accessed 9 December 2014). The elevated vulnerability of Central American salamanders largely is due to the small geographic ranges and limited vegetational occurrence of most species (respective average component scores of 5.1 of 6 and 7.3 of 8; Table 4). All Central American plethodontids are direct developers, so the score for reproductive mode always is 4. The average total EVS score is 16.5, which is in the middle of the range of high vulnerability scores (14–20).

The next most vulnerable group of amphibians contains the caecilians, of which only 15 species occur in Central America. Typically, these amphibians are more broadly distributed, both geographically and vegetationally (average component scores of 3.9 and 6.8, respectively). Although their reproductive biology remains poorly understood, all species likely are direct developers or viviparous, and thus are allocated reproductive mode scores of 4 or 5.

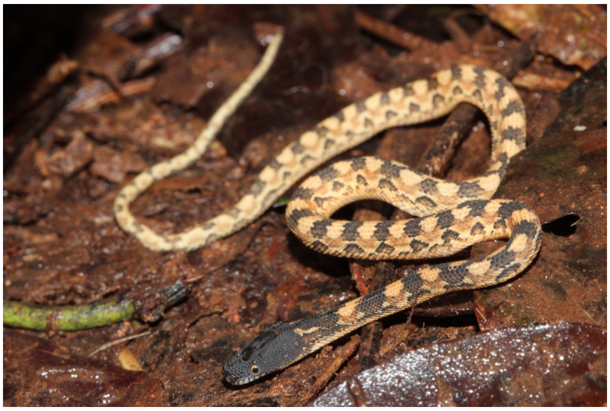
Anurans generally are less environmentally vulnerable than caecilians or salamanders (average EVS of 13.7). This situation principally is due to the relatively fewer species with high scores for reproductive mode (average score 2.8 of 6). Otherwise, the other component scores for anurans are similar to those for caecilians (4.4 vs. 3.9 for geographic distribution and 6.7 vs. 6.8 for ecological distribution). Nonetheless, our assessment showed 59.6% of the 319 anuran species with high EVS scores.

Of the 319 anuran species, 238 (74.6%) are categorized in three families, the Bufonidae (39 species), Craugastoridae (101), and Hylidae (98). Generally, members of these families are more geographically widespread than the typical salamander (respective average geographic component scores of 4.4, 4.8, and 4.4 compared to that of 5.1 for salamanders). This situation also is the case with vegetational occurrence (6.6, 7.0, and 6.7 vs. 7.3). Typical bufonid and hylid anuran species lay eggs in standing or flowing water, whereas craugastorid species have direct development. Thus, the component for reproductive mode is lower for bufonids and hylids (1.3 and 2.0, respectively) than for craugastorids (4.0). Nonetheless, we found the species with the highest EVS scores, including the highest possible score, among the hylid anurans. We calculated a total score of 20 for six hylids (Appendix 1), four in the genus *Ecnomiohyla* (*E. bailarina*, *E. rabborum*, *E. thysanota*, and *E. veraguensis*), one in the genus *Isthmohyla* (*I. melacaena*), and one in the genus *Ptychohyla* (*P. dendrophasma*). Given a total score of 20, each of these species is known only from their respective type localities, from a single vegetation zone, and has a reproductive mode of either laying eggs in tree holes or in bromeliads (Appendix 1).

The reason why we assessed fewer crocodylians, squamates, and turtles in the high EVS category than amphibians primarily is due to their greater breadth in geographic and ecological distribution (respective average values of 4.0 vs. 4.6 and 6.1 vs. 6.9). Nevertheless, a slightly higher average score for degree of persecution is present in these creatures (3.6) than for reproductive mode in amphibians (3.2).

We found turtles and squamates slightly less vulnerable than crocodylians (13.5 and 13.3, respectively, vs. 14.3). Obviously, the patterns of vulnerability are skewed toward the squamates, since 96.2% of the Central American crocodylians, squamates, and turtles are squamates.

Most squamates are classified in the families Dactyloidae (95 species), Sphaerodactylidae (19), Colubridae (74), Dipsadidae (144), and Viperidae (32). Their total number (364) represents 68.4% of the 532 species for which an EVS can be calculated. We found the average EVS scores for these families, respectively, as follows: 14.4, 14.4, 11.9, 13.0, and 15.1. Only the values for the colubrids and dipsadids fell outside of the high value



*Nothopsis rugosus*. This unusual snake is distributed from northeastern Honduras to northwestern Colombia on the Atlantic versant, and on the Pacific versant from southwestern Costa Rica to northwestern Ecuador, where it occurs in Lowland Moist and Premontane Wet forests at elevations from near sea level to 900 m. We estimated its EVS as 10, placing it at the lower end of the medium vulnerability category, and its IUCN status is Least Concern. This individual is from the Serranía de San Blas, in Panama. *Photo by Abel Batista.*

*Nototriton matama*. The Matama Moss Salamander is known only from the type locality at the southeastern end of the Fila Matama, a ridge on the Atlantic slope of Cerro Chirripó in southeastern Costa Rica, where it occurs in Premontane Wet Forest at an elevation of 1,300 m. We calculated its EVS as 18, placing it in the upper portion of the high vulnerability category, but its IUCN status has not been determined. This individual is the holotype of the species. *Photo by Eduardo Boza Oviedo.*

*Micrurus stewarti*. This coralsnake is distributed in central Panama, where it occurs in Lowland Moist and Premontane Wet forests at elevations from 500 to 1,200 m. We gauged its EVS as 17, placing it in the middle portion of the high vulnerability category, and its IUCN status is Least Concern. This individual is from Donoso, province of Colón, Panama. *Photo by Abel Batista.*

*Mastigodryas dorsalis*. This racer is distributed from western Guatemala to north-central Nicaragua, where it occurs in Premontane Wet, Lower Montane Wet, and Lower Montane Moist forests at elevations from 635 to 2,200 m. We determined its EVS as14, placing it at the lower end of the high vulnerability category, and its IUCN status is Least Concern. This individual is from Cerro Kilambé, department of Jinotega, Nicaragua. *Photo by Javier Sunyer.*

range (14–20). The proportion of high EVS species fell below 50% only in colubrids (39.2%). In the other families, the percentage values were, respectively, 72.7, 73.7, 52.8, and 78.1. We did not assign a total EVS score of 20 to any crocodylian, squamate, or turtle, although we accorded a score of 19 to five species (four iguanids and one viperid; Appendix 2). The four iguanids all are members of the genus *Ctenosaura* (*C. bakeri*, *C. oedirhina*, *C. palearis*, and *C. quinquecarinata*). The single viperid is the recently described *Bothriechis guifarroi*.

In the case of amphibians and the remainder of the herpetofauna, the typical member is a species allocated to either the lower portion of the high vulnerability range (14.7) or slightly above the upper portion of the medium vulnerability category (13.3). Consequently, management plans for the general protection of the herpetofauna, and particularly the high vulnerability species, require development in all regions of Central America.

## Comparison of IUCN Categorizations and EVS Values

Wilson et al. (2013a) stated that, “since the IUCN categorizations and EVS values both measure the degree of environmental threat impinging on a given species, a certain degree of correlation between the results of these two measures is expected.” They also noted that, “Townsend and Wilson (2010) demonstrated this relationship with reference to the Honduran herpetofauna, by comparing the IUCN and EVS values for 362 species of amphibians and terrestrial reptiles in their table 4.”

**Table 4.** Summary of Environmental Vulnerability Scores by component, total score, and category, arranged by family. The numbers in the Environmental Vulnerability Scores columns represent ranges followed by means in parentheses. Values for EVS categories are percentages. L = low vulnerability; M = medium vulnerability; H = high vulnerability.

| Families | Environmental Vulnerability Scores | | | | EVS Categories |
|---|---|---|---|---|---|
| | Geographic Distribution (range 1–6) | Ecological Distribution (range 1–8) | Reproductive Mode/Degree of Persecution (range 1–6) | Total Score (range 3–20) | |
| Aromobatidae (3) | 1–6 (4.0) | 6–8 (7.0) | 4 (4.0) | 11–18 (15.0) | L = 0.0, M = 33.3, H = 66.7 |
| Bufonidae (39) | 1–6 (4.4) | 1–8 (6.6) | 1–4 (1.3) | 3–17 (12.2) | L = 20.5, M = 41.0, H = 38.5 |
| Centrolenidae (14) | 1–5 (2.3) | 4–8 (6.6) | 3 (3.0) | 8–16 (11.1) | L = 14.3, M = 64.3, H = 21.4 |
| Craugastoridae (101) | 2–6 (4.8) | 3–8 (7.0) | 4 (4.0) | 9–18 (15.8) | L = 1.0, M = 7.9, H = 91.1 |
| Dendrobatidae (19) | 4–6 (4.8) | 6–8 (7.3) | 4 (4.0) | 14–18 (15.3) | L = 0.0, M = 0.0, H = 100 |
| Eleutherodactylidae (11) | 2–6 (4.5) | 5–8 (7.2) | 4 (4.0) | 11–18 (15.6) | L = 0.0, M = 18.2, H = 81.8 |
| Hemiphractidae (3) | 3–4 (3.7) | 7 (7.0) | 5 (5.0) | 15–16 (15.7) | L = 0.0, M = 0.0, H = 100 |
| Hylidae (98) | 1–6 (4.4) | 1–8 (6.7) | 1–6 (2.0) | 3–20 (13.1) | L = 12.2, M = 44.9, H = 42.9 |
| Leptodactylidae (9) | 1–5 (2.7) | 2–8 (5.2) | 2 (2.0) | 5–14 (10.0) | L = 44.4, M = 44.4, H = 11.2 |
| Microhylidae (9) | 2–5 (3.3) | 1–8 (5.8) | 1 (1.0) | 4–14 (10.1) | L = 33.3, M = 55.6, H = 11.1 |
| Pipidae (1) | 4 (4.0) | 8 (8.0) | 5 (5.0) | 17 (17.0) | L = 0.0, M = 0.0, H = 100 |
| Ranidae (11) | 1–6 (4.1) | 1–8 (4.8) | 1 (1.0) | 3–15 (9.9) | L = 45.4, M = 36.4, 18.2 |
| Rhinophrynidae (1) | 2 (2.0) | 5 (5.0) | 1 (1.0) | 8 (8.0) | L = 100, M = 0.0, H = 0.0 |
| **Total Anurans (319)** | **1–6 (4.4)** | **1–8 (6.7)** | **1–6 (2.8)** | **3–20 (13.7)** | **L = 11.3, M = 29.2, H = 59.6** |
| Plethodontidae (159) | 1–6 (5.1) | 3–8 (7.3) | 4 (4.0) | 8–18 (16.5) | L = 1.3, M = 6.3, H = 92.4 |
| **Total Salamanders (159)** | **1–6 (5.1)** | **3–8 (7.3)** | **4 (4.0)** | **8–18 (16.5)** | **L = 1.3, M = 6.3, H = 92.4** |
| Caeciliidae (7) | 3–6 (4.4) | 7–8 (7.9) | 4–5 (4.4) | 15–19 (16.7) | L = 0.0, M = 0.0, H = 100 |
| Dermophiidae (8) | 1–5 (3.4) | 1–8 (5.9) | 5 (5.0) | 7–18 (14.3) | L = 12.5, M = 25.0, H = 62.5 |
| **Total Caecilians (15)** | **1–6 (3.9)** | **1–8 (6.8)** | **4–5 (4.7)** | **7–19 (15.4)** | **L = 6.7, M = 13.3, H = 80.0** |
| **Total Amphibians (493)** | **1–6 (4.6)** | **1–8 (6.9)** | **1–6 (3.2)** | **3–20 (14.7)** | **L = 7.9, M = 21.3, H = 70.8** |
| Alligatoridae (1) | 3 (3.0) | 7 (7.0) | 6 (6.0) | 16 (16.0) | L = 0.0, M = 0.0, H = 100 |
| Crocodylidae (2) | 2–3 (2.5) | 5 (5.0) | 6 (6.0) | 13–14 (13.5) | L = 0.0, M = 50.0, H = 50.0 |
| **Total Crocodylians (3)** | **2–3 (2.7)** | **5–7 (5.7)** | **6 (6.0)** | **13–16 (14.3)** | **L = 0.0, M = 33.3, H = 66.7** |

**Table 4 (continued).** Summary of Environmental Vulnerability Scores by component, total score, and category, arranged by family. The numbers in the Environmental Vulnerability Scores columns represent ranges followed by means in parentheses. Values for EVS categories are percentages. L = low vulnerability; M = medium vulnerability; H = high vulnerability.

| Families | Environmental Vulnerability Scores | | | | EVS Categories |
|---|---|---|---|---|---|
| | Geographic Distribution (range 1–6) | Ecological Distribution (range 1–8) | Reproductive Mode/Degree of Persecution (range 1–6) | Total Score (range 3–20) | |
| Amphisbaenidae (2) | 3 (3.0) | 7–8 (7.5) | 1 (1.0) | 11–12 (11.5) | L = 0.0, M = 100, H = 0.0 |
| Anguidae (28) | 2–6 (4.9) | 3–8 (7.2) | 3–4 (3.6) | 8–18 (15.7) | L = 3.6, M = 3.6, H = 92.8 |
| Corytophanidae (9) | 1–5 (3.0) | 3–7 (4.9) | 3 (3.0) | 7–15 (10.9) | L = 33.3, M = 55.6, H = 11.1 |
| Dactyloidae (95) | 1–6 (4.7) | 2–8 (6.7) | 3 (3.0) | 7–17 (14.4) | L = 8.4, M = 18.9, H = 72.7 |
| Eublepharidae (2) | 3–5 (4.0) | 3–5 (4.0) | 4 (4.0) | 10–14 (12.0) | L = 0.0, M = 50.0, H = 50.0 |
| Gymnophthalmidae (14) | 2–5 (4.0) | 3–8 (7.0) | 2–3 (2.7) | 9–16 (13.7) | L = 7.1, M = 21.5, H = 71.4 |
| Helodermatidae (2) | 3–5 (4.0) | 6–8 (7.0) | 5 (5.0) | 14–18 (16.0) | L = 0.0, M = 0.0, H = 100 |
| Hoplocercidae (2) | 3–4 (3.5) | 7–8 (7.5) | 3 (3.0) | 13–15 (14.0) | L = 0.0, M = 50.0, H = 50.0 |
| Iguanidae (11) | 1–5 (4.0) | 3–8 (6.5) | 3–6 (5.7) | 10–19 (16.3) | L = 0.0, M = 27.3, H = 72.7 |
| Mabuyidae (5) | 1–6 (4.4) | 2–8 (6.4) | 3 (3.0) | 6–17 ( 13.8) | L = 20.0, M = 0.0, H = 80.0 |
| Phrynosomatidae (17) | 1–5 (3.6) | 1–8 (5.0) | 3 (3.0) | 5–15 (11.6) | L = 11.8m M = 64.7, H = 23.5 |
| Phyllodactylidae (5) | 1–6 (3.8) | 4–8 (6.4) | 3 (3.0) | 8–17 (13.2) | L = 40.0, M = 0.0, H = 60.0 |
| Polychrotidae (1) | 1 (1.0) | 8 (8.0) | 3 (3.0) | 12 (12.0) | L = 0.0, M = 100, H = 0.0 |
| Scincidae (3) | 4–5 (4.3) | 5–6 (5.7) | 3 (3.0) | 12–14 (13.0) | L = 0.0, M = 66.7, H = 33.3 |
| Sphaerodactylidae (19) | 1–6 (4.3) | 3–8 (7.1) | 3 (3.0) | 8–17 (14.4) | L = 10.5, M = 15.8, H = 73.7 |
| Sphenomorphidae (4) | 2–6 (4.0) | 2–8 (4.8) | 3 (3.0) | 7–17 (11.8) | L = 50.0, M = 0.0, H = 50.0 |
| Teiidae (12) | 1–5 (3.6) | 2–8 (6.3) | 3 (3.0) | 6–16 (12.9) | L = 16.7, M = 25.0, H = 58.3 |
| Xantusiidae (4) | 2–5 (3.5) | 4–7 (5.5) | 2 (2.0) | 9–13 (11.0) | L = 50.0, M = 50.0, H = 0.0 |
| Xenosauridae (1) | 3 (3.0) | 1 (1.0) | 3 (3.0) | 7 (7.0) | L = 100, M = 0.0, H = 0.0 |
| Anomalepididae (3) | 2–5 (3.3) | 5–8 (6.3) | 1 (1.0 | 9–12 (10.7) | L = 33.3, M = 66.7, H = 0.0 |
| Boidae (4) | 1–3 (1.5) | 1–8 (5.5) | 2–6 (3.0) | 8–13 (10.0) | L = 50.0, M = 50.0, H = 0.0 |
| Charinidae (2) | 2–4 (3.0) | 5–6 (5.5) | 2 (2.0) | 9–12 (10.5) | L = 50.0, M = 50.0, H = 0.0 |
| Colubridae (74) | 1–6 (3.6) | 1–8 (5.1) | 2–5 (3.2) | 5–17 (11.9) | L = 25.7m M = 35.1, H = 39.2 |

**Table 4 (continued).** Summary of Environmental Vulnerability Scores by component, total score, and category, arranged by family. The numbers in the Environmental Vulnerability Scores columns represent ranges followed by means in parentheses. Values for EVS categories are percentages. L = low vulnerability; M = medium vulnerability; H = high vulnerability.

| Families | Environmental Vulnerability Scores | | | | EVS Categories |
|---|---|---|---|---|---|
| | Geographic Distribution (range 1–6) | Ecological Distribution (range 1–8) | Reproductive Mode/Degree of Persecution (range 1–6) | Total Score (range 3–20) | |
| Dipsadidae (144) | 1–6 (4.1) | 1–8 (6.2) | 2–5 (4.0) | 4–17 (13.0) | L = 13.9, M = 33.3, H = 52.8 |
| Elapidae (17) | 2–5 (4.0) | 1–8 (5.7) | 5 (5.0) | 9–18 (14.7) | L = 11.8, M = 17.6, H = 70.6 |
| Leptotyphlopidae (5) | 3–5 (3.6) | 1-8 (4.2) | 1 (1.0) | 5–12 (8.8) | L = 40.0, M = 60.0, H = 0.0 |
| Loxocemidae (1) | 1 (1.0) | 5 (5.0) | 4 (4.0) | 11 (11.0) | L = 0.0, M = 100, H = 0.0 |
| Natricidae (5) | 1–4 (2.8) | 1–5 (3.4) | 2–4 (3.6) | 8–13 (9.8) | L = 60.0, M = 40.0, H = 0.0 |
| Sibynophiidae (2) | 1 (1.0) | 5–7 (6.0) | 5 (5.0) | 11–13 (12.0) | L = 0.0, M = 100, H = 0.0 |
| Tropidophiidae (1) | 3 (3.0) | 5 (5.0) | 3 (3.0) | 11 (11.0) | L = 0.0, M = 100, H = 0.0 |
| Typhlopidae (5) | 4–5 (4.6) | 5–8 (6.4) | 1 (1.0) | 11–14 (12.0) | L = 0.0, M = 80.0, H = 20.0 |
| Viperidae (32) | 1–6 (4.0) | 2–8 (6.0) | 5 (5.0) | 9–19 (15.1) | L = 3.1, M = 18.8, H = 78.1 |
| **Total Squamates (531)** | **1–6 (4.1)** | **1–8 (6.1)** | **1–6 (3.5)** | **4–19 (13.3)** | **L = 14.7, M = 29.6, H = 55.7** |
| Chelydridae (2) | 1–4 (2.5) | 4–7 (5.5) | 6 (6.0) | 11–17 (14.0) | L = 0.0, M = 50.0, H = 50.0 |
| Dermatemydidae (1) | 4 (4.0) | 7 (7.0) | 6 (6.0) | 17 (17.0) | L = 0.0, M = 0.0, H = 100 |
| Emydidae (2) | 1–5 (3.0) | 4–8 (6.0) | 6 (6.0) | 11–19 (15.0) | L = 0.0, M = 50.0, H = 50.0 |
| Geoemydidae (5) | 1–5 (3.2) | 4–8 (6.6) | 3 (3.0) | 8–16 (12.8) | L = 20.0, M = 40.0, H = 40.0 |
| Kinosternidae (4) | 1–5 (2.8) | 4–8 (5.8) | 3 (3.0) | 8–16 (11.5) | L = 50.0, M = 0.0, H = 50.0 |
| Staurotypidae (3) | 4 (4.0) | 4–8 (6.7) | 3 (3.0) | 13–14 (13.7) | L = 0.0, M = 33.3, H = 66.7 |
| Testudinidae (1) | 3 (3.0) | 8 (8.0) | 6 (6.0) | 17 (17.0) | L = 0.0, M = 0.0, H = 100 |
| **Total Turtles (18)** | **1–5 (3.2)** | **4–8 (6.3)** | **3–6 (4.0)** | **8–19 (13.5)** | **L = 16.7, M = 27.8, H = 55.5** |
| **Total “Reptiles” (552)** | **1–6 (4.0)** | **1–8 (6.1)** | **1–6 (3.6)** | **4–19 (13.3)** | **L = 14.7, M = 29.5, H = 55.8** |
| **Total Herpetofauna (1045)** | **1–6 (4.3)** | **1–8 (6.5)** | **1–6 (3.4)** | **3–20 (14.0)** | **L = 11.5, M = 25.6, H = 62.9** |

As Wilson et al. (2013a, b) developed for the Mexican herpetofauna, we constructed a pair of tables (Tables 5 and 6) to judge whether such a correspondence exists between these two measures of conservation status for the Central American herpetofauna. The results for the Mexican and Central American amphibian faunas are comparable to a point, but not otherwise. With respect to the IUCN categorizaitons, the absolute numbers for the three threat categories and the NT category are similar to one another (Central American values indicated first; CR = 91 vs. 88, EN = 75 vs. 79, VU = 44 vs. 44, NT = 26 vs. 21), even though 114 more amphibian species occur in Central America than in Mexico (493 vs. 379). Interestingly, the values for the LC, DD, and NE categories are not similar between the two regions, especially with respect to the latter two (LC = 147 vs. 91, DD = 55 vs. 38, NE = 52 vs. 17). Apparently, a correlation exists between the greater number of amphibian species in Central America and those in Mexico, and the number of species relegated to the LC, DD, and NE categories in the two regions. Of the 493 Central American amphibian species, 236 (47.9%) have been categorized as CR, EN, VU, and NT. In Mexico, 232 (61.4%) of these species have been assessed in these categories. In Central America, however, a significantly larger percentage of the species have been assessed in the LC, DD, and NE categories (254 [51.5%]) than in Mexico (146 [38.6%]). Note that the two percentage figures for Central America do not add up to 100, because three species in this region have been judged as extinct (Appendix 1). Why such a relatively large percentage of DD + NE species (21.7%) is present in Central American amphibians compared to those in Mexico (14.6%) is not evident, but it means that more than one in every five species in Central America has not been evaluated or is too poorly known to allow for an evaluation. This situation provided us with a special impetus to conduct an EVS analysis on these creatures.

Like Wilson et al. (2013b) did for the Mexican amphibians, we determined the mean EVS for each of the IUCN columns in Table 5, including the NE species and the total species. The results are as follows: CR (91 spp.) = 15.4 (range 7–20); EN (75 spp.) = 15.3 (9–18); VU (44 spp.) = 14.8 (7–18); NT (26 spp.) = 14.9 (8–20); LC (147 spp.) = 8.0 (3–17); DD (55 spp.) = 16.8 (13–20); NE (52 spp.) = 17.3 (8–20); and total (493 spp.) = 14.7 (3–20). Some interesting resemblances are evident between these data and those for the Mexican amphibians (Wilson et al. 2013b). As with the Mexican species, the mean EVS value decreases steadily (though not as dramatically) from the CR category (15.4) through the EN (15.3), and VU (14.8) categories, with the value for the NT species (14.9) almost the same as that for the VU species. A precipitous drop also is evident from the VU and NT values to those for the LC species (8.0), more so than for the Mexican amphibians. Although this decrease was expected, as for the Mexican amphibians we did not anticipate the size of the mean value for the DD species in Central America (16.8), which is almost the highest mean value for these categories. Thus, this value is substantially higher than that for any of the threat species. Even more surprising is that the mean value for the NE species is even higher (17.3) than that for the DD species. The value for the DD species supports our stated opinion about these species; apparently the NE group also is comprised of such species. As expected, the EVS values for almost all the DD (54 of 55 [98.2%]) and the NE species (51 of 52 [98.1%]) fell into the high vulnerability category, including the average total value (14.7). These additional reasons provide a compelling argument for conducting a reassessment of the Central American herpetofauna based on the EVS measure.

A revealing statistic is that the average EVS value for each IUCN category, except for the LC, fell into the high vulnerability category. With the LC category, of the 38 amphibian species with EVS values in the low vulnerability category, 30 (78.9%) have been placed in this IUCN category; however, 51 (34.7%) of the LC species fell into the medium category, with the remaining 66 (44.9%) species into the high category. Thus, as with our work on the Mexican herpetofauna, these data support our opinion that the LC category is applied too broadly in IUCN assessments to be of significant value in conservation planning.

As with Table 5, the data in Table 6 illustrate the relationship between the IUCN ratings and EVS values for the 552 Central American crocodylians, squamates, and turtles. These data can be compared to those for these creatures in Mexico (see Wilson et al. 2013a). With reference to the IUCN categorizations, the absolute numbers for the three threat categories and the NT category for the two regions are not as similar to one another for the crocodylians, squamates, and turtles as they are for the amphibians (Central American values listed first; CR = 14 vs. 6, EN = 30 vs. 36, VU = 18 vs. 44, NT = 21 vs. 26). The figures for Central America total 83, compared to 112 for Mexico. The total figures for the two regions, however, comprise reasonably close percentages of the respective total non-amphibian herpetofaunas (i.e., 83 of 552 [15.0%] vs. 112 of 841 [13.3%]). We believe, however, that once the IUCN categorizations are available for Central American anoles that the ranks of the three threat categories and the NT category will be augmented, similar to when the categorizations are published for the species in Central and South America. With respect to the remainder of the IUCN categorizations, however, the total relative figures are comparable for Central America and Mexico. The comparable absolute figures for the two regions, respectively, are as follows: LC = 208 vs. 422, DD = 35 vs. 118, NE = 226 vs. 189. For Central America, the three absolute values total 469 species (85.0% of the total of 552); for Mexico, the comparable figures are 729 and 86.7%.

Equivalent to the approach in Wilson et al. (2013a) for Mexican crocodylians, squamates, and turtles, we ascertained the mean EVS scores for each of the IUCN columns in Table 6, including the NE species and the total species. The results are as follows: CR (14 spp.) = 16.6 (15–19); EN (30 spp.) = 15.9 (13–19); VU (18 spp.) = 15.0 (7–18); NT (21 spp.) = 14.3 (12–16); LC (208 spp.) = 12.3 (4–18); DD (35 spp.) = 15.6 (11–18); NE (226 spp.) = 13.2 (4–19). In common with Mexican crocodylians, squamates, and turtles (Wilson et al. 2013a), a corresponding increase in average EVS scores is evident with ascending degrees of threat, from LC through CR. Similar to the situation with Mexican crocodylians,

**Table 5.** Comparison of Environmental Vulnerability Scores (EVS) and IUCN categorizations for Central American amphibians. Shaded area at the top encompasses low vulnerability scores, and that at the bottom high vulnerability scores.

| EVS | IUCN categories | | | | | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|
| | Extinct | Critically Endangered | Endan-gered | Vulner-able | Near Threatened | Least Concern | Data Deficient | Not Evaluated | |
| 3 | — | — | — | — | — | 3 | — | — | 3 |
| 4 | — | — | — | — | — | 3 | — | — | 3 |
| 5 | — | — | — | — | — | 2 | — | — | 2 |
| 6 | — | — | — | — | — | 2 | — | — | 2 |
| 7 | — | 1 | — | 1 | — | 4 | — | — | 6 |
| 8 | — | — | — | 1 | 1 | 9 | — | 1 | 12 |
| 9 | — | 1 | 1 | 1 | — | 8 | — | — | 11 |
| 10 | — | 2 | 2 | 1 | — | 6 | — | — | 11 |
| 11 | — | 2 | — | 4 | — | 14 | — | — | 20 |
| 12 | — | 5 | 6 | 3 | 5 | 17 | — | — | 36 |
| 13 | — | 14 | 4 | 2 | 2 | 14 | 1 | 1 | 38 |
| 14 | — | 9 | 8 | 3 | 2 | 17 | 4 | — | 43 |
| 15 | 2 | 11 | 8 | 6 | 4 | 19 | 7 | 1 | 58 |
| 16 | — | 7 | 24 | 7 | 7 | 25 | 10 | 5 | 85 |
| 17 | — | 12 | 18 | 5 | 1 | 4 | 11 | 12 | 63 |
| 18 | 1 | 23 | 4 | 10 | 2 | — | 19 | 30 | 89 |
| 19 | — | 2 | — | — | 1 | — | 2 | — | 5 |
| 20 | — | 2 | — | — | 1 | — | 1 | 2 | 6 |
| **Totals** | **3** | **91** | **75** | **44** | **26** | **147** | **55** | **52** | **493** |

**Table 6.** Comparison of Environmental Vulnerability Scores (EVS) and IUCN categorizations for Central American crocodylians, squamates, and turtles. Shaded area at the top encompasses low vulnerability scores, and that at the bottom high vulnerability scores.

| EVS | IUCN categories | | | | | | | Totals |
|---|---|---|---|---|---|---|---|---|
| | Critically Endangered | Endangered | Vulnerable | Near Threatened | Least Concern | Data Deficient | Not Evaluated | |
| 3 | — | — | — | — | — | — | — | — |
| 4 | — | — | — | — | 1 | — | 1 | 2 |
| 5 | — | — | — | — | 1 | — | 4 | 5 |
| 6 | — | — | — | — | 6 | — | 5 | 11 |
| 7 | — | — | 1 | — | 7 | — | 6 | 14 |
| 8 | — | — | — | — | 9 | — | 10 | 19 |
| 9 | — | — | — | — | 17 | — | 12 | 29 |
| 10 | — | — | — | — | 15 | — | 11 | 26 |
| 11 | — | — | — | — | 13 | 2 | 12 | 27 |
| 12 | — | — | — | 1 | 33 | 1 | 17 | 52 |
| 13 | — | 3 | — | 4 | 28 | 1 | 24 | 60 |
| 14 | — | 4 | 6 | 6 | 27 | 1 | 30 | 74 |
| 15 | 1 | 5 | 2 | 7 | 25 | 6 | 34 | 80 |
| 16 | 8 | 7 | 5 | 3 | 18 | 17 | 26 | 84 |
| 17 | 1 | 5 | 3 | — | 6 | 4 | 30 | 49 |
| 18 | 3 | 4 | 1 | — | 2 | 3 | 1 | 14 |
| 19 | 1 | 2 | — | — | — | — | 3 | 6 |
| 20 | — | — | — | — | — | — | — | — |
| **Totals** | **14** | **30** | **18** | **21** | **208** | **35** | **226** | **552** |

squamates, and turtles, the average EVS scores for the DD species (15.6) is closest to that for the VU species (15.5), which also suggests that if and when these species are better known, they likely will be judged as VU, EN, or CR. The amount of decrease in average EVS scores for Central American crocodylians, squamates, and turtles from the NT to the LC categories (14.3 to 12.3) is comparable to the same groups in Mexico (12.9 to 10.5), although those for Central America are higher. The NE species constitute the largest component of the Central American crocodylian, squamate, and turtle fauna (226 species [40.9%] of the total). The average EVS score for these species is closest to that for the LC species (13.2 vs. 12.3), the second largest group (208 species). The ranges in their EVS values are similar to one another (4–19 for NE species, 4–18 for LC species). Eventually, the large number of NE species likely will join the large number of LC species when the IUCN categorizations have been determined for the former group. If so, then the combined 226 NE and 208 LC species would comprise 434 species (78.6% of the Central American crocodylian, squamate, and turtle fauna). If this eventually occurs, it would constitute a travesty of conservation effort, allowing for a serious degradation of the significance of this fauna.

Similar to the situation with Central American amphibians, most of the average EVS values we assessed for the crocodylians, squamates, and turtles, except for those in the LC and NE categories, fell into the high vulnerability category. The LC and NE averages, however, fell into the upper portion of the medium vulnerability category (12.3 and 13.2, respectively). Interestingly, the ranges of EVS values for the LC and NE species are similar (4–18 and 4–19, respectively). Both of these ranges are close to the total possible EVS range of 3–20. The EVS values, however, were not evenly distributed among the three vulnerability categories in either case. With the LC category, 41 of the 208 species (19.7%) fell into the low vulnerability grouping, 89 (42.8%) into the medium category, and 78 (37.5%) into the high category. With regard to the NE category, the comparable values are 38 (16.8%), 64 (28.3%), and 122 (54.9%). As with the Central American amphibians, the LC category appears too broadly applied to a large a group of species to be of meaningful conservation value for decision-making. Given the large number of species that remain unevaluated, many of these species likely will be allocated to the LC category, thus inflating the lack of utility of this category to reasonably reflect the conservation status of the species involved.

We harbor no illusions that the EVS measure will come to replace the IUCN system of categorization of conservation status and do not necessarily desire for this change to happen, but we maintain that the IUCN system has serious disadvantages when compared with the EVS measure. For the purposes of this analysis, if we divide the IUCN categories into three groups so they can be compared with the three EVS categories, and determine the absolute and relative numbers of species occupying each, the results are germane to our conclusions.

The three groupings of the IUCN categories are as follows: EX+CR+EN+VU; NT+LC; and DD+NE. Summing the numbers of species from tables 5 and 6 in each of these groupings for amphibians and the remainder of the herpetofauna provides a set of absolute values for the entire herpetofauna, in respective order as follows: 275 species (26.3%); 402 (38.5%); and 368 (35.2%). For the three EVS groupings, from high through medium to low, the results are as follows: 656 (62.8%); 270 (25.8%); and 119 (11.4%). The three IUCN groups and the three EVS groupings are not entirely comparable; nonetheless, the first IUCN grouping (EX+CR+EN+VU), i.e., the threat categories plus the extinct one, can be compared to the high vulnerability EVS grouping. Only 275 species (26.3%) of the total are allocated to the IUCN grouping, whereas 656 species (62.8%) are placed in the EVS grouping. The second IUCN grouping (NT+LC) is grossly comparable to the low vulnerability EVS grouping; the respective values are: 402 (38.5%) and 119 (11.4%). The third IUCN grouping is not comparable to any of the EVS groupings, since all the species can be evaluated using the latter, whereas a substantial proportion (367 species [35.2%]) of the former remain unevaluated. Even with the discrepancies between the IUCN and EVS systems, the use of the latter identifies a substantially larger absolute and relative number of species in need of serious conservation attention (275 [26.3%] vs. 656 [62.8%], respectively) and a substantially smaller absolute and relative number of species least needing this attention (402 [38.5%] vs. 119 [11.4%], respectively). These highly divergent results have profound consequences in efforts to conserve the highly significant Central American herpetofauna. The IUCN evaluation implies that this is a much simpler task to accomplish than the EVS evaluation. Such a conservation effort presently is a huge undertaking, which will grow increasingly in extent into the forseeable future.

## Comparison of EVS Results for Central America and Mexico

We demonstrated that a large proportion of the Central American herpetofauna is highly vulnerable to environmental deterioration, more so than for the Mexican herpetofauna. To examine this situation in more detail, we constructed Table 7, in which the absolute and relative distribution of EVS values is indicated for the major herpetofaunal groups. For ease of understanding, we collapsed these data (Table 8) into the three categories of vulnerability generally recognized for the EVS measure, i.e., low, medium, and high.

Perusal of the data in Table 8 indicates that the general pattern for amphibians is for the numbers and percentages to increase from the low through the medium to the high categories. This pattern is evident in both regions

**Table 7.** Comparison of Environmental Vulnerability Scores and Percentages for the Central American and Mexican herpetofauna, arranged by major groups. Shaded area to the left encompasses low vulnerability scores, and to the right high vulnerability scores. CA = Central American. Data for Central American taxa are from Table 3, and for Mexican taxa from Wilson et al. (2013a, b).

| Major groups | Number of species | Environmental Vulnerability Scores | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| CA Anurans | 319 | 3 | 3 | 2 | 2 | 5 | 11 | 10 | 11 | 18 | 34 | 30 | 37 | 39 | 50 | 26 | 29 | 3 | 6 |
| **Percentages** | — | **0.9** | **0.9** | **0.6** | **0.6** | **1.6** | **3.4** | **3.1** | **3.4** | **5.6** | **10.7** | **9.4** | **11.6** | **12.2** | **15.7** | **8.2** | **9.1** | **0.9** | **1.9** |
| Mexican Anurans | 237 | 4 | 3 | 3 | 4 | 9 | 12 | 14 | 13 | 20 | 25 | 29 | 36 | 30 | 8 | 14 | 12 | 1 | — |
| **Percentages** | — | **1.7** | **1.3** | **1.3** | **1.7** | **3.8** | **5.1** | **5.9** | **5.4** | **8.4** | **10.5** | **12.2** | **15.2** | **12.7** | **3.4** | **5.9** | **5.1** | **8.4** | — |
| CA Salamanders | 159 | — | — | — | — | — | 1 | 1 | — | 2 | 2 | 6 | 4 | 17 | 34 | 35 | 57 | — | — |
| **Percentages** | — | — | — | — | — | — | **0.6** | **0.6** | — | **1.3** | **1.3** | **3.8** | **2.5** | **10.7** | **21.4** | **22.0** | **35.8** | — | — |
| Mexican Salamanders | 139 | — | — | — | — | — | — | 1 | 2 | 2 | 6 | 7 | 13 | 23 | 13 | 36 | 36 | — | — |
| **Percentages** | — | — | — | — | — | — | — | **0.7** | **1.4** | **1.4** | **4.3** | **5.0** | **9.4** | **16.6** | **9.4** | **25.9** | **25.9** | — | — |
| CA Caecilians | 15 | — | — | — | — | 1 | — | — | — | — | — | 2 | 2 | 2 | 2 | 2 | 2 | 2 | — |
| **Percentages** | — | — | — | — | — | **6.7** | — | — | — | — | — | **13.3** | **13.3** | **13.3** | **13.3** | **13.3** | **13.3** | **13.3** | — |
| Mexican Caecilians | 3 | — | — | — | — | — | — | — | — | 1 | 1 | — | — | — | 1 | — | — | — | — |
| **Percentages** | — | — | — | — | — | — | — | — | — | **33.3** | **33.3** | — | — | — | **33.3** | — | — | — | — |
| CA Amphibians | 493 | 3 | 3 | 2 | 2 | 6 | 12 | 11 | 11 | 20 | 36 | 38 | 42 | 58 | 87 | 63 | 88 | 5 | 6 |
| **Percentages** | — | **0.6** | **0.6** | **0.4** | **0.4** | **1.2** | **2.4** | **2.2** | **2.2** | **4.1** | **7.3** | **7.7** | **8.5** | **11.8** | **17.6** | **12.8** | **17.8** | **1.0** | **1.2** |
| Mexican Amphibians | 379 | 4 | 3 | 3 | 4 | 9 | 12 | 15 | 15 | 23 | 32 | 36 | 49 | 53 | 22 | 50 | 48 | 1 | — |
| **Percentages** | — | **1.1** | **0.8** | **0.8** | **1.1** | **2.4** | **3.2** | **4.0** | **4.0** | **6.1** | **8.4** | **9.5** | **12.9** | **14.0** | **5.8** | **13.2** | **12.7** | **0.3** | — |
| CA Crocodylians | 3 | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — | 1 | — | — | — | — |
| **Percentages** | — | — | — | — | — | — | — | — | — | — | — | **33.3** | **33.3** | — | **33.3** | — | — | — | — |
| Mexican Crocodylians | 3 | — | — | — | — | — | — | — | — | — | — | 1 | 1 | — | 1 | — | — | — | — |
| **Percentages** | — | — | — | — | — | — | — | — | — | — | — | **33.3** | **33.3** | — | **33.3** | — | — | — | — |
| CA Lizards | 236 | — | — | 1 | 2 | 5 | 9 | 11 | 7 | 6 | 15 | 26 | 29 | 45 | 33 | 34 | 9 | 4 | — |
| **Percentages** | — | — | — | **0.4** | **0.8** | **2.1** | **3.8** | **4.7** | **3.0** | **2.5** | **6.4** | **11.0** | **12.3** | **19.1** | **14.0** | **14.4** | **3.8** | **1.7** | |
| Mexican Lizards | 413 | — | — | 1 | 3 | 6 | 11 | 13 | 14 | 28 | 39 | 49 | 54 | 67 | 78 | 38 | 10 | 2 | — |
| **Percentages** | — | — | — | **0.2** | **0.7** | **1.5** | **2.7** | **3.1** | **3.4** | **6.8** | **9.4** | **11.9** | **13.1** | **16.2** | **18.9** | **9.2** | **2.4** | **0.5** | — |
| CA Snakes | 295 | — | 2 | 4 | 9 | 8 | 8 | 19 | 18 | 18 | 35 | 31 | 41 | 35 | 47 | 14 | 5 | 1 | — |
| **Percentages** | — | — | **0.7** | **1.4** | **3.1** | **2.7** | **2.7** | **6.4** | **6.1** | **6.1** | **11.9** | **10.5** | **13.9** | **11.9** | **15.9** | **4.7** | **1.7** | **0.3** | — |
| Mexican Snakes | 383 | 1 | 1 | 7 | 10 | 9 | 19 | 17 | 30 | 25 | 31 | 47 | 52 | 50 | 44 | 24 | 9 | 7 | — |
| **Percentages** | — | **0.3** | **0.3** | **1.8** | **2.6** | **2.3** | **5.0** | **4.4** | **7.8** | **6.5** | **8.1** | **12.3** | **13.6** | **13.1** | **11.5** | **6.3** | **2.3** | **1.8** | — |
| CA Turtles | 18 | — | — | — | — | — | 3 | — | — | 2 | 1 | 2 | 3 | 1 | 2 | 3 | — | 1 | — |
| **Percentages** | — | — | — | — | — | — | **16.7** | — | — | **11.1** | **5.5** | **11.1** | **16.7** | **5.5** | **11.1** | **16.7** | — | **5.5** | — |
| Mexican Turtles | 42 | — | — | — | — | — | 1 | — | 3 | 1 | 1 | 3 | 8 | 6 | 4 | 3 | 5 | 6 | 1 |
| **Percentages** | — | — | — | — | — | — | **2.4** | — | **7.1** | **2.4** | **2.4** | **7.1** | **19.0** | **14.3** | **9.5** | **7.1** | **11.9** | **14.3** | **2.4** |
| CA "Reptiles" | 552 | — | 2 | 5 | 11 | 13 | 20 | 30 | 25 | 26 | 51 | 60 | 74 | 81 | 83 | 51 | 14 | 6 | — |
| **Percentages** | — | — | **0.4** | **0.9** | **2.0** | **2.4** | **3.6** | **5.4** | **4.5** | **4.7** | **9.2** | **10.9** | **13.4** | **14.7** | **15.0** | **9.2** | **2.5** | **1.1** | — |
| Mexican "Reptiles" | 841 | 1 | 1 | 8 | 13 | 15 | 31 | 30 | 47 | 54 | 71 | 100 | 115 | 123 | 127 | 65 | 24 | 15 | 1 |
| **Percentages** | — | **0.1** | **0.1** | **1.0** | **1.5** | **1.8** | **3.7** | **3.6** | **5.6** | **6.4** | **8.4** | **11.9** | **13.7** | **14.6** | **15.1** | **7.7** | **2.9** | **1.8** | **0.1** |

(Central America and Mexico), and in each of the major groups (anurans, caecilians, and salamanders). The relationship of the numbers and percentages changes, however, between the two regions and among the three major groups. Among the anurans, proportionately more taxa were assigned to the high category in Central America (59.5%) than in Mexico (42.6%). Among the salamanders, the same situation is evident (92.4% vs. 87.1%). This relationship is not evident among the caecilians, since there is only one of three Mexican caecilians, including the recently reported *Gymnopis syntrema* with an assessed score falling into the high category. Overall, more taxa were assessed in the high category in Central America than Mexico (70.8% vs. 58.8%, respectively). In both Central America and Mexico, the group of amphibians exhibiting the greatest vulnerability to environmental damage were the salamanders, with about nine of every 10 species assessed in the high category. A ma-

**Table 8.** Summary comparison of EVS category values and percentages from Table 6 for the Central American and Mexican herpetofauna, arranged by major groups.

| Major groups | Number of species | EVS Categories | | |
|---|---|---|---|---|
| | | Low | Medium | High |
| CA Anurans | 319 | 36 | 93 | 190 |
| **Percentages** | — | **11.3** | **29.2** | **59.5** |
| Mexican Anurans | 237 | 49 | 87 | 101 |
| **Percentages** | — | **20.7** | **36.7** | **42.6** |
| CA Salamanders | 159 | 2 | 10 | 147 |
| **Percentages** | — | **1.3** | **6.3** | **92.4** |
| Mexican Salamanders | 139 | 1 | 17 | 121 |
| **Percentages** | — | **0.7** | **12.2** | **87.1** |
| CA Caecilians | 15 | 1 | 2 | 12 |
| **Percentages** | — | **6.7** | **13.3** | **80.0** |
| Mexican Caecilians | 3 | — | 2 | 1 |
| **Percentages** | — | — | **66.7** | **33.3** |
| CA Amphibians | 493 | 39 | 105 | 349 |
| **Percentages** | — | **7.9** | **21.3** | **70.8** |
| Mexican Amphibians | 379 | 50 | 106 | 223 |
| **Percentages** | — | **13.2** | **28.0** | **58.8** |
| CA Crocodylians | 3 | — | 1 | 2 |
| **Percentages** | — | — | **33.3** | **66.7** |
| Mexican Crocodylians | 3 | — | 1 | 2 |
| **Percentages** | — | — | **33.3** | **66.7** |
| CA Lizards | 236 | 28 | 54 | 154 |
| **Percentages** | — | **11.9** | **22.9** | **65.2** |
| Mexican Lizards | 413 | 34 | 130 | 249 |
| **Percentages** | — | **8.2** | **31.5** | **60.3** |
| CA Snakes | 295 | 50 | 102 | 143 |
| **Percentages** | — | **16.9** | **34.6** | **48.5** |
| Mexican Snakes | 383 | 64 | 133 | 186 |
| **Percentages** | — | **16.7** | **34.7** | **48.6** |
| CA Turtles | 18 | 3 | 5 | 10 |
| **Percentages** | — | **16.7** | **27.8** | **55.5** |
| Mexican Turtles | 42 | 1 | 8 | 33 |
| **Percentages** | — | **2.4** | **19.0** | **78.6** |
| CA “Reptiles” | 552 | 81 | 162 | 309 |
| **Percentages** | — | **14.7** | **29.3** | **56.0** |
| Mexican “Reptiles” | 841 | 99 | 272 | 470 |
| **Percentages** | — | **11.8** | **32.3** | **55.9** |

jor distinction is evident between the salamanders and the anurans, given that about four of every 10 species of anurans in Mexico and about six of every 10 species in Central America were assessed in the high category. In both Central America and Mexico (thus, all of Mesoamerica) salamanders are of most crucial conservation concern.

The same general pattern we found among the amphibians also is evident among the remainder of the herpetofauna, i.e., an increase in the numbers and percentages from low through medium to high in both regions and within each group. Again, as with the amphibians, some distinctions can be made among the proportions of taxa falling into the three categories of vulnerability. Among the turtles, a greater proportion fell into the high category in Mexico than in Central America (78.6% vs. 55.5%). Among the lizards, however, the proportions falling into the three categories are similar to one another in Cen-

*Nototriton lignicola.* This salamander is endemic to mountains in north-central Honduras, where it occurs in Lower Montane Wet Forest at elevations from 1,760 to 2,000 m. We determined its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Critically Endangered. This individual is from Cataguana, Parque Nacional Montaña de Yoro, department of Yoro. *Photo by Josiah H. Townsend.*

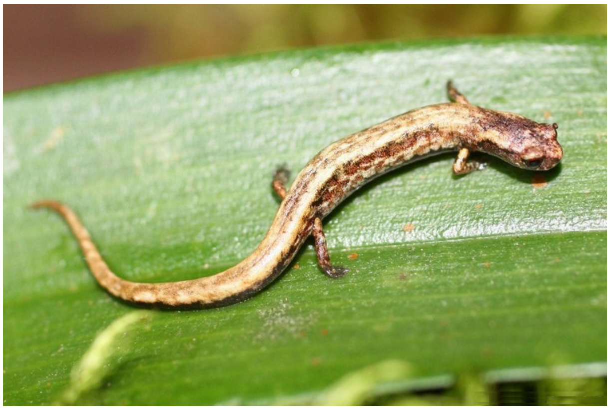
tral America and Mexico, respectively (low: 11.9 vs. 8.2; medium: 22.9 vs. 31.5; high: 65.2 vs. 60.3). Interestingly, among the snakes, the proportions were almost the same in Central America and Mexico (low: 16.9 vs.16.7; medium: 34.6 vs. 34.7; high: 48.5 vs. 48.6). Considering the two larger species groups, lizards and snakes, lizards generally were more vulnerable to environmental damage than snakes in both Central America and Mexico (65.2% and 60.3% for lizards and 48.5% and 48.6% for snakes, respectively). Nonetheless, just as with amphibians, more than one-half of the combined Central American and Mexican crocodylians, squamates, and turtles fell into the high category of vulnerability (56.0% and 55.9%, respectively), which is of major conservation concern.

## Discussion

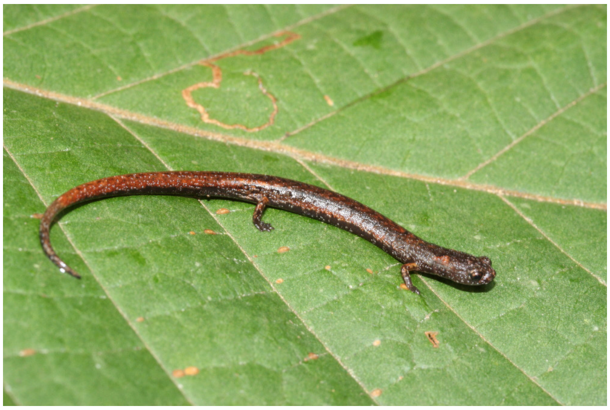
Biodiversity conservation requires one of the greatest efforts for crisis intervention ever undertaken by humanity. As we stated in the Introduction, the fundamental significance of this effort generally goes unappreciated by humanity at large. Thus, the attempt to salvage planet Earth as a haven for life essentially falls to the interest of an extremely small number of professional conservation biologists and a somewhat larger group of committed non-professional environmentalists. In essence, this tiny group of people is pitted against the remainder of humanity, collectively termed the “planetary killer” by Wilson (2002), which, knowingly or unknowingly, has cooperated to create the sixth mass extinction episode in Earth’s history (Wake and Vredenburg 2008).

No matter what the actual number of people devoted to conserving biodiversity is, it pales in significance when compared to the number of humans who collectively represent the reason why biodiversity decline exists. At the time of this writing (4:20 PM on 10 December 2014), the global human population was estimated as 7,210,491,630 (www.census.gov). This constantly increasing figure is the most important statistic in attempting to determine the impact of humanity on the natural world. According to the Population Reference Bureau World (PRB) 2013 Population Data Sheet (available at www.prb.org), the current rate of natural increase is 1.2 (i.e., crude birth rate – crude death rate / 10). Thus, the current doubling time of the global population is 58.3 years. In other words, the current world population indicated above will double to 14,420,098,326 by early April, 2073, assuming that the growth rate remains constant. Nonetheless, the growth rate has been declining since peaking in the period from 1962 to 1963 and is projected to fall to zero in about 2080; thus, the total human population might peak at about 10.3 billion (Population growth, Wikipedia, en.wikipedia.org; accessed 9 January 2014). The actual pattern of growth will depend on the extent of family planning on the growth rate. The 2013 Population Data Sheet projects that the mid-2050 global population will be 9.727 billion, and that the greatest amount of growth (1.3 billion) will come in Sub-Saharan Africa. This figure exceeds the growth expected in Asia, the population giant. By the year 2050, Nigeria will surpass the United States to become the world’s third most populous nation, after India and China (which will switch positions to become the largest and second most populous nations, respectively). In contrast, by 2050 the populations of North America and Europe are projected to remain at their current levels (at 0.4 and 0.7 billion, respectively).

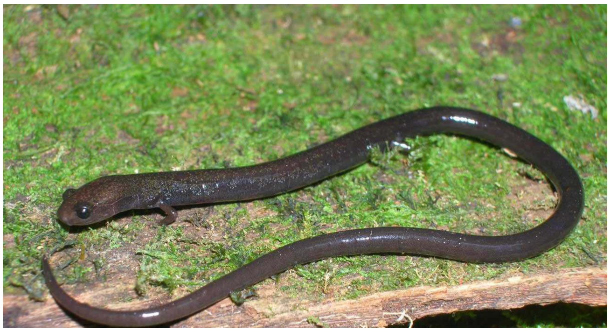
Given this projected pattern of growth, what consequences can we expect? With respect to human impact on planetary biodiversity, we can expect that “nearly all future population growth will be in the world’s less developed countries” (PRB 2012 Population Data Sheet: 5). The current population level in the less developed countries is 4.7 times greater than that of the more developed



*Nototriton mime.* This moss salamander is known only from the type locality, Cerro de Ulloa on the border of the departments of Colón and Olancho in north-central Honduras, where it occurs in Lower Montane Wet Forest at an elevation of 1,705 m. We evaluated its EVS as 18, placing it in the upper portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from the type locality. *Photo by Josiah H. Townsend.*



*Nototriton stuarti.* Stuart's Moss Salamander is known only from the type locality, Montañas del Mico in extreme eastern Guatemala, where it occurs in Premontane Wet Forest at an elevation of 744 m. We assessed its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Data Deficient. *Photo by Sean Michael Rovito.*



*Oedipina nica.* This worm salamander is known only from three isolated localities in north-central Nicaragua, where it occurs in Lower Montane Wet Forest at elevations from 1,360 to 1,660 m. We gauged its EVS as 17, placing it in the middle portion of the high vulnerability category, but its IUCN status has not been determined. This individual is from Finca Monimbo, department of Matagalpa. *Photo by Javier Sunyer.*

*Oedipina carablanca.* This worm salamander is known only from the vicinity of the type locality in east-central Costa Rica, where it occurs in Lowland Moist Forest at elevations from 60 to 260 m. We established its EVS as 18, placing it in the upper portion of the high vulnerability category, and its IUCN status is Endangered. This individual is from Pocora, 15 km NW Siquirres, province of Limón. *Photo by Brian Kubicki.*

ones (PRB 2012 Population Data Sheet). Based on the population projection in this same data sheet, the level will rise to 6.2 in the year 2050. This increasing disparity is expected to continue into the foreseeable future, again assuming that growth rates remain constant. The more developed countries are all of those in Europe and North America (i.e., Canada and the United States), as well as Australia, Japan, and New Zealand. The less developed ones comprise the world's remaining countries. The remarkable disparity in growth patterns between the more and less developed countries also is evident by comparing the rates of natural increase between the two regions. For the more developed countries, the figure is 0.1%, and for the less developed ones 1.4%. Thus, the growth rate for the less developed region is 14 times greater than that for the more developed area.

Because this paper deals with the Central American herpetofauna, we will examine the population growth trends in this region. The mid-2013 population for the seven Central American nations is 45.2 million (PRB 2013 Population Data Sheet: 8). The rate of natural increase ranges from a low of 1.2 in Costa Rica and El Salvador to 2.6 in Guatemala; the latter figure is 2.2 times greater than that of the former. Thus, the doubling time in Costa Rica and El Salvador is 58.3 years, the same as for the entire globe. That for Guatemala, however, is 26.9 years, which is slightly more than for Nigeria (25.0 years); as noted above, Nigeria is projected to become the world's third most populous nation by 2050. The average rate of natural increase for all of Central America is 1.8, which provides a doubling time of 38.9 years. Assuming no change in the average growth rate, the population of Central America would double to 90.4 million by about 2052. The growth rate for the region is predicted to decrease, however, so the PRB 2013 Population Data Sheet provides an estimate of 74 million by 2050. Nonetheless, this figure is about 29 million more than the mid-2013 figure, a 64.2% size increase.

The decrease in growth rate is relatively good news, but largely will depend on the rate of increase in the use of contraceptives and the consequential frequency of decrease of the total fertility rate. The current average percentage rate for the use of all types of contraceptives by married women ages 15–49 is 65.9% (PRB Population Data Sheet 2013). This statistic, however, does not consider the use of contraceptives by unmarried women or women outside of the usual reproductive age range, or the failure rate of contraceptive use by women or the use of contraceptives by men. Assuming that the rate of natural increase will decrease in the next 36 years to allow for a population of 73.5 million by the year 2050, this growth pattern will measurably increase the impact of population pressure on the remaining natural areas in Central America. The current average density of human population in the region is 103.1 people per km$^2$, and this figure should grow to 167.7 in the intervening 36 years. The rate of deforestation can be expected to be roughly comparable to that of the addition of people to the population. Deforestation, therefore, can be predicted to continue, especially given the income disparity in the region. The average percentage comprising the poorest one-fifth of the population is 3.7, and the wealthiest one-fifth 55.3. These figures exceed those for the entire world, which are 6.7 and 45.8, respectively (PRB Population Data Sheet 2013).

Our examination of the average figures for population growth and related factors tell only a portion of the story. The average figures hide rather sizable disparities in these statistics on a country level. When we examined these statistics on a country basis, it became evident that Guatemala is faced with the most serious problems and Belize the least. Of the 45.2 million people currently inhabiting Central America, 15.4 million (34.1%) live in Guatemala; the next most populous country is Honduras, with 8.6 million (19.0%); and the least populated country is Belize with 0.3 million (0.7%). Any reduction in the human population growth rate in Central America would be highly desirable in terms of biodiversity conservation, but will the projected decrease in growth rate be sufficient to allow for the continued protection of this biodiversity?

The most significant reason for biodiversity decline generally is conceded as habitat destruction, fragmentation, and degradation (Raven and Berg 2004; Vitt and Caldwell 2009). This premise is easy to understand, because the word habitat is defined as "the local environment in which an organism, population, or species lives" (Raven and Berg 2004). Living organisms derive the resources to support their lives and their efforts at reproduction from their habitats. The relationship between an organism and its habitat has evolved over time, and thus is an outcome of the evolutionary process. Anthropogenic damage to habitats reduces the capability of the resident organisms to survive and reproduce in their natural homes. The extent of such damage is evident in the following statement in Vitt and Caldwell (2009): "Humans have modified the environment everywhere." They further noted that "such a comment may seem to be an exaggeration, but it is not an overstatement … Globally, our activities have resulted in a rising average annual temperature and in a rise in ultraviolet radiation at the earth's surface. These climatic effects are only one facet of our environmental alteration, which ranges from global climatic change to the local loss of a marsh or a patch of forest."

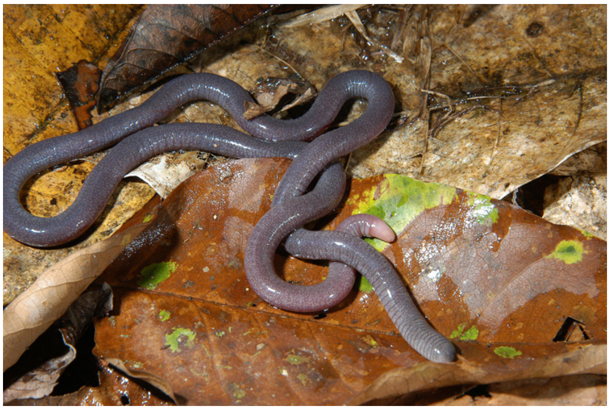
Habitat alteration proceeds at a rate commensurate with the following three principal factors: 1) an increase in the number of people inhabiting the Earth; 2) an increase in standards of living; and 3) the level of technological advantage enjoyed by these people. These three factors have a combined environmental effect that is described by the formula I = PAT, in which I stands for "human impact," P for "population," A for "affluence," and T for "technology" (Chertow 2000). This formula describes how our growing population, affluence, and technology contribute to our increasing environmental impact. It also predicts that the increase in any one of these factors, or in any combination, can increase the amount of environmental impact felt not only by us, but also by the biosphere at large. This formula also predicts that environmental impact can increase as a consequence of rising affluence and technological capability, most evident in the more developed countries, just as it does with increasing population numbers, most evident in the less developed countries. Thus, environmental impact arises from all outcomes of the human experiment on our planet. Nonetheless, not all technological advances are undesirable (Chertow 2000). What is undesirable is humanity's willingness to augment the undesirable aspects of such technology, i.e., planned obsolescence, lack of recycling of resources, accumulation of pollutants, and so forth.

The human experiment has been an effort, ostensibly successful, to move away from being under the control of the environmental limiting factors that impinge on all organisms. In human terms, this has meant attempting to improve the standards of living of human beings. No matter how desirable this effort might be, however, it has resulted in the creation of an unsustainable society, of which the defects and the consequences are becoming increasingly apparent over time. Perusal of the data on income distribution in the PRB 2013 Population Data Sheet is informative in this regard. Improvements to standards of living have been more beneficial to the wealthy than the poor, both at the global and individual levels. Currently, the distinction in the gross national income in purchasing power parity (GNI PPP) between the more developed and less developed sectors is startling; in the former it is $35,800 and in the latter $6,600, a disparity of 5.4 times between the two. The PRB data also indicate

*Oedipina koehleri.* This worm salamander is limited in distribution to three isolated montane regions in northern Nicaragua, where it occurs in Premontane Moist and Premontane Wet forests at elevations from about 600 to 945 m. We estimated its EVS as 16, placing it in the middle portion of the high vulnerability category, but its IUCN status has not been assessed. This individual is from the Reserva Natural Cerro Musún, department of Matagalpa. *Photo by Javier Sunyer.*

*Rhinoclemmys funerea.* The Black River Turtle is distributed from the Río Coco on the border between Honduras and Nicaragua southward to central Panama, where it occurs in Lowland Moist Forest at elevations from near sea level to 600 m. We established its EVS as 16, placing it in the middle portion of the high vulnerability category, and its IUCN status is Near Threatened. This individual is from the Río Puerto Viejo, Sarapiqui, province of Alajuela, Costa Rica. *Photo by Alejandro Solórzano.*

*Rhinobothryum bovallii.* This arboreal false coralsnake occurs from southeastern Honduras to northwestern Venezuela and northwestern Ecuador, where it occurs in Lowland Moist and Wet forests at elevations from near sea level to 550 m. We calculated its EVS as 16, placing it in the middle portion of the high vulnerability category, and its IUCN status is Least Concern. This individual is from Guayacán, Costa Rica. *Photo by Tobias Eisenberg.*



*Oscaecilia osae.* This caecilian is endemic to the Golfo Dulce region of southwestern Costa Rica, where it occurs in Lowland Moist Forest at elevations from near sea level to 40 m. We calculated its EVS as 19, placing it in the upper portion of the high vulnerability category, and its IUCN status is Data Deficient. This individual is from La Gamba, province of Puntarenas. *Photo by Peter Weish.*

that the percentage growth of the gross domestic product (GDP) has been decreasing both in the more developed and less developed portions of the world. In the more developed nations, the percentage dropped from 6.3 during the period of 2000–2006 to 1.9 during 2007–2011. In the less developed nations, the drop was from 10.2 to 7.8.

As unnerving as these statistics are, living in the more developed portion of the world does not confer insulation from economic disparity. The percent share of income between the poorest one-fifth and the richest one-fifth in the less developed and more developed regions of the world essentially is the same (6.7 and 46.3 in the former, 6.7 and 43.4 in the latter). This economic reality is relevant in the United States, where the PRB report (p. 4) concludes that "the rich get richer and the poor get poorer," a common way to characterize this disparity. Moreover, "despite having one of the world's highest standards of living, the gap between the income share of the wealthiest and poorest households in the United States is one of the widest among industrialized countries" and has increased over time. In 1967, the richest one-fifth controlled 43.6 percent of household income, compared to 4.0 percent for the poorest one-fifth. In 2011, the poorest one-fifth of households received only 3.2 percent of total national household income, while the wealthiest one-fifth received 51.1 percent. This inequality is expected to continue to grow and the economy of the United Sates will continue to suffer, even though this country's economy is discussed widely on a daily basis. So, the affluence factor in the I = PAT formula looks a bit shaky.

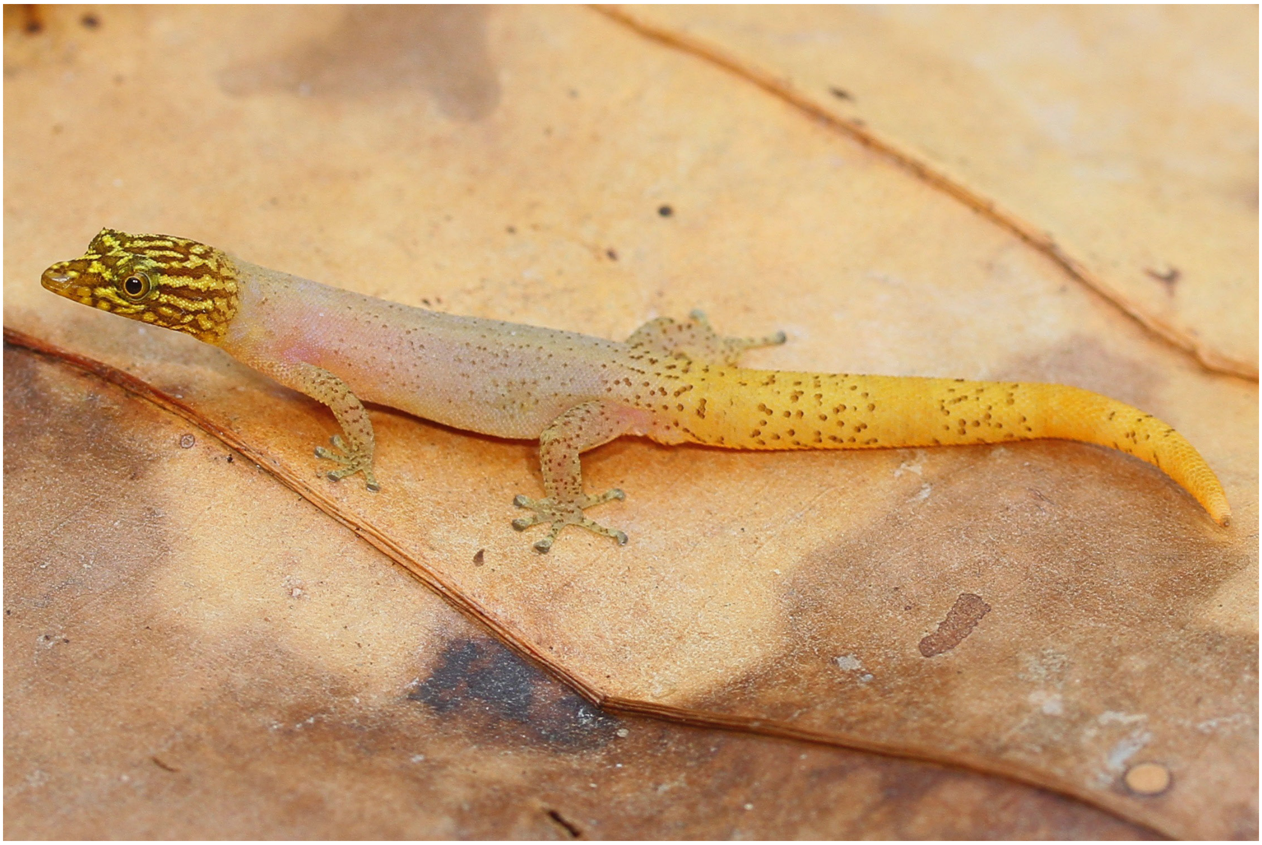
Since Earth presents a finite quantity of area for the human population to occupy, the density of this population will continue to increase with time. Actually, the amount of habitable land will continue to decrease with time, as a predicted consequence of global warming (Intergovernmental Panel on Climate Change [IPCC] Approved Climate Change Summary for Policymakers: 27 September 2013). Currently, the average density of the population in the less developed world is 71 people per square kilometer, which is 2.6 times greater than that in the more developed world (27/km$^2$). The increasing movement of people from rural to urban areas across the globe worsens this overall pattern. As noted in the PRB report, "in 1950, 117 million people lived in the top 30 [metropolitan areas] but that number rose to 426 million by 2011. In 1950, 19 of the top 30 ["mega-cities"] were in industrialized countries. By 2011, that number had shrunk to eight. In 1950, Delhi was not even in the top 30 but it is now second behind only Tokyo. Such phenomenal growth usually is due to rural-urban migration, as migrants seek a better life in cities. Unfortunately, the better life being sought often proves illusory, inasmuch as rural areas are those that provide the resources necessary to support life in both rural and urban areas. The economic investment necessary to support people in urban settings increases the impact on the resource base in rural regions. As these unsustainable practices continue environmental degradation mounts, and the impact on the remaining natural areas increases commensurately.

These features of human social evolution portend disaster for the maintenance of biodiversity. Economic primacy, especially in the more developed world, and uncontrolled population growth, especially in the less developed world, combines to create an unsustainable society for humanity (Raven and Berg 2004). Unsustainability increases the environmental pressure on organismic populations. Increasing environmental pressure promotes increasing endangerment of the other members of the living world. Thus, the job for conservation biologists grows more diffcult with the passing of time. Consequently, the time lost to inaction becomes increasingly important.

Perhaps the most unfortunate aspect of attempts at conserving biodiversity is that the most biodiverse areas overlap those that support the most rapidly growing human populations. As posted at the Conservational International website (www.conservation.org/hotspots), "the world's most remarkable places are also the most threatened." The most biodiverse areas of the planet have been termed "biodiversity hotspots." Thirty-four such areas are recognized (www.conservation.org/hotspots). Four of these areas, as recognized by Conservation International, lie in North and Central America. Almost all of two of these areas, however, lie in what we define as Mesoamerica, i.e., Mexico and Central America (Wilson and Johnson, 2010). These two are termed the Madrean Pine-Oak Woodlands and Mesoamerica; the latter name a different usage of the term than that of Wilson and Johnson (2010). The former encompasses the main mountain chains in Mexico and isolated islands in Baja California, and the southern United States (actually the southwestern United States in southeastern Arizona, southwestern New Mexico, and southwestern Texas). Apart from the northernmost portions lying in the southwestern United States, the remainder of this hotspot lies in Mexico. The other hotspot includes the lowland and premontane areas from northern Sinaloa on the Pacific versant and the Gulf coastal plain as far north as Tampico, Tamaulipas, on the Atlantic versant south to eastern Panama. This hotspot encompasses essentially all of Central America. Although the Mesoamerican forests, as defined by Conservation International, constitute the third largest hotspot in the world, the original extent of 1,130,019 km$^2$ has been reduced to 226,004 km$^2$ (to 20.0% of the original). Of the original extent, only 142,103 km$^2$ (12.6%) are protected, with only 63,902 km$^2$ (5.7%) afforded higher levels of protection. We presume that the relative figures for the entire hotspot also apply to its portion in Central America.

Ultimately, answering all the questions about biodiversity conservation will depend on finding fundamental answers to the questions about why biodiversity decline occurs. Until we uncover why humans represent such a great threat to the rest of the planet's organisms, i.e., why they have assembled themselves into unsustainable societies of one sort or another, we will have no hope of devising lasting solutions to this problem. Even though we do not intend to explore this subject in depth, at least we can offer what we consider some important comments indicating the seriousness of biodiversity decline.

1. If, as Wake and Vredenburg (2008) reported "we are entering or in the midst of the sixth great mass extinction," and that "intense human pressure, both direct and indirect, is having profound effects on natural environments," then our species is predicted to be responsible for a mass extinction episode that will be equivalent in impact to those that have preceded it. Scientists have documented that "in each of the five events" generally thought to have occurred during Earth's history, "there was a profound loss of biodiversity during a relatively short period" (Wake and Vredenburg 2008). "The most recent mass extinction was at the Cretaceous-Tertiary boundary (~65 Mya); 16% of the families, 47% of the genera of marine organisms, and 18% of the vertebrate families were lost. Most notable was the disappearance of nonavian dinosaurs; causes continue to be debated (Wake and Vreden-



*Sphaerodactylus homolepis.* This gecko is distributed from extreme southeastern Nicaragua to north-central Panama, where it occurs in Lowland Moist and Wet forests at elevations from near sea level to 600 m. We established its EVS as 16, placing in the middle portion of the high vulnerability category, and its IUCN status is Least Concern. This individual is from the province of Bocas del Toro, Panama. *Photo by Adam G. Clause.*

burg 2008). Given that whole genera and families of organisms, including vertebrates, disappeared during this most recent event, then a central question for humanity is whether the progenitor of the sixth mass extinction episode will survive its own malevolent creation.

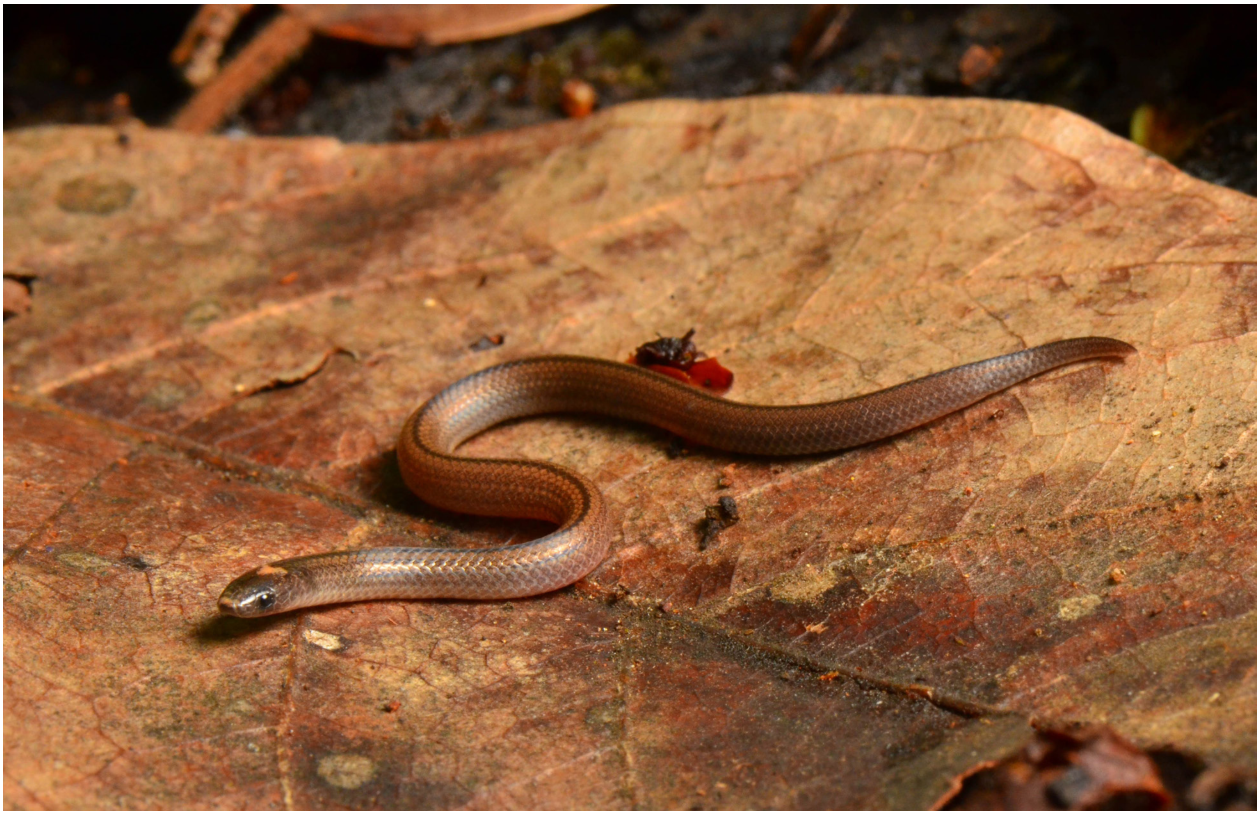
2. Organisms persist on our planet because sufficient quantities of resources exist over time to support their populations. These resources arise from the atmosphere, hydrosphere, and lithosphere, as well as from the sphere of life. The three abiotic spheres interact among themselves and with the biosphere, and these interactions allow life to exist and persist on our planet. These statements are very simple and can be confirmed by a cursory examination of any ecology or environmental science textbook; however, humanity proceeds as though its collective actions are exempt from these fundamental rules of survival.

3. Natural science is one of the principal intellectual undertakings of the human species (Wilson 1998). What we know about the natural world is the result of the application of scientific methodology to the endless questions that arise from our boundless curiosity. The design of science and its use is the result of the way in which rationality operates. We generally consider that humans are the best exemplars of the rational being. Only a few other creatures (e.g., cetaceans) are thought to have the mental ability to compare favorably with our rational capacity. No other organism, however, has the benefit of our brain design coupled with bipedal posture and an opposable thumb on a five-fingered hand. Interestingly, finding an operational definition of rationality is elusive; the effort commonly results in the construction of circular definitions (i.e., definitions that do not actually define, but eventually lead back to the word one is attempting to define). Irrespectively, rationality is a function of our nervous system that allows for the connection of cause to effect from the past through the present to the future. It allows us to understand the consequences of our actions. Strangely, rationality also allows us to "ignore" the consequences of our actions. Thus, the use of scientific methodology, which is one outcome of rationality, can allow us to ask and answer questions about the natural world, within limits, but whether the answers lead to ap-

propriate actions depends on a number of other factors, such as can be understood from the viewing of any day's events in the human world.

4. Scientific advance depends on the use of scientific methodology to generate tangible and sometimes reproducible evidence to falsify hypotheses in order to support philosophies. In turn, assembling such evidence depends upon the functioning of our sensory structures, as assisted by scientific instrumentation. Other sorts of systems exist, however, that do not depend on structuring ideas based on evidence. Many people use these types of belief systems in the conduct of their lives (Ehrlich and Ehrlich 1996). To illustrate our meaning, we will use the example of evolution. As any biologist knows, the theory of evolution is the central concept of modern-day biology; examination of any modern-day university-level biology textbook will confirm this statement (e.g., Reese et al. 2013). Broad-based disciplines such as environmental science and conservation biology have the same conceptual foundation. Among the general public, however, the reality of the evolutionary process often is thought to be a matter of opinion. The word "opinion" is defined as "a belief or conclusion held with confidence but not substantiated by positive knowledge or proof" (American Heritage Dictionary, 3rd edition). A recent report (30 December 2013) of the Pew Research Center (www.pewresearch.org; accessed 2 January 2014) entitled "Public's Views on Human Evolution" is based on telephone interviews conducted from 21 March to 8 April 2013 among a national sample of 1,983 adults (age 18 and older) living in all 50 U.S. states. The question asked of the respondents was whether "humans and other living things have existed in their present form since the beginning of time, or humans and other living things have evolved over time." Thirty-three percent of the respondents agreed with the former statement and 60 percent with the latter. The greatest divergence from the results for all adults was evidenced among white evangelical Protestants (64 vs. 27%), which also was the largest group to think that evolution has been guided by a supreme being (36 vs. 36%), and Republicans (43 vs. 48%). Since the Pew Research Center's survey questions ask for yes or no responses, the basis for the variation in the responses was not explored, although it seems unlikely that it has to do with the scientific examination of the evidence for the theory of evolution through natural selection.

5. Climate change is another issue subject to the vagaries of public opinion. This term refers to the phenomenon of the anthropogenic alteration of global climatic patterns. In the sense of this definition, climate change is an environmental superproblem, in the sense of Bright (2000). Wilson and McCranie (2004) reflected that Bright "uses this term to describe environmental synergisms resulting from the interaction of two or more environmental problems, so that their combined effect is greater than the sum of their individual effects. These problems represent an environmental worst-case scenario—the point when environmental problems become so serious that they produce unanticipated results, the successful resolution of which threatens to slip forever from the grasp of humanity." This global superproblem has been studied by the Intergovernmental Panel of Climate Change (IPCC), which released its latest report in September of 2013. The panel produced an "approved summary for policymakers," which includes several conclusions of great importance. The most significant conclusion is as follows (p. 3): "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millenia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased." With respect to the atmosphere, the report concluded that, "each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. In the Northern Hemisphere, 1983–2012 was likely the warmest 30-year period of the last 1,400 years (medium confidence)." Concerning the ocean, the report concluded that, "ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 (high confidence). It is virtually certain that the upper ocean (0–700 m) warmed from 1971 to 2010." The IPCC report summary also indicated that with regard to the cryosphere "over the last two decades, the Greenland and antarctic ice sheets have been losing mass, glaciers have continued to shrink almost worldwide, and Arctic sea ice and Northern Hemisphere spring snow cover have continued to decrease in extent (high confidence)." As a consequence of this diminution of ice and snow at the polar regions, "the rate of sea level rise since the mid-19th century has been larger than the mean rate during previous two millennia (high confidence). Over the period of 1901–2010, global mean sea level rose by 0.19 [0.17 to 0.21] m." Finally, the report indicated that, "the atmospheric concentrations of carbon dioxide ($CO_2$), methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years. $CO_2$ concentrations have increased by 40% since pre-industrial times, primarily from fossil



*Tantilla vermiformis.* This centipede snake is distributed from El Salvador to northwestern Costa Rica, where it occurs in Lowland Dry Forest at elevations from near sea level to 520 m. We evaluated its EVS as 14, placing it at the lower end of the high vulnerability category, and its IUCN status is Least Concern. This juvenile individual is from Volcán Masaya, Nicaragua. *Photo by José Gabriel Martínez-Fonseca.*

fuel emissions and secondarily from net land use change emissions. The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification." Taken in their entirety, these conclusions about the anthropogenic impact on the global climate system are extremely frightening and portend future environmental changes that will have worldwide effects of hugely significant consequence. These conclusions also point very clearly to the way in which the lithosphere, the home of humanity, interacts with the atmosphere and how the atmosphere interacts with the hydrosphere and, in turn, the lithosphere. Thus, climate change is a best-case example of how an environmental superproblem evolves. In light of the general high confidence levels for the summary statements in the IPCC report, we examined the results of a Pew Research Center report published 5 November 2013 (available at www.pewresearch.org) and entitled "Climate Change: Key Data Points from Pew Research," which concluded that "the American public routinely ranks dealing with global warming low on its list of priorities for the president and Congress. This year, it ranked at the bottom of the 21 tested." Of the people surveyed in January of 2013, just 28% indicated that dealing with global warming is a top priority. This statistic contrasts most markedly with strengthening the economy, which was identified as a top priority by 86% of the survey respondents. Even dealing with "moral breakdown" at 40% beat out global warming as a top priority. Interestingly, people in the United States, who collectively are major contributors to global climate change, fell behind people in most other countries in recognizing global climate change as a major threat. Beyond all this opinion, some people opine that global warming is "just not happening." Another view of the significance of global climate change is provided in the report of the World Economic Forum entitled "Outlook on the Global Agenda 2014" (2013). One portion of this report identifies the Top Trends of 2014. Interestingly, "inaction on climate change" is on the list, but only at spot number five and after "rising societal tensions in the Middle East and North Africa," "widening income disparities," "persistent structural unemployment," and "intensifying cyber threats." Addressing issues of biodiversity decline, however, does not appear on the list. Given the glacial pace at which scientific research results are transformed into governmental policy and, beyond that, into sufficiently comprehensive plans of action that are put into effect, the question obviously arises as to whether humanity, even with its vaunted rational capacity, has the wherewithal to deal with the gargantuan problems of its own creation, especially since those problems increase in severity at a rate commensurate with the exponential growth of human population. As always, however, time will tell.

6. Given that all of humanity is faced with environmental superproblems, exemplified by global climate change, and that these problems originate in planetary spheres remote from human control, the question arises as to what effect these superproblems will have on efforts to conserve organismic populations in particular, and the structure and function of the biosphere in general. The biosphere, the entire compendium of life on Earth, exists at the interface of the three abiotic spheres based on the retrieval of resources from them. Inasmuch as the three abiotic spheres and their interrelationships evolve over time, the biosphere generally persists over time by also evolving to adapt to these environmental changes. The adaptability of organisms depends on the process of evolution according to natural selection, which obviously is a powerful enough force to allow life on Earth to survive several mass extinction episodes that date back to as far as ≈439 Mya (Wake and Vredenburg 2008). All of these past episodes have been geological in nature. As noted by Wake and Vredenburg (2008), "many scientists think that we are just now entering a profound spasm of extinction and that one of its main causes is global climate change … Furthermore, both global climate change and many other factors (e.g., habitat destruction and modification) responsible for extinction events are directly related to activities of humans." Thus, perhaps the major question facing humanity now and in the future is what portion of the biosphere will disappear into the extinction void, and if ultimately humans will join these other unfortunate creatures.

7. Presently we do not know the answers to these fundamental questions, but we are beginning to understand the extent of the impact on selected groups of organisms, especially the best known. Most zoologists work on vertebrate animals and we three are among them. As herpetologists working in one of Earth's most significant biodiversity hotspots (Mesoamerica), and attempting to assess the conservation status of the herpetofaunal species resident in this hotspot, we offer some ideas about how the sixth mass extinction episode will impact these creatures. We bring to this subject some 102 person-years of experience, as judged by the date of publication of the first scientific paper for each of us. All three of us were involved in the production of the 2010 volume entitled *Conservation of Mesoamerican Amphibians and Reptiles*, and last year we coauthored two papers in the Special Mexico Issue of the journal Amphibian & Reptile Conservation entitled "A conservation reassessment of the reptiles of Mexico based on the EVS measure" and "A conservation reassessment of the amphibians of Mexico based on the EVS measure." Other herpetologists also have weighed in on these questions, most importantly Gibbons et al. (2000), Wake and Vredenburg (2008), Stuart et al. (2010), and Böhm et al. (2013). The Gibbons et al. (2000) study was written in part to document that crocodylians, squamates, and turtles are undergoing population declines similar in scope on a global scale "to those experienced by amphibians in terms of taxonomic breadth, geographic scope, and severity." Böhm et al. (2013) presented "the first-ever global analysis of extinction risk in reptiles, based on a random representative sample of 1,500 species (16% of all currently known species)" and concluded that, "nearly one in five reptilian species [is] threatened with extinction, with another one in five species classed as Data Deficient." They further concluded that, "conservation actions specifically need to mitigate the effects of human-induced habitat loss and harvesting, which are the predominant threats to reptiles." The Stuart et al. (2010) paper reiterated the Global Amphibian Assessment analysis presented in the Stuart et al. (2004) study and concluded that "a plethora of threats impact amphibian species globally, with habitat loss and degradation being the principal threat followed by pollution. Disease is a less significant threat on a global scale, but can bring about rapid population declines leading to extinction. Deforestation is a significant threat to amphibian population stability, inasmuch as the vast majority of species depend on forest for their survival. A sizable number also depends on flowing and still freshwater habitats, largely due to their biphasic lifestyle. If the observed declines are not quickly understood and reversed, hundreds of species of amphibians will face extinction within the next few decades." Finally, Wake and Vredenburg (2008) attempted to answer the question "Are we in the midst of the sixth mass extinction?" using amphibians as a test group. These authors concluded in the most sweeping way of any of these four papers that "multiple factors acting synergistically are contributing to the loss of amphibians. But we can be sure that behind all of these activities is one weedy species, *Homo sapiens*, which has unwittingly achieved the ability to directly affect its own fate and that of most of the other species on this planet. It is an intelligent species that potentially has the capability of exercising necessary controls on the direction, speed, and intensity of factors related to the extinction crisis.

Education and changes of political direction take time that we do not have, and political leadership to date has been ineffective largely because of so many competing, short-term demands. *A primary message from the amphibians, other organisms, and environments, such as the oceans, is that little time remains to stave off mass extinction, if it is possible at all*" (emphasis ours). Using the conclusions of Wake and Vredenburg (2008) as a starting point, we provide our conclusions and recommendations on the conservation status of the Central American herpetofauna.

## Conclusions and Recommendations

One or more of us previously have provided sets of conclusions and recommendations for addressing the issues of conservation of the Mesoamerican herpetofauna (Wilson and Townsend 2010; Wilson et al. 2013a, b). We used this information as a partial framework and starting point for our conclusions and recommendations concerning the conservation of the Central American herpetofauna.

1. Biodiversity decline is an environmental problem of global dimensions, comparable to the more commonly publicized problem of climate change. Both of these environmental superproblems exist because of human action and inaction, exacerbated by humanity's anthropocentric focus.

2. Our work deals with the scientific study of the herpetofauna, of which all groups are prominent components of terrestrial ecosystems in temperate and tropical regions across the globe. Only crocodylians, squamates, and turtles have made relatively limited inroads into marine habitats. Some of our earlier work dealt with the conservation status of the herpetofauna of Mexico; in this study, we are concerned with the herpetofauna of Central America.

3. Central America is a major component of Mesoamerica, the other component consisting of Mexico. Together, these two regions contribute to and extend beyond the limits of the third largest of the 34 biodiversity hotspots identified by Conservation International. The herpetofauna of Central America is of major significance and presently consists of 493 amphibians and 559 crocodylians, squamates, and turtles, for a total of 1,052 species. Our knowledge of the dimensions of this herpetofauna will continue to augment with time. In the interim between 31 December 2008 and the present, 92 species have been added to this herpetofauna, an increase of 9.7% percent over the number considered in Wilson and Johnson (2010). Presently, there are more amphibians in Central America than in Mexico (493 vs. 383), and more crocodylians, squamates, and turtles collectively in Mexico than in Central America (869 vs. 559). Although more amphibians, crocodylians, squamates, and turtles occur in Mexico than in Central America (1,252 vs. 1,052), Mexico is about three and three-quarters the size of Central America, indicating significantly greater herpetofaunal numbers per unit area in Central America than in Mexico.

4. Herpetofaunal endemism also is significant in Central America. Of the 493 amphibians known from the region, 324 (65.7%) are endemic. Of the 559 reptiles found there, 261 (46.7%) are endemic. The entire herpetofauna is characterized by an endemicity of 55.6%. These figures are fairly comparable to those for Mexico. Amphibian endemism is only slightly higher in Mexico than in Central America (67.4 vs. 65.7%). Endemism of the remainder of the herpetofauna is about 11 percentage points higher in Mexico than in Central America (57.4 vs. 46.7%). Endemism for the total herpetofauna is only a few percentage points higher in Mexico than in Central America (60.4% vs. 55.6%). Thus, more than one-half of the Central American herpetofauna is endemic to the region, compared to six of every 10 species in Mexico.

5. The IUCN employs the most commonly used means of conservation status assessment. The implementation of this system, however, is expensive, time-consuming, slow to respond to systematic advances, and likely to resort to the Data Deficient category when assessing taxa described from single specimens and/or single localities, and to the Least Concern category as a kind of conservation "dumping ground" for species that deserve a more careful examination.

6. Given the problems we see with the use of the IUCN system of categorizaitons, we employed a revised Environmental Vulnerability Score (EVS) measure that allowed us to address the deficiencies of the IUCN system and to provide a conservation assessment for all of the species now known to comprise the Central America herpetofauna. The EVS values can range from 3–20 and are placed in three categories: low (3–9); medium (10–13); and high (14–20). Our calculations indicate that the EVS values for amphibians are categorized as follows: low (39 species of 493 [7.9%]); medium (105 [21.3%]); and high (349 [70.8%]). For the crocodylians, squamates, and turtles, the values are: low (81 of 552 [14.7%]); medium (162 [29.3%]); and high (309 [56.0%]). For the entire herpetofauna, the values are: low (119 of 1,045 [11.4%]); medium (267 [25.6%]); and high (658 [63.0%]). Thus,

*Ungaliophis panamensis.* This small arboreal boa is found on the Atlantic versant from southeastern Nicaragua to northwestern Colombia, and on the Pacific versant from northwestern Costa Rica to western Panama, where it occurs in Lowland Moist and Wet, Premontane Wet, and Lower Montane Wet forests at elevations from near sea level to 2,100 m. We gauged its EVS as 12, placing it in the upper portion of the medium vulnerability category, but its IUCN status has not been determined. This individual is from the Río Indio Lodge located in the Indio Maiz Biological Reserve, department of Río San Juan, in southeastern Nicaragua. *Photo by Javier Sunyer.*

our analysis indicates that more than six of every 10 herpetofaunal species are highly vulnerable to environmental damage from anthropogenic causes.

7. In 2013, we conducted a similar study of the Mexican herpetofauna. When comparing our results for Central America and Mexico, a greater proportion of amphibians in Central America fell into the high vulnerability category than in Mexico (70.8% vs. 58.8%). In both regions, salamanders are the most vulnerable when compared to anurans and caecilians. Among the rest of the herpetofauna, however, we found about the same proportion in the high vulnerability category in Central America (56.0%) as in Mexico (55.9%). Considering the two highest species groups (lizards and snakes), in both Mexico and Central America lizards are more vulnerable to environmental damage than snakes.

8. Given the length of time it takes for an IUCN assessment to appear at the Red List website after a new species is described and the expense involved to produce such an assessment, we recommend that the original describers provide at least an estimate of the conservation status of the taxon in question in the original description. In addition, since this task might be difficult to undertake, given the deficiencies of the IUCN system we have identified here and elsewhere, we also recommend that the original describers calculate an Environmental Vulnerability Score to provide an additional assessment of the conservation status for the species being described.

9. Assessments of the conservation status of any group of organisms essentially remain academic exercises, unless sufficient attention is provided to the imperatives underlying the threats to biodiversity created by humanity. Humanity lives unsustainably on planet Earth. The pressure placed on limited resources by an exponentially growing human population creates this reality. Humans are cosmopolitan animals that become more so with the passage of time. The approach is the same wherever one finds humans, as essentially it is a unidirectional track from point A (what humans want) to point B (what humans obtain), with the minimal amount of possible diversion between the two points. Unidirectionality, however, is not a feature of the structure and function of Earth.

Rather, this planet, especially the portion of most concern to humanity, consists of four primary spheres that intertwine among themselves to create an environment in which humanity can exist. All of these spheres, the atomsphere, hydrosphere, lithosphere, and biosphere provide resources to our species, without which its survival is impossible. One way of looking at this matter is that humanity, in return for life support and from its perch on Earth's surface, favors these spheres with a plethora of environmental problems that retrace the same pathways as exist in the natural world to make the resources for life support available to humans. As an example, burning forests and fossil fuels pumps $CO_2$ into the atmosphere and this pollutant causes its temperature to rise and creates global warming, which in turn produces climate change that impacts the planet's solid and liquid surfaces. Burning forests to make way for agriculture also degrades habitats for the world's creatures, especially those that live on land, creating biodiversity decline.

10. More than two decades ago on 18 November 1992, the Union of Concerned Scientists issued the World Scientists' Warning to Humanity (www.ucsusa.org). To date, this statement has been signed by "some 1,700 of the world's leading scientists, including the majority of Nobel laureates in the sciences" (www.ucsusa.org/about/1992-world-scientists.html; accessed 2 February 2014). The one-paragraph introduction to the statement is cogently powerful. "Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know [emphasis ours]. Fundamental changes are urgent if we are to avoid the collision our present course will bring about." For all intents and purposes, we have lost the intervening two decades to inaction and further encroachment.

11. The warning to humanity contained a simple and elegant statement of "what we must do." This statement consists of "five inextricably linked areas that must be addressed simultaneously," as follows:

    "**We must bring environmentally damaging activities under control to restore and protect the integrity of the earth's systems we depend on.** We must, for example, move away from fossil fuels to more benign, inexhaustible energy sources to cut greenhouse gas emissions and the pollution of our air and water. Priority must be given to the development of energy sources matched to Third World needs—small-scale and relatively easy to implement."

    "**We must manage resources crucial to human welfare more effectively.** We must give high priority to efficient use of energy, water, and other materials, including expansion of conservation and recycling."

    "**We must stabilize population.** This will be possible only if all nations recognize that it requires improved social and economic conditions, and the adoption of effective, voluntary family planning."

    "**We must reduce and eliminate poverty.**"

    "**We must ensure sexual equality, and guarantee women control over their own reproductive decisions.**"

12. Only within the context of simultaneously addressing the above-indicated "inextricably linked" social imperatives can we sensibly discuss "what we must do" to safeguard organismic populations, including those of the herpetofauna of Central America. So, our most significant recommendation is to address these imperatives in the shortest time possible.

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## Addendum (changes past conclusion of analyses)

We chose a cut-off date of 1 March 2015 for which to discontinue revising the hundreds to thousands of numbers and calculations dealing with the 1,052 herpetofaunal species in this paper. After this date, we continued adding pertinent taxa and publications in this addendum, as follows:

(1) *Hyalinobatrachium dianae*. Kubicki et al. (2015) described this new species of glassfrog from the lowland and premontane forests of Caribbean Costa Rica, which is known from the provinces of Heredia and Limón at elevations from 400 to 900 m. Its EVS can be calculated as 5+7+3=15.

(2) *Gerrhonotus liocephalus*. Morales et al. (2015) reported this alligator lizard, formerly limited in distribution to Mexico and Texas in the United States, from Guatemala, thus adding this species to the Central American herpetofauna. Its EVS remains as 2+1+3=6.

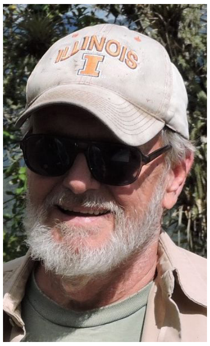
(3) *Ecnomiohyla bailarina*. Kubicki and Salazar (2015) reported this fringe-limbed treefrog, formally known only from the type locality in Panama, from the Caribbean foothills of southeastern Costa Rica. As a consequence, its EVS needs to be recalcuated as 5+7+6=18.

(4) *Holcosus* spp. Meza-Lázaro and Nieto Montes de Oca (2015) revised the species *Holcosus undulatus* and elevated nine former subspecies to species level in Mesoamerica, including five taxa in Central America (*H. hartwegi*, *H. miadis*, *H. parvus*, *H. pulcher*, and *H. thomasi*). As a consequence, the ranges of these elevated taxa naturally are smaller and the resulting EVS will be higher than that calculated in Appendix 2 for the former *H. undulatus*.

(5) *Bradytriton silus*. Since its description in 1983, this plethodontid salamander species, the single member of its genus, has been considered endemic to Guatemala and, therefore, to Central America. Recently, however, a specimen was collected by a field crew associated with Sean Rovito at San Francisco Jimbal in northern Chiapas, which constitutes the first record for this species in Mexico (Bouzid et al. 2015). Thus, *B. silus* no longer is a Central American endemic.

**Jerry D. Johnson** is Professor of Biological Sciences at The University of Texas at El Paso, and has extensive experience investigating the herpetofauna of Mesoamerica, especially in Mexico. Presently, he is the Director of the 40,000 acre "Indio Mountians Research Station" located in the Chihuahuan Desert near the Mexican border. Jerry is a co-editor of the recently published *Conservation of Mesoamerican Amphibians and Reptiles*, is Mesoamerica/Caribbean section editor for Geographic Distribution segment of *Herpetological Review*, and is an Associate Editor and Co-chair of the Taxonomic Board for the Journal *Mesoamerican Herpetology*. Johnson has authored or co-authored 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," as well as two 2013 articles in the Special Mexican Edition of *Amphibian & Reptile Conservation* entitled, "A conservation reassessment of the reptiles of Mexico based on the EVS measure, and "A conservation reassessment of the amphibians of Mexico based on the EVS measure." He was also Co-editor for the books *Middle American Herpetology: A Bibliographic Checklist* and *Mesoamerican Herpetology: Systematics, Zoogeography, and Conservation*.

**Vicente Mata-Silva** is a herpetologist interested in ecology, conservation, geographic distribution, and the monitoring of amphibians and reptiles in Mexico and the southwestern United States. His bachelor's thesis at the Universidad Nacional Autónoma de México (UNAM) compared herpetofaunal richness in Puebla, México, in habitats with different degrees of human-related disturbance. Vicente's master thesis focused primarily on the diet of two syntopic whiptail lizard species, one unisexual and the other bisexual, in the Trans-Pecos region of the Chihuanhuan Desert. 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 60 peer-reviewed scientific publications. Currently, he is a research fellow and lecturer at the University of Texas at El Paso, where his work focuses on the ecology of rattlesnake populations in a Chihuahuan Desert habitat; he also is a Distribution Notes Section Editor for the journal *Mesoamerican Herpetology*.



**Larry David Wilson** is a herpetologist with lengthy experience in Mesoamerica, totaling six and one-half collective years (combined over the past 49). Larry is the senior editor of *Conservation of Mesoamerican Amphibians and Reptiles* (2010) and the co-author of seven of its chapters. He is retired from 35 years of service as a professor of biology at Miami-Dade College in Miami, Florida. Larry is the author or co-author of over 315 peer-reviewed papers and books on herpetology, including the 2004 *Amphibian & Reptile Conservation* paper entitled "The conservation status of the herpetofauna of Honduras" and the two 2013 papers 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." His other books include *The Snakes of Honduras* (1985), *Middle American Herpetology* (1988), *The Amphibians of Honduras* (2002), *Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras* (2005), *The Amphibians and Reptiles of the Honduran Mosquitia* (2006), and *Guide to the Amphibians & Reptiles of Cusuco National Park, Honduras* (2008). For 33 years he served as the Snake Section Editor for the *Catalogue of American Amphibians and Reptiles*. Over his career to date, he has authored or co-authored the descriptions of 70 currently recognized herpetofaunal species and six species have been named in his honor, including the anuran *Craugastor lauraster* and the snakes *Cerrophidion wilsoni*, *Myriopholis wilsoni*, and *Oxybelis wilsoni*.

**Appendix 1.** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| **Order Anura (319 species)** | | | | | | |
| **Family Aromobatidae (3 species)** | | | | | | |
| *Allobates talamancae* | LC | 1 | 6 | 4 | 11 | M |
| *Anomaloglossus astralogaster** | NE | 6 | 8 | 4? | 18 | H |
| *Anomaloglossus isthminus** | NE | 5 | 7 | 4? | 16 | H |
| **Family Bufonidae (39 species)** | | | | | | |
| *Atelopus certus** | EN | 5 | 8 | 1 | 14 | H |
| *Atelopus chiriquiensis** | CR | 5 | 8 | 1 | 14 | H |
| *Atelopus chirripoensis** | CR | 6 | 8 | 1? | 15 | H |
| *Atelopus glyphus* | CR | 4 | 8 | 1 | 13 | M |
| *Atelopus limosus** | EN | 5 | 8 | 1 | 14 | H |
| *Atelopus senex** | CR | 5 | 7 | 1 | 13 | M |
| *Atelopus varius** | CR | 5 | 5 | 1 | 11 | M |
| *Atelopus zeteki** | CR | 5 | 7 | 1 | 13 | M |
| *Incilius aucoinae** | LC | 5 | 8 | 1 | 14 | H |
| *Incilius aurarius* | NE | 4 | 8 | 1 | 13 | M |
| *Incilius bocourti* | LC | 4 | 6 | 1 | 11 | M |
| *Incilius campbelli* | NT | 4 | 7 | 1 | 12 | M |
| *Incilius canaliferus* | LC | 4 | 3 | 1 | 8 | L |
| *Incilius chompipe** | VU | 5 | 7 | 1? | 13 | M |
| *Incilius coccifer* | LC | 3 | 5 | 1 | 9 | L |
| *Incilius coniferus* | LC | 1 | 6 | 1 | 8 | L |
| *Incilius epioticus** | LC | 5 | 7 | 4? | 16 | H |
| *Incilius fastidiosus** | CR | 5 | 7 | 1 | 13 | M |
| *Incilius guanacaste** | DD | 5 | 8 | 4? | 17 | M |
| *Incilius holdridgei** | CR | 5 | 8 | 1 | 14 | H |
| *Incilius ibarrai** | EN | 5 | 7 | 1 | 13 | M |
| *Incilius karenlipsae** | NE | 6 | 8 | 1? | 15 | H |
| *Incilius leucomyos** | EN | 5 | 6 | 1 | 12 | M |
| *Incilius luetkenii* | LC | 3 | 3 | 1 | 7 | L |
| *Incilius macrocristatus* | VU | 4 | 6 | 1 | 11 | M |
| *Incilius melanochlorus** | VU | 5 | 6 | 1 | 12 | M |
| *Incilius periglenes** | EX | 6 | 8 | 1 | 15 | H |
| *Incilius peripatetes** | CR | 5 | 8 | 1? | 14 | H |
| *Incilius porteri** | DD | 5 | 8 | 1? | 14 | H |
| *Incilius signifer** | LC | 5 | 8 | 1? | 14 | H |
| *Incilius tacanensis* | EN | 4 | 4 | 1 | 9 | L |
| *Incilius tutelarius* | EN | 4 | 5 | 1 | 10 | M |
| *Incilius valliceps* | LC | 3 | 2 | 1 | 6 | L |
| *Rhaebo haematiticus* | LC | 1 | 7 | 1 | 9 | L |
| *Rhinella acrolopha* | DD | 4 | 8 | 4? | 16 | H |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Rhinella alata* | DD | 4 | 7 | 4? | 15 | H |
| *Rhinella centralis** | LC | 5 | 8 | 1 | 14 | H |
| *Rhinella chrysophora** | EN | 5 | 7 | 1 | 13 | M |
| *Rhinella marina* | LC | 1 | 1 | 1 | 3 | L |
| **Family Centrolenidae (14 species)** | | | | | | |
| *Cochranella euknemos* | LC | 1? | 6 | 3 | 10 | M |
| *Cochranella granulosa** | LC | 5 | 7 | 3 | 15 | H |
| *Espadarana prosoblepon* | LC | 1? | 5 | 3 | 9 | L |
| *Hyalinobatrachium aureoguttatum* | NT | 3 | 7 | 3 | 13 | M |
| *Hyalinobatrachium chirripoi* | LC | 2 | 7 | 3 | 12 | M |
| *Hyalinobatrachium colymbiphyllum* | LC | 1? | 6 | 3 | 10 | M |
| *Hyalinobatrachium fleischmanni* | LC | 1? | 4 | 3 | 8 | L |
| *Hyalinobatrachium talamancae** | LC | 5 | 8 | 3 | 16 | H |
| *Hyalinobatrachium valerioi* | LC | 1? | 7 | 3 | 11 | M |
| *Hyalinobatrachium vireovittatum** | DD | 5 | 8 | 3 | 16 | H |
| *Sachatamia albomaculata* | LC | 2 | 7 | 3 | 12 | M |
| *Sachatamia ilex* | LC | 2? | 7 | 3? | 12 | M |
| *Teratohyla pulverata* | LC | 2? | 7 | 3 | 12 | M |
| *Teratohyla spinosa* | LC | 1? | 7 | 3 | 11 | M |
| **Family Craugastoridae (101 species)** | | | | | | |
| *Craugastor adamastus** | DD | 6 | 8 | 4 | 18 | H |
| *Craugastor alfredi* | VU | 2 | 5 | 4 | 11 | M |
| *Craugastor amniscola* | DD | 4 | 6 | 4 | 14 | H |
| *Craugastor anciano** | CR | 5 | 7 | 4 | 16 | H |
| *Craugastor andi** | CR | 5 | 8 | 4 | 17 | H |
| *Craugastor angelicus** | CR | 5 | 6 | 4 | 15 | H |
| *Craugastor aphanus** | VU | 5 | 8 | 4 | 17 | H |
| *Craugastor aurilegulus** | EN | 5 | 6 | 4 | 15 | H |
| *Craugastor azueroensis** | EN | 5 | 7 | 4 | 16 | H |
| *Craugastor bocourti** | VU | 5 | 7 | 4 | 16 | H |
| *Craugastor bransfordii** | LC | 5 | 4 | 4 | 13 | M |
| *Craugastor brocchi* | VU | 4 | 6 | 4 | 14 | H |
| *Craugastor campbelli** | DD | 5? | 7 | 4 | 16 | H |
| *Craugastor catalinae** | CR | 5 | 8 | 4 | 17 | H |
| *Craugastor chac** | NT | 5 | 7 | 4 | 16 | H |
| *Craugastor charadra** | EN | 5 | 6 | 4 | 15 | H |
| *Craugastor chingopetaca** | DD | 6 | 8 | 4 | 18 | H |
| *Craugastor chrysozetetes** | EX | 6 | 8 | 4 | 18 | H |
| *Craugastor coffeus** | CR | 6 | 8 | 4 | 18 | H |
| *Craugastor crassidigitus* | LC | 2 | 6 | 4 | 12 | M |
| *Craugastor cruzi** | CR | 6 | 8 | 4 | 18 | H |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| **Species** | **IUCN rating** | **Environmental Vulnerability Score** | | | | **EVS Category** |
|---|---|---|---|---|---|---|
| | | **Geographic Distribution** | **Ecological Distribution** | **Reproductive Mode** | **Total Score** | |
| *Craugastor cuaquero** | DD | 6 | 8 | 4 | 18 | H |
| *Craugastor cyanochthebius** | NT | 6 | 8 | 4 | 18 | H |
| *Craugastor daryi** | EN | 5 | 8 | 4 | 17 | H |
| *Craugastor emcelae** | CR | 5 | 8 | 4 | 17 | H |
| *Craugastor emleni** | CR | 5 | 6 | 4 | 15 | H |
| *Craugastor epochthidius** | CR | 5 | 7 | 4 | 16 | H |
| *Craugastor escoces** | EX | 5 | 6 | 4 | 15 | H |
| *Craugastor evanesco** | NE | 5 | 8 | 4 | 17 | H |
| *Craugastor fecundus** | CR | 5 | 7 | 4 | 16 | H |
| *Craugastor fitzingeri* | LC | 2 | 6 | 4 | 12 | M |
| *Craugastor fleischmanni** | CR | 5 | 7 | 4 | 16 | H |
| *Craugastor gollmeri** | LC | 5 | 7 | 4 | 16 | H |
| *Craugastor greggi* | CR | 4 | 7 | 4 | 15 | H |
| *Craugastor gulosus** | EN | 5 | 8 | 4 | 17 | H |
| *Craugastor inachus** | EN | 5 | 8 | 4 | 17 | H |
| *Craugastor jota** | DD | 6 | 8 | 4 | 18 | H |
| *Craugastor laevissimus** | EN | 5 | 3 | 4 | 12 | M |
| *Craugastor laticeps* | NT | 4 | 4 | 4 | 12 | M |
| *Craugastor lauraster** | EN | 5 | 7 | 4 | 16 | H |
| *Craugastor lineatus* | CR | 4 | 7 | 4 | 15 | H |
| *Craugastor loki* | LC | 4 | 4 | 4 | 12 | M |
| *Craugastor longirostris* | LC | 3 | 7 | 4 | 14 | H |
| *Craugastor matudai* | VU | 4 | 7 | 4 | 15 | H |
| *Craugastor megacephalus** | LC | 5 | 7 | 4 | 16 | H |
| *Craugastor melanostictus** | LC | 5 | 7 | 4 | 16 | H |
| *Craugastor merendonensis** | CR | 6 | 8 | 4 | 18 | H |
| *Craugastor milesi** | CR | 5 | 7 | 4 | 16 | H |
| *Craugastor mimus** | LC | 5 | 7 | 4 | 16 | H |
| *Craugastor monnichorum** | DD | 5 | 7 | 4 | 16 | H |
| *Craugastor myllomyllon** | DD | 6 | 8 | 4 | 18 | H |
| *Craugastor nefrens** | DD | 6 | 8 | 4 | 18 | H |
| *Craugastor noblei** | LC | 5 | 7 | 4 | 16 | H |
| *Craugastor obesus** | EN | 5 | 8 | 4 | 17 | H |
| *Craugastor olanchano** | CR | 6 | 8 | 4 | 18 | H |
| *Craugastor omoaensis** | CR | 6 | 8 | 4 | 18 | H |
| *Craugastor opimus* | LC | 4 | 7 | 4 | 15 | H |
| *Craugastor palenque* | DD | 4 | 7 | 4 | 15 | H |
| *Craugastor pechorum** | EN | 5 | 7 | 4 | 16 | H |
| *Craugastor persimilis** | VU | 5 | 7 | 4 | 16 | H |
| *Craugastor phasma** | DD | 6 | 8 | 4 | 18 | H |
| *Craugastor podiciferus** | NT | 5 | 6 | 4 | 15 | H |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Craugastor polyptychus** | LC | 5 | 8 | 4 | 17 | H |
| *Craugastor psephosypharus** | VU | 5 | 7 | 4 | 16 | H |
| *Craugastor punctariolus** | EN | 5 | 7 | 4 | 16 | H |
| *Craugastor pygmaeus* | VU | 2 | 3 | 4 | 9 | L |
| *Craugastor raniformis* | LC | 4 | 7 | 4 | 15 | H |
| *Craugastor ranoides** | CR | 5 | 6 | 4 | 15 | H |
| *Craugastor rayo** | DD | 5 | 7 | 4 | 16 | H |
| *Craugastor rhyacobatrachus** | EN | 5 | 7 | 4 | 16 | H |
| *Craugastor rivulus** | VU | 5 | 8 | 4 | 17 | H |
| *Craugastor rostralis** | NT | 5 | 7 | 4 | 16 | H |
| *Craugastor rugosus** | LC | 5 | 7 | 4 | 16 | H |
| *Craugastor rupinius* | LC | 4 | 5 | 4 | 13 | H |
| *Craugastor sabrinus** | EN | 5 | 7 | 4 | 16 | H |
| *Craugastor saltuarius** | CR | 6 | 8 | 4 | 18 | H |
| *Craugastor sandersoni** | EN | 5 | 7 | 4 | 16 | H |
| *Craugastor stadelmani** | CR | 5 | 7 | 4 | 16 | H |
| *Craugastor stejnegerianus** | LC | 5 | 5 | 4 | 14 | H |
| *Craugastor stuarti* | EN | 4 | 7 | 4 | 15 | H |
| *Craugastor tabasarae** | CR | 5 | 8 | 4 | 17 | H |
| *Craugastor talamancae** | LC | 5 | 8 | 4 | 17 | H |
| *Craugastor taurus** | CR | 5 | 8 | 4 | 17 | H |
| *Craugastor trachydermus** | CR | 6 | 8 | 4 | 18 | H |
| *Craugastor underwoodi** | LC | 5 | 7 | 4 | 16 | H |
| *Craugastor xucanebi** | VU | 5 | 7 | 4 | 16 | H |
| *Pristimantis achatinus* | LC | 3 | 7 | 4 | 14 | H |
| *Pristimantis adnus** | NE | 6 | 8 | 4 | 18 | H |
| *Pristimantis altae** | NT | 5 | 7 | 4 | 16 | H |
| *Pristimantis caryophyllaceus** | NT | 5 | 6 | 4 | 15 | H |
| *Pristimantis cerasinus** | LC | 5 | 7 | 4 | 16 | H |
| *Pristimantis cruentus* | LC | 4 | 6 | 4 | 14 | H |
| *Pristimantis gaigeae* | LC | 4 | 8 | 4 | 16 | H |
| *Pristimantis moro* | LC | 4 | 8 | 4 | 16 | H |
| *Pristimantis museosus** | EN | 5 | 8 | 4 | 17 | H |
| *Pristimantis pardalis** | NT | 5 | 8 | 4 | 17 | H |
| *Pristimantis pirrensis** | DD | 6 | 8 | 4 | 18 | H |
| *Pristimantis ridens* | LC | 2 | 6 | 4 | 12 | M |
| *Pristimantis taeniatus* | LC | 4 | 8 | 4 | 16 | H |
| *Strabomantis bufoniformis* | LC | 4 | 8 | 4 | 16 | H |
| *Strabomantis laticorpus** | DD | 5 | 8 | 4 | 17 | H |
| **Family Dendrobatidae (19 species)** | | | | | | |
| *Ameerega maculata** | DD | 6 | 8 | 4? | 18 | H |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Andinobates claudiae** | DD | 6 | 8 | 4 | 18 | H |
| *Andinobates fulguritus* | LC | 4 | 7 | 4 | 15 | H |
| *Andinobates geminisae** | NE | 6 | 8 | 4 | 18 | H |
| *Andinobates minutus* | LC | 4 | 7 | 4 | 15 | H |
| *Colostethus latinasus** | DD | 5 | 6 | 4 | 15 | H |
| *Colostethus panamensis* | LC | 4 | 7 | 4 | 15 | H |
| *Colostethus pratti* | LC | 4 | 7 | 4 | 15 | H |
| *Dendrobates auratus* | LC | 4 | 7 | 4 | 15 | H |
| *Hyloxalus chocoensis* | DD | 4 | 8 | 4 | 16 | H |
| *Oophaga arborea** | EN | 5 | 7 | 4 | 16 | H |
| *Oophaga granulifera** | VU | 5 | 8 | 4 | 17 | H |
| *Oophaga pumilio** | LC | 5 | 7 | 4 | 16 | H |
| *Oophaga speciosa** | EN | 5 | 7 | 4 | 16 | H |
| *Oophaga vicentei** | DD | 5 | 7 | 4 | 16 | H |
| *Phyllobates lugubris** | LC | 5 | 8 | 4 | 17 | H |
| *Phyllobates vittatus** | EN | 5 | 8 | 4 | 17 | H |
| *Silverstoneia flotator** | LC | 5 | 7 | 4 | 16 | H |
| *Silverstoneia nubicola* | NT | 4 | 6 | 4 | 14 | H |
| **Family Eleutherodactylidae (11 species)** | | | | | | |
| *Diasporus citrinobapheus** | NE | 5 | 8 | 4 | 17 | H |
| *Diasporus diastema** | LC | 5 | 6 | 4 | 15 | H |
| *Diasporus hylaeformis** | LC | 5 | 8 | 4 | 17 | H |
| *Diasporus igneus** | NE | 6 | 8 | 4 | 18 | H |
| *Diasporus quidditus* | LC | 4 | 8 | 4 | 16 | H |
| *Diasporus tigrillo** | DD | 6 | 8 | 4 | 18 | H |
| *Diasporus ventrimaculatus** | VU | 6 | 8 | 4 | 18 | H |
| *Diasporus vocator* | LC | 4 | 7 | 4 | 15 | H |
| *Eleutherodactylus leprus* | VU | 2 | 6 | 4 | 12 | M |
| *Eleutherodactylus pipilans* | LC | 2 | 5 | 4 | 11 | M |
| *Eleutherodactylus rubrimaculatus* | VU | 4 | 7 | 4 | 15 | H |
| **Family Hemiphractidae (3 species)** | | | | | | |
| *Gastrotheca cornuta* | EN | 4 | 7 | 5 | 16 | H |
| *Gastrotheca nicefori* | LC | 3 | 7 | 5 | 15 | H |
| *Hemiphractus fasciatus* | NT | 4 | 7 | 5 | 16 | H |
| **Family Hylidae (98 species)** | | | | | | |
| *Agalychnis annae** | EN | 5 | 7 | 3 | 15 | H |
| *Agalychnis callidryas* | LC | 3 | 5 | 3 | 11 | M |
| *Agalychnis lemur* | CR | 2 | 7 | 3 | 12 | M |
| *Agalychnis litodryas* | VU | 4 | 8 | 3 | 15 | H |
| *Agalychnis moreletii* | CR | 1 | 3 | 3 | 7 | L |
| *Agalychnis saltator** | LC | 5 | 6 | 3 | 14 | H |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Agalychnis spurrelli* | LC | 4 | 7 | 3 | 14 | H |
| *Anotheca spinosa* | LC | 3 | 6 | 6 | 15 | H |
| *Bromeliohyla bromeliacia* | EN | 4 | 7 | 6 | 17 | H |
| *Cruziohyla calcarifer* | LC | 4 | 8 | 3 | 15 | H |
| *Dendropsophus ebraccatus* | LC | 3 | 6 | 3 | 12 | M |
| *Dendropsophus microcephalus* | LC | 3 | 3 | 1 | 7 | L |
| *Dendropsophus phlebodes* | LC | 3 | 7 | 1 | 11 | M |
| *Dendropsophus robertmertensi* | LC | 4 | 4 | 1 | 9 | L |
| *Dendropsophus subocularis* | LC | 4 | 8 | 1 | 13 | M |
| *Duellmanohyla lythrodes** | EN | 5 | 8 | 1 | 14 | H |
| *Duellmanohyla rufioculis** | LC | 5 | 8 | 1 | 14 | H |
| *Duellmanohyla salvavida** | CR | 5 | 7 | 1 | 13 | M |
| *Duellmanohyla schmidtorum* | VU | 4 | 3 | 1 | 8 | L |
| *Duellmanohyla soralia** | CR | 5 | 6 | 1 | 12 | M |
| *Duellmanohyla uranochroa** | EN | 5 | 6 | 1 | 12 | M |
| *Ecnomiohyla bailarina** | NE | 6 | 8 | 6? | 20 | H |
| *Ecnomiohyla fimbrimembra* | CR | 6 | 7 | 6 | 19 | H |
| *Ecnomiohyla miliaria** | VU | 5 | 7 | 6 | 18 | H |
| *Ecnomiohyla minera** | EN | 5 | 7 | 6 | 18 | H |
| *Ecnomiohyla rabborum** | CR | 6 | 8 | 6 | 20 | H |
| *Ecnomiohyla salvaje** | CR | 5 | 8 | 6 | 19 | H |
| *Ecnomiohyla sukia** | NE | 5 | 7 | 6 | 18 | H |
| *Ecnomiohyla thysanota** | DD | 6 | 8 | 6? | 20 | H |
| *Ecnomiohyla veraguensis** | NE | 6 | 8 | 6? | 20 | H |
| *Exerodonta catracha** | EN | 5 | 8 | 1 | 14 | H |
| *Exerodonta perkinsi** | CR | 6 | 8 | 1 | 15 | H |
| *Hyla bocourti** | CR | 5 | 8 | 1 | 14 | H |
| *Hyla walkeri* | VU | 4 | 6 | 1 | 11 | M |
| *Hyloscirtus colymba* | CR | 4 | 8 | 1 | 13 | M |
| *Hyloscirtus palmeri* | LC | 4 | 8 | 1 | 13 | M |
| *Hypsiboas boans* | LC | 3 | 8 | 1 | 12 | M |
| *Hypsiboas crepitans* | LC | 3 | 8 | 1 | 12 | M |
| *Hypsiboas pugnax* | LC | 4 | 8 | 1 | 13 | M |
| *Hypsiboas rosenbergi* | LC | 4 | 8 | 1 | 13 | M |
| *Hypsiboas rufitelus** | LC | 5 | 8 | 1 | 14 | H |
| *Isthmohyla angustilineata** | CR | 5 | 7 | 1 | 13 | M |
| *Isthmohyla calypsa** | CR | 5 | 8 | 3 | 16 | H |
| *Isthmohyla debilis** | CR | 5 | 8 | 1 | 14 | H |
| *Isthmohyla graceae** | CR | 5 | 7 | 1 | 13 | M |
| *Isthmohyla infucata** | DD | 5 | 8 | 1 | 14 | H |
| *Isthmohyla insolita** | CR | 6 | 8 | 3 | 17 | H |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Isthmohyla lancasteri** | LC | 5 | 8 | 1 | 14 | H |
| *Isthmohyla melacaena** | NT | 6 | 8 | 6 | 20 | H |
| *Isthmohyla picadoi** | NT | 5 | 8 | 6 | 19 | H |
| *Isthmohyla pictipes** | EN | 5 | 8 | 1 | 14 | H |
| *Isthmohyla pseudopuma** | LC | 5 | 7 | 1 | 13 | M |
| *Isthmohyla rivularis** | CR | 5 | 7 | 1 | 13 | M |
| *Isthmohyla tica** | CR | 5 | 7 | 1 | 13 | M |
| *Isthmohyla xanthosticta** | DD | 6 | 8 | 1 | 15 | H |
| *Isthmohyla zeteki** | NT | 5 | 7 | 6 | 18 | H |
| *Phyllomedusa venusta* | LC | 4 | 8 | 1 | 13 | M |
| *Plectrohyla acanthodes* | CR | 4 | 7 | 1 | 12 | M |
| *Plectrohyla avia* | CR | 4 | 8 | 1 | 13 | M |
| *Plectrohyla chrysopleura** | CR | 5 | 7 | 1 | 13 | M |
| *Plectrohyla dasypus** | CR | 6 | 7 | 1 | 14 | H |
| *Plectrohyla exquisita** | CR | 6 | 8 | 1 | 15 | H |
| *Plectrohyla glandulosa** | EN | 5 | 6 | 1 | 12 | M |
| *Plectrohyla guatemalensis* | CR | 4 | 4 | 1 | 9 | L |
| *Plectrohyla hartwegi* | CR | 4 | 5 | 1 | 10 | M |
| *Plectrohyla ixil* | CR | 4 | 7 | 1 | 12 | M |
| *Plectrohyla matudai* | VU | 4 | 6 | 1 | 11 | M |
| *Plectrohyla pokomchi** | CR | 5 | 7 | 1 | 13 | M |
| *Plectrohyla psiloderma** | EN | 5 | 8 | 1 | 14 | H |
| *Plectrohyla quecchi** | CR | 5 | 7 | 1 | 13 | M |
| *Plectrohyla sagorum* | EN | 4 | 5 | 1 | 10 | M |
| *Plectrohyla tecunumani** | CR | 5 | 8 | 1 | 14 | H |
| *Plectrohyla teuchestes** | CR | 6 | 8 | 1 | 15 | H |
| *Ptychohyla dendrophasma** | CR | 6 | 8 | 6? | 20 | H |
| *Ptychohyla euthysanota* | NT | 4 | 3 | 1 | 8 | L |
| *Ptychohyla hypomykter** | CR | 5 | 4 | 1 | 10 | M |
| *Ptychohyla legleri** | EN | 5 | 8 | 1 | 14 | H |
| *Ptychohyla macrotympanum* | CR | 4 | 6 | 1 | 11 | M |
| *Ptychohyla panchoi** | EN | 5 | 7 | 1 | 13 | M |
| *Ptychohyla salvadorensis** | EN | 5 | 6 | 1 | 12 | M |
| *Ptychohyla sanctaecrucis** | CR | 6 | 7 | 1 | 14 | H |
| *Ptychohyla spinipollex** | EN | 5 | 6 | 1 | 12 | M |
| *Scinax altae** | LC | 5 | 8 | 1 | 14 | H |
| *Scinax boulengeri* | LC | 4 | 6 | 1 | 11 | M |
| *Scinax elaeochroa** | LC | 5 | 7 | 1 | 13 | M |
| *Scinax rostrata* | LC | 3 | 7 | 1 | 11 | M |
| *Scinax rubra* | LC | 3 | 7 | 1 | 11 | M |
| *Scinax staufferi* | LC | 2 | 1 | 1 | 4 | L |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Smilisca baudinii* | LC | 1 | 1 | 1 | 3 | L |
| *Smilisca cyanosticta* | NT | 4 | 7 | 1 | 12 | M |
| *Smilisca phaeota* | LC | 4 | 6 | 1 | 11 | M |
| *Smilisca puma** | LC | 5 | 8 | 1 | 14 | H |
| *Smilisca sila* | LC | 4 | 5 | 1 | 10 | M |
| *Smilisca sordida* | LC | 2 | 5 | 1 | 8 | L |
| *Tlalocohyla loquax* | LC | 3 | 3 | 1 | 7 | L |
| *Tlalocohyla picta* | LC | 2 | 5 | 1 | 8 | L |
| *Trachycephalus typhonius* | LC | 1 | 2 | 1 | 4 | L |
| *Triprion petasatus* | LC | 4 | 5 | 1 | 10 | M |
| **Family Leptodactylidae (9 species)** | | | | | | |
| *Engystomops pustulosus* | LC | 3 | 2 | 2 | 7 | L |
| *Leptodactylus fragilis* | LC | 1 | 2 | 2 | 5 | L |
| *Leptodactylus fuscus* | LC | 3 | 7 | 2 | 12 | M |
| *Leptodactylus insularum* | LC | 3 | 7 | 2 | 12 | M |
| *Leptodactylus melanonotus* | LC | 1 | 3 | 2 | 6 | L |
| *Leptodactylus poecilochilus* | LC | 4 | 6 | 2 | 12 | M |
| *Leptodactylus savagei* | LC | 2 | 5 | 2 | 9 | L |
| *Leptodactylus silvanimbus** | CR | 5 | 7 | 2 | 14 | H |
| *Pleurodema brachyops* | LC | 3 | 8 | 2 | 13 | M |
| **Family Microhylidae (9 species)** | | | | | | |
| *Ctenophryne aterrima* | LC | 4 | 7 | 1 | 12 | M |
| *Elachistocleis ovalis* | LC | 3 | 7 | 1 | 11 | M |
| *Elachistocleis panamensis* | LC | 4 | 7 | 1 | 12 | M |
| *Elachistocleis pearsei* | LC | 3 | 8 | 1 | 12 | M |
| *Gastrophryne elegans* | LC | 2 | 5 | 1 | 8 | L |
| *Hypopachus barberi* | VU | 4 | 5 | 1 | 10 | M |
| *Hypopachus pictiventris** | LC | 5 | 8 | 1 | 14 | H |
| *Hypopachus ustus* | LC | 3 | 4 | 1 | 8 | L |
| *Hypopachus variolosus* | LC | 2 | 1 | 1 | 4 | L |
| **Family Pipidae (1 species)** | | | | | | |
| *Pipa myersi** | EN | 4 | 8 | 5 | 17 | H |
| **Family Ranidae (11 species)** | | | | | | |
| *Lithobates brownorum* | NE | 4 | 3 | 1 | 8 | L |
| *Lithobates forreri* | LC | 1 | 1 | 1 | 3 | L |
| *Lithobates juliani** | NT | 5 | 6 | 1 | 12 | M |
| *Lithobates macroglossa* | VU | 4 | 7 | 1 | 12 | M |
| *Lithobates maculatus* | LC | 3 | 1 | 1 | 5 | L |
| *Lithobates miadis** | VU | 6 | 8 | 1 | 15 | H |
| *Lithobates pipiens complex* | LC | 4 | 4 | 1 | 9 | L |
| *Lithobates taylori** | LC | 5 | 6 | 1 | 12 | M |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Lithobates vaillanti* | LC | 3 | 5 | 1 | 9 | L |
| *Lithobates vibicarius** | VU | 5 | 8 | 1 | 14 | H |
| *Lithobates warszewitschii** | LC | 5 | 4 | 1 | 10 | M |
| **Family Rhinophrynidae (1 species)** | | | | | | |
| *Rhinophrynus dorsalis* | LC | 2 | 5 | 1 | 8 | L |
| **Order Caudata (159 species)** | | | | | | |
| **Family Plethodontidae (159 species)** | | | | | | |
| *Bolitoglossa alvaradoi** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa anthracina** | DD | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa aureogularis** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa biseriata* | LC | 1 | 8 | 4 | 13 | M |
| *Bolitoglossa bramei** | DD | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa carri** | CR | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa cataguana** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa celaque** | EN | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa centenorum** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa cerroensis** | LC | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa chucantiensis* | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa colonnea** | LC | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa compacta** | EN | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa conanti** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa copia** | DD | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa cuchumatana** | NT | 5 | 5 | 4 | 14 | H |
| *Bolitoglossa cuna** | DD | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa daryorum** | NE | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa decora** | CR | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa diaphora** | CR | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa diminuta** | VU | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa dofleini** | NT | 5 | 6 | 4 | 15 | H |
| *Bolitoglossa dunni** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa engelhardti* | EN | 4 | 7 | 4 | 15 | H |
| *Bolitoglossa epimela** | DD | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa eremia** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa flavimembris* | EN | 4 | 7 | 4 | 15 | H |
| *Bolitoglossa flaviventris* | EN | 4 | 5 | 4 | 13 | M |
| *Bolitoglossa franklini* | EN | 4 | 6 | 4 | 14 | H |
| *Bolitoglossa gomezi** | DD | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa gracilis** | VU | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa hartwegi* | NT | 4 | 4 | 4 | 12 | M |
| *Bolitoglossa heiroreias** | EN | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa helmrichi** | NT | 5 | 7 | 4 | 16 | H |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Bolitoglossa huehuetenanguensis** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa indio** | DD | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa insularis** | VU | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa jacksoni** | DD | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa jugivagans** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa kamuk** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa kaqchikelorum** | NE | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa la** | NE | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa lignicolor** | VU | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa lincolni* | NT | 4 | 5 | 4 | 13 | M |
| *Bolitoglossa longissima** | CR | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa magnifica** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa marmorea** | EN | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa medemi* | VU | 4 | 7 | 4 | 15 | H |
| *Bolitoglossa meliana** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa mexicana* | LC | 1 | 3 | 4 | 8 | L |
| *Bolitoglossa minutula** | EN | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa mombachoensis** | VU | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa morio** | LC | 5 | 4 | 4 | 13 | M |
| *Bolitoglossa mulleri* | VU | 2 | 7 | 4 | 13 | M |
| *Bolitoglossa nigrescens** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa ninadormida** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa nussbaumi** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa nympha** | NE | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa obscura** | VU | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa occidentalis* | LC | 4 | 3 | 4 | 11 | M |
| *Bolitoglossa odonnelli** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa omniumsanctorum** | NE | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa oresbia** | CR | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa pacaya** | NE | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa pesrubra** | VU | 5 | 6 | 4 | 15 | H |
| *Bolitoglossa phalarosoma* | DD | 4 | 8 | 4 | 16 | H |
| *Bolitoglossa porrasorum** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa psephena** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa pygmaea** | NE | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa robinsoni** | NE | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa robusta** | LC | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa rostrata* | VU | 4 | 6 | 4 | 14 | H |
| *Bolitoglossa rufescens* | LC | 1 | 4 | 4 | 9 | L |
| *Bolitoglossa salvinii** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa schizodactyla** | LC | 5 | 6 | 4 | 15 | H |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Bolitoglossa sombra** | VU | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa sooyorum** | EN | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa splendida** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa striatula** | LC | 5 | 7 | 4 | 16 | H |
| *Bolitoglossa stuarti* | DD | 4 | 7 | 4 | 15 | H |
| *Bolitoglossa subpalmata** | EN | 5 | 6 | 4 | 15 | H |
| *Bolitoglossa suchitanensis** | DD | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa synoria** | CR | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa taylori** | DD | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa tenebrosa** | NE | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa tica** | EN | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa tzultacaj** | NE | 6 | 8 | 4 | 18 | H |
| *Bolitoglossa xibalba** | NE | 5 | 8 | 4 | 17 | H |
| *Bolitoglossa yucatana* | LC | 4 | 7 | 4 | 15 | H |
| *Bolitoglossa zacapensis** | NE | 6 | 8 | 4 | 18 | H |
| *Bradytriton silus** | CR | 6 | 8 | 4 | 18 | H |
| *Cryptotriton monzoni** | CR | 6 | 8 | 4 | 18 | H |
| *Cryptotriton nasalis** | EN | 6 | 8 | 4 | 18 | H |
| *Cryptotriton necopinus* | NE | 6 | 8 | 4 | 18 | H |
| *Cryptotriton sierraminensis** | DD | 5 | 8 | 4 | 17 | H |
| *Cryptotriton veraepacis** | CR | 5 | 8 | 4 | 17 | H |
| *Dendrotriton bromeliacius** | CR | 5 | 8 | 4 | 17 | H |
| *Dendrotriton chujorum** | CR | 6 | 8 | 4 | 18 | H |
| *Dendrotriton cuchumatanus** | CR | 6 | 8 | 4 | 18 | H |
| *Dendrotriton kekchiorum** | EN | 6 | 8 | 4 | 18 | H |
| *Dendrotriton rabbi** | CR | 5 | 8 | 4 | 17 | H |
| *Dendrotriton sanctibarbarus** | VU | 6 | 8 | 4 | 18 | H |
| *Nototriton abscondens** | LC | 5 | 7 | 4 | 16 | H |
| *Nototriton barbouri** | EN | 5 | 7 | 4 | 16 | H |
| *Nototriton brodiei** | CR | 5 | 8 | 4 | 17 | H |
| *Nototriton gamezi** | VU | 6 | 8 | 4 | 18 | H |
| *Nototriton guanacaste** | VU | 5 | 8 | 4 | 17 | H |
| *Nototriton lignicola** | CR | 6 | 8 | 4 | 18 | H |
| *Nototriton limnospectator** | EN | 5 | 8 | 4 | 17 | H |
| *Nototriton major** | CR | 6 | 8 | 4 | 18 | H |
| *Nototriton matama** | NE | 6 | 8 | 4 | 18 | H |
| *Nototriton mime** | NE | 6 | 8 | 4 | 18 | H |
| *Nototriton picadoi** | NT | 5 | 7 | 4 | 16 | H |
| *Nototriton picucha** | NE | 6 | 8 | 4 | 18 | H |
| *Nototriton richardi** | NT | 5 | 7 | 4 | 16 | H |
| *Nototriton saslaya** | VU | 6 | 8 | 4 | 18 | H |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| *Nototriton stuarti** | DD | 6 | 8 | 4 | 18 | H |
| *Nototriton tapanti** | VU | 6 | 8 | 4 | 18 | H |
| *Nototriton tomamorum** | NE | 6 | 8 | 4 | 18 | H |
| *Nyctanolis pernix* | EN | 4 | 7 | 4 | 15 | H |
| *Oedipina alfaroi** | VU | 5 | 7 | 4 | 16 | H |
| *Oedipina alleni** | LC | 5 | 7 | 4 | 16 | H |
| *Oedipina altura** | CR | 6 | 8 | 4 | 18 | H |
| *Oedipina carablanca** | EN | 6 | 8 | 4 | 18 | H |
| *Oedipina chortiorum** | NE | 6 | 8 | 4 | 18 | H |
| *Oedipina collaris** | DD | 5 | 8 | 4 | 17 | H |
| *Oedipina complex* | LC | 1 | 6 | 4 | 11 | M |
| *Oedipina cyclocauda** | LC | 5 | 6 | 4 | 15 | H |
| *Oedipina elongata* | LC | 2 | 7 | 4 | 13 | M |
| *Oedipina fortunensis** | NE | 6 | 8 | 4 | 18 | H |
| *Oedipina gephyra** | EN | 5 | 8 | 4 | 17 | H |
| *Oedipina gracilis** | EN | 5 | 7 | 4 | 16 | H |
| *Oedipina grandis** | EN | 5 | 8 | 4 | 17 | H |
| *Oedipina ignea** | DD | 5 | 6 | 4 | 15 | H |
| *Oedipina kasios** | NE | 5 | 7 | 4 | 16 | H |
| *Oedipina koehleri** | NE | 5 | 7 | 4 | 16 | H |
| *Oedipina leptopoda** | NE | 5 | 8 | 4 | 17 | H |
| *Oedipina maritima** | CR | 6 | 8 | 4 | 18 | H |
| *Oedipina motaguae** | NE | 6 | 8 | 4 | 18 | H |
| *Oedipina nica** | NE | 5 | 8 | 4 | 17 | H |
| *Oedipina nimaso** | NE | 6 | 8 | 4 | 18 | H |
| *Oedipina pacificensis** | LC | 5 | 7 | 4 | 16 | H |
| *Oedipina parvipes* | LC | 4 | 7 | 4 | 15 | H |
| *Oedipina paucidentata** | CR | 6 | 8 | 4 | 18 | H |
| *Oedipina petiola** | NE | 6 | 8 | 4 | 18 | H |
| *Oedipina poelzi** | EN | 5 | 7 | 4 | 16 | H |
| *Oedipina pseudouniformis** | EN | 5 | 7 | 4 | 16 | H |
| *Oedipina quadra** | NE | 5 | 8 | 4 | 17 | H |
| *Oedipina savagei** | DD | 6 | 8 | 4 | 18 | H |
| *Oedipina stenopodia** | EN | 5 | 8 | 4 | 17 | H |
| *Oedipina stuarti** | DD | 5 | 6 | 4 | 15 | H |
| *Oedipina taylori** | LC | 5 | 5 | 4 | 14 | H |
| *Oedipina tomasi** | CR | 6 | 8 | 4 | 18 | H |
| *Oedipina tzutujilorum** | NE | 6 | 8 | 4 | 18 | H |
| *Oedipina uniformis** | NT | 5 | 6 | 4 | 15 | H |
| *Pseudoeurycea brunnata* | CR | 4 | 7 | 4 | 15 | H |
| *Pseudoeurycea exspectata** | CR | 6 | 8 | 4 | 18 | H |
| *Pseudoeurycea goebeli* | CR | 4 | 7 | 4 | 15 | H |
| *Pseudoeurycea rex* | CR | 4 | 4 | 4 | 12 | M |

**Appendix 1 (continued).** Comparison of the IUCN Ratings from the Red List website (updated to 10 August 2014) and Environmental Vulnerability Scores for 493 Central American amphibians. See text for explanations of the IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America. ? = reproductive mode estimated based on phylogenetic relationships.

| Species | IUCN rating | Environmental Vulnerability Score | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Reproductive Mode | Total Score | |
| **Order Gymnophiona (15 species)** | | | | | | |
| **Family Caeciliiidae (7 species)** | | | | | | |
| *Caecilia isthmica* | DD | 4 | 8 | 4? | 16 | H |
| *Caecilia leucocephala* | LC | 3 | 8 | 4? | 15 | H |
| *Caecilia nigricans* | LC | 3 | 8 | 4? | 15 | H |
| *Caecilia volcani** | DD | 5 | 8 | 4? | 17 | H |
| *Oscaecilia elongata** | DD | 6 | 8 | 5 | 19 | H |
| *Oscaecilia ochrocephala* | LC | 4 | 7 | 5 | 16 | H |
| *Oscaecilia osae** | DD | 6 | 8 | 5? | 19 | H |
| **Family Dermophiidae (8 species)** | | | | | | |
| *Dermophis costaricensis** | DD | 5 | 8 | 5 | 18 | H |
| *Dermophis glandulosus* | DD | 2 | 6 | 5? | 13 | M |
| *Dermophis gracilior** | DD | 5 | 8 | 5 | 18 | H |
| *Dermophis mexicanus* | VU | 1 | 1 | 5 | 7 | L |
| *Dermophis occidentalis** | DD | 5 | 7 | 5 | 17 | H |
| *Dermophis parviceps* | LC | 2 | 6 | 5? | 13 | M |
| *Gymnopis multiplicata** | LC | 5 | 4 | 5 | 14 | H |
| *Gymnopis syntrema* | DD | 4 | 7 | 5 | 16 | H |

**Appendix 2.** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| **Order Crocodylia (3 species)** | | | | | | |
| **Family Alligatoridae (1 species)** | | | | | | |
| *Caiman crocodilus* | LC | 3 | 7 | 6 | 16 | H |
| **Family Crocodylidae (2 species)** | | | | | | |
| *Crocodylus acutus* | VU | 3 | 5 | 6 | 14 | H |
| *Crocodylus moreletii* | LC | 2 | 5 | 6 | 13 | M |
| **Order Squamata (532 species)** | | | | | | |
| **Family Amphisbaenidae (2 species)** | | | | | | |
| *Amphisbaena fuliginosa* | LC | 3 | 7 | 1 | 11 | M |
| *Amphisbaena spurrelli* | NE | 3 | 8 | 1 | 12 | M |
| **Family Anguidae (28 species)** | | | | | | |
| *Abronia anzuetoi** | VU | 6 | 8 | 4 | 18 | H |
| *Abronia aurita** | EN | 5 | 7 | 4 | 16 | H |
| *Abronia campbelli** | CR | 6 | 8 | 4 | 18 | H |
| *Abronia fimbriata** | NE | 5 | 7 | 4 | 16 | H |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Abronia frosti** | CR | 6 | 8 | 4 | 18 | H |
| *Abronia gaiophantasma** | EN | 5 | 7 | 4 | 16 | H |
| *Abronia lythrochila* | LC | 4 | 7 | 4 | 15 | H |
| *Abronia matudai* | EN | 4 | 7 | 4 | 15 | H |
| *Abronia meledona** | EN | 6 | 8 | 4 | 18 | H |
| *Abronia montecristoi** | EN | 5 | 8 | 4 | 17 | H |
| *Abronia ochoterenai* | DD | 4 | 8 | 4 | 16 | H |
| *Abronia salvadorensis** | EN | 5 | 8 | 4 | 17 | H |
| *Abronia vasconcelosii** | VU | 5 | 7 | 4 | 16 | H |
| *Celestus adercus** | DD | 6 | 8 | 3 | 17 | H |
| *Celestus atitlanensis** | NE | 5 | 7 | 3 | 15 | H |
| *Celestus bivittatus** | EN | 5 | 7 | 3 | 15 | H |
| *Celestus cyanochloris** | LC | 5 | 6 | 3 | 14 | H |
| *Celestus hylaius** | NT | 5 | 8 | 3 | 16 | H |
| *Celestus montanus** | EN | 5 | 7 | 3 | 15 | H |
| *Celestus orobius** | DD | 5 | 8 | 3 | 16 | H |
| *Celestus rozellae* | LC | 4 | 6 | 3 | 13 | M |
| *Celestus scansorius** | NT | 5 | 7 | 3 | 15 | H |
| *Coloptychon rhombifer** | DD | 5 | 8 | 3 | 16 | H |
| *Diploglossus bilobatus** | LC | 5 | 7 | 4 | 16 | H |
| *Diploglossus monotropis* | NE | 4 | 7 | 4 | 15 | H |
| *Diploglossus montisilvestris** | DD | 6 | 8 | 4 | 18 | H |
| *Mesaspis monticola** | LC | 5 | 6 | 3 | 14 | H |
| *Mesaspis moreletii* | LC | 2 | 3 | 3 | 8 | L |
| **Family Corytophanidae (9 species)** | | | | | | |
| *Basiliscus basiliscus* | NE | 4 | 4 | 3 | 11 | M |
| *Basiliscus galeritus* | NE | 3 | 7 | 3 | 13 | M |
| *Basiliscus plumifrons* | LC | 5 | 7 | 3 | 15 | H |
| *Basiliscus vittatus* | NE | 1 | 3 | 3 | 7 | L |
| *Corytophanes cristatus* | NE | 2 | 5 | 3 | 10 | M |
| *Corytophanes hernandesii* | LC | 4 | 6 | 3 | 13 | M |
| *Corytophanes percarinatus* | LC | 4 | 4 | 3 | 11 | M |
| *Laemanctus longipes* | LC | 1 | 5 | 3 | 9 | L |
| *Laemanctus serratus* | LC | 3 | 3 | 3 | 9 | L |
| **Family Dactyloidae (95 species)** | | | | | | |
| *Anolis allisoni* | NE | 3 | 7 | 3 | 13 | M |
| *Dactyloa casildae** | NE | 5 | 8 | 3 | 16 | H |
| *Dactyloa chloris* | NE | 3 | 8 | 3 | 14 | H |
| *Dactyloa chocorum* | NE | 4 | 8 | 3 | 15 | H |
| *Dactyloa frenata* | NE | 4 | 7 | 3 | 14 | H |
| *Dactyloa ginaelisae** | NE | 5 | 4 | 3 | 12 | M |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Dactyloa ibanezi** | NE | 5 | 7 | 3 | 15 | H |
| *Dactyloa insignis** | NE | 5 | 6 | 3 | 14 | H |
| *Dactyloa kunayalae** | NE | 5 | 7 | 3 | 15 | H |
| *Dactyloa latifrons* | NE | 3 | 7 | 3 | 13 | M |
| *Dactyloa microtus** | NE | 5 | 7 | 3 | 15 | H |
| *Norops alocomyos* | NE | 5 | 8 | 3 | 16 | H |
| *Norops altae** | LC | 5 | 7 | 3 | 15 | H |
| *Norops amplisquamosus** | EN | 6 | 8 | 3 | 17 | H |
| *Norops apletophallus** | NE | 5 | 7 | 3 | 15 | H |
| *Norops aquaticus** | NE | 5 | 7 | 3 | 15 | H |
| *Norops auratus* | NE | 3 | 7 | 3 | 13 | M |
| *Norops beckeri* | NE | 3 | 6 | 3 | 12 | M |
| *Norops benedikti** | NE | 5 | 8 | 3 | 16 | H |
| *Norops bicaorum** | NE | 6 | 8 | 3 | 17 | H |
| *Norops biporcatus* | NE | 2 | 4 | 3 | 9 | L |
| *Norops campbelli** | NE | 6 | 8 | 3 | 17 | H |
| *Norops capito* | NE | 2 | 6 | 3 | 11 | M |
| *Norops carpenteri** | LC | 5 | 8 | 3 | 16 | H |
| *Norops charlesmyersi** | NE | 5 | 8 | 3 | 16 | H |
| *Norops cobanensis** | NE | 5 | 5 | 3 | 13 | M |
| *Norops crassulus* | NE | 2 | 4 | 3 | 9 | L |
| *Norops cristifer* | DD | 4 | 6 | 3 | 13 | M |
| *Norops cryptolimifrons** | NE | 5 | 8 | 3 | 16 | H |
| *Norops cupreus** | NE | 5 | 5 | 3 | 13 | M |
| *Norops cusuco** | EN | 6 | 8 | 3 | 17 | H |
| *Norops datzorum** | NE | 5 | 7 | 3 | 15 | H |
| *Norops dollfusianus* | NE | 4 | 6 | 3 | 13 | M |
| *Norops fortunensis** | DD | 6 | 8 | 3 | 17 | H |
| *Norops fungosus** | NE | 5 | 7 | 3 | 15 | H |
| *Norops fuscoauratus* | NE | 3 | 7 | 3 | 13 | M |
| *Norops gaigei* | NE | 4 | 7 | 3 | 14 | H |
| *Norops gruuo** | NE | 6 | 8 | 3 | 17 | H |
| *Norops haguei** | NE | 6 | 8 | 3 | 17 | H |
| *Norops heteropholidotus** | NE | 5 | 8 | 3 | 16 | H |
| *Norops humilis** | NE | 5 | 6 | 3 | 14 | H |
| *Norops intermedius** | NE | 5 | 6 | 3 | 14 | H |
| *Norops johnmeyeri** | NE | 5 | 8 | 3 | 16 | H |
| *Norops kemptoni** | NE | 5 | 7 | 3 | 15 | H |
| *Norops kreutzi** | NE | 6 | 8 | 3 | 17 | H |
| *Norops laeviventris* | NE | 2 | 3 | 3 | 8 | L |
| *Norops leditzigorum* | NE | 5 | 7 | 3 | 15 | H |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Norops lemurinus* | NE | 2 | 2 | 3 | 7 | L |
| *Norops limifrons** | NE | 5 | 7 | 3 | 15 | H |
| *Norops lionotus** | LC | 5 | 6 | 3 | 14 | H |
| *Norops loveridgei** | EN | 5 | 6 | 3 | 14 | H |
| *Norops macrophallus** | NE | 5 | 7 | 3 | 15 | H |
| *Norops magnaphallus** | NE | 6 | 8 | 3 | 17 | H |
| *Norops marsupialis** | NE | 5 | 8 | 3 | 16 | H |
| *Norops matudai* | NE | 4 | 6 | 3 | 13 | M |
| *Norops monteverde** | NE | 6 | 8 | 3 | 17 | H |
| *Norops morazani** | NE | 6 | 8 | 3 | 17 | H |
| *Norops muralla** | VU | 6 | 8 | 3 | 17 | H |
| *Norops ocelloscapularis** | NE | 5 | 7 | 3 | 15 | H |
| *Norops osa** | NE | 5 | 8 | 3 | 16 | H |
| *Norops pachypus** | LC | 5 | 7 | 3 | 15 | H |
| *Norops pentaprion** | NE | 5 | 4 | 3 | 12 | M |
| *Norops petersii* | NE | 2 | 4 | 3 | 9 | L |
| *Norops pijolensis** | NE | 6 | 7 | 3 | 16 | H |
| *Norops poecilopus* | NE | 4 | 7 | 3 | 14 | H |
| *Norops polylepis** | NE | 5 | 7 | 3 | 15 | H |
| *Norops pseudokemptoni** | NE | 6 | 8 | 3 | 17 | H |
| *Norops pseudopachypus** | NE | 6 | 8 | 3 | 17 | H |
| *Norops purpurgularis** | NE | 5 | 8 | 3 | 16 | H |
| *Norops quaggulus** | NE | 5 | 7 | 3 | 15 | H |
| *Norops roatanensis** | NE | 6 | 8 | 3 | 17 | H |
| *Norops rodriguezii* | NE | 4 | 3 | 3 | 10 | M |
| *Norops rubribarbaris** | NE | 6 | 8 | 3 | 17 | H |
| *Norops sagrei* | NE | 3 | 7 | 3 | 13 | M |
| *Norops salvini** | NE | 5 | 7 | 3 | 15 | H |
| *Norops sericeus* | NE | 2 | 3 | 3 | 8 | L |
| *Norops serranoi* | NE | 4 | 5 | 3 | 12 | M |
| *Norops sminthus** | DD | 5 | 7 | 3 | 15 | H |
| *Norops tenorioensis** | NE | 6 | 8 | 3 | 17 | H |
| *Norops townsendi** | NE | 6 | 8 | 3 | 17 | H |
| *Norops triumphalis** | NE | 6 | 8 | 3 | 17 | H |
| *Norops tropidogaster* | NE | 3 | 7 | 3 | 13 | M |
| *Norops tropidolepis** | NE | 5 | 7 | 3 | 15 | H |
| *Norops tropidonotus* | NE | 4 | 2 | 3 | 9 | L |
| *Norops uniformis* | NE | 4 | 6 | 3 | 13 | M |
| *Norops unilobatus* | NE | 1 | 3 | 3 | 7 | L |
| *Norops utilensis** | NE | 6 | 8 | 3 | 17 | H |
| *Norops villai** | NE | 6 | 8 | 3 | 17 | H |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Norops vittigerus* | NE | 4 | 7 | 3 | 14 | H |
| *Norops wampuensis** | NE | 6 | 8 | 3 | 17 | H |
| *Norops wellbornae** | NE | 5 | 7 | 3 | 15 | H |
| *Norops wermuthi** | NE | 5 | 8 | 3 | 16 | H |
| *Norops woodi** | NE | 5 | 6 | 3 | 14 | H |
| *Norops yoroensis** | NE | 5 | 7 | 3 | 15 | H |
| *Norops zeus** | NE | 5 | 7 | 3 | 15 | H |
| **Family Eublepharidae (2 species)** | | | | | | |
| *Coleonyx elegans* | LC | 3 | 3 | 4 | 10 | M |
| *Coleonyx mitratus* | LC | 5 | 5 | 4 | 14 | H |
| **Family Gymnophthalmidae (14 species)** | | | | | | |
| *Anadia ocellata** | NE | 5 | 8 | 3 | 16 | H |
| *Anadia vittata* | NE | 4 | 7 | 3 | 14 | H |
| *Bachia blairi** | NT | 5 | 8 | 2 | 15 | H |
| *Bachia pallidiceps* | NE | 4 | 8 | 2 | 14 | H |
| *Cercosaura vertebralis* | NE | 3 | 7 | 3 | 13 | M |
| *Echinosaura palmeri* | NE | 3 | 7 | 2 | 12 | M |
| *Echinosaura panamensis** | LC | 5 | 7 | 2 | 14 | H |
| *Gymnophthalmus speciosus* | NE | 3 | 3 | 3 | 9 | L |
| *Leposoma rugiceps* | LC | 4 | 8 | 3 | 15 | H |
| *Leposoma southi* | NE | 4 | 7 | 3 | 14 | H |
| *Potamites apodemus** | LC | 5 | 7 | 3 | 15 | H |
| *Ptychoglossus festae* | NE | 4 | 7 | 3 | 14 | H |
| *Ptychoglossus myersi** | LC | 5 | 8 | 3 | 16 | H |
| *Ptychoglossus plicatus* | NE | 2 | 6 | 3 | 11 | M |
| **Family Helodermatidae (2 species)** | | | | | | |
| *Heloderma alvarezi* | NE | 3 | 6 | 5 | 14 | H |
| *Heloderma charlesbogerti** | NE | 5 | 8 | 5 | 18 | H |
| **Family Hoplocercidae (2 species)** | | | | | | |
| *Enyalioides heterolepis* | NE | 3 | 7 | 3 | 13 | M |
| *Morunasaurus groi* | NE | 4 | 8 | 3 | 15 | H |
| **Family Iguanidae (11 species)** | | | | | | |
| *Ctenosaura acanthura* | NE | 3 | 4 | 6 | 13 | M |
| *Ctenosaura alfredschmidti* | NT | 4 | 8 | 3 | 15 | H |
| *Ctenosaura bakeri** | CR | 5 | 8 | 6 | 19 | H |
| *Ctenosaura flavidorsalis** | EN | 5 | 7 | 6 | 18 | H |
| *Ctenosaura melanosterna** | EN | 5 | 7 | 6 | 18 | H |
| *Ctenosaura oedirhina** | EN | 5 | 8 | 6 | 19 | H |
| *Ctenosaura palearis** | EN | 5 | 8 | 6 | 19 | H |
| *Ctenosaura praeocularis** | DD | 5 | 7 | 6 | 18 | H |
| *Ctenosaura quinquecarinata** | NE | 5 | 8 | 6 | 19 | H |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Ctenosaura similis* | LC | 1 | 4 | 6 | 11 | M |
| *Iguana iguana* | NE | 1 | 3 | 6 | 10 | M |
| **Family Mabuyidae (5 species)** | | | | | | |
| *Marisora alliacea** | LC | 5 | 7 | 3 | 15 | H |
| *Marisora brachypoda* | LC | 1 | 2 | 3 | 6 | L |
| *Marisora magnacornae** | DD | 6 | 8 | 3 | 17 | H |
| *Marisora roatanae** | CR | 5 | 8 | 3 | 16 | H |
| *Marisora unimarginata** | LC | 5 | 7 | 3 | 15 | H |
| **Family Phrynosomatidae (17 species)** | | | | | | |
| *Phrynosoma asio* | LC | 3 | 6 | 3 | 12 | M |
| *Sceloporus acanthinus* | LC | 4 | 7 | 3 | 14 | H |
| *Sceloporus carinatus* | LC | 4 | 5 | 3 | 12 | M |
| *Sceloporus chrysostictus* | LC | 4 | 6 | 3 | 13 | M |
| *Sceloporus internasalis* | LC | 4 | 4 | 3 | 11 | M |
| *Sceloporus lunaei** | LC | 5 | 7 | 3 | 15 | H |
| *Sceloporus lundelli* | LC | 4 | 7 | 3 | 14 | H |
| *Sceloporus malachiticus** | LC | 5 | 2 | 3 | 10 | M |
| *Sceloporus melanorhinus* | LC | 3 | 4 | 3 | 10 | M |
| *Sceloporus prezygus* | LC | 4 | 8 | 3 | 15 | H |
| *Sceloporus serrifer* | LC | 3 | 1 | 3 | 7 | L |
| *Sceloporus siniferus* | LC | 3 | 6 | 3 | 12 | M |
| *Sceloporus smaragdinus* | LC | 4 | 5 | 3 | 12 | M |
| *Sceloporus squamosus* | LC | 2 | 5 | 3 | 10 | M |
| *Sceloporus taeniocnemis* | LC | 4 | 5 | 3 | 12 | M |
| *Sceloporus teapensis* | LC | 4 | 6 | 3 | 13 | M |
| *Sceloporus variabilis* | LC | 1 | 1 | 3 | 5 | L |
| **Family Phyllodactylidae (5 species)** | | | | | | |
| *Phyllodactylus insularis** | VU | 6 | 8 | 3 | 17 | H |
| *Phyllodactylus palmeus** | NE | 5 | 8 | 3 | 16 | H |
| *Phyllodactylus paralepis** | NE | 6 | 8 | 3 | 17 | H |
| *Phyllodactylus tuberculosus* | LC | 1 | 4 | 3 | 8 | L |
| *Thecadactylus rapicauda* | NE | 1 | 4 | 3 | 8 | L |
| **Family Polychrotidae (1 species)** | | | | | | |
| *Polychrus gutturosus* | NE | 1 | 8 | 3 | 12 | M |
| **Family Scincidae (3 species)** | | | | | | |
| *Mesoscincus managuae* | LC | 5 | 6 | 3 | 14 | H |
| *Mesoscincus schwartzei* | LC | 4 | 6 | 3 | 13 | M |
| *Plestiodon sumichrasti* | LC | 4 | 5 | 3 | 12 | M |
| **Family Sphaerodactylidae (19 species)** | | | | | | |
| *Aristelliger georgeensis* | NE | 3 | 7 | 3 | 13 | M |
| *Aristelliger praesignis* | NE | 3 | 8 | 3 | 14 | H |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Gonatodes albogularis* | NE | 1 | 5 | 3 | 9 | L |
| *Lepidoblepharis sanctaemartae* | LC | 4 | 7 | 3 | 14 | H |
| *Lepidoblepharis xanthostigma* | LC | 4 | 6 | 3 | 13 | M |
| *Sphaerodactylus alphus** | NE | 6 | 8 | 3 | 17 | H |
| *Sphaerodactylus continentalis* | NE | 2 | 3 | 3 | 8 | L |
| *Sphaerodactylus dunni** | LC | 5 | 7 | 3 | 15 | H |
| *Sphaerodactylus glaucus* | LC | 4 | 5 | 3 | 12 | M |
| *Sphaerodactylus graptolaemus** | LC | 5 | 8 | 3 | 16 | H |
| *Sphaerodactylus guanaje** | NE | 6 | 8 | 3 | 17 | H |
| *Sphaerodactylus homolepis** | LC | 5 | 8 | 3 | 16 | H |
| *Sphaerodactylus leonardovaldesi** | NE | 5 | 8 | 3 | 16 | H |
| *Sphaerodactylus lineolatus* | NE | 4 | 7 | 3 | 14 | H |
| *Sphaerodactylus millepunctatus** | LC | 5 | 7 | 3 | 15 | H |
| *Sphaerodactylus notatus* | LC | 3 | 8 | 3 | 14 | H |
| *Sphaerodactylus pacificus** | LC | 6 | 8 | 3 | 17 | H |
| *Sphaerodactylus poindexteri** | NE | 6 | 8 | 3 | 17 | H |
| *Sphaerodactylus rosaurae** | LC | 5 | 8 | 3 | 16 | H |
| **Family Sphenomorphidae (4 species)** | | | | | | |
| *Scincella assatus* | LC | 3 | 2 | 3 | 8 | L |
| *Scincella cherriei* | LC | 2 | 2 | 3 | 7 | L |
| *Scincella incerta* | NE | 5 | 7 | 3 | 15 | H |
| *Scincella rara** | DD | 6 | 8 | 3 | 17 | H |
| **Family Teiidae (12 species)** | | | | | | |
| *Ameiva praesignis* | NE | 3 | 8 | 3 | 14 | H |
| *Aspidoscelis angusticeps* | LC | 4 | 6 | 3 | 13 | M |
| *Aspidoscelis deppii* | LC | 1 | 4 | 3 | 8 | L |
| *Aspidoscelis maslini* | LC | 4 | 8 | 3 | 15 | H |
| *Aspidoscelis motaguae* | LC | 4 | 5 | 3 | 12 | M |
| *Cnemidophorus duellmani** | NE | 5 | 8 | 3 | 16 | H |
| *Cnemidophorus ruatanus** | NE | 5 | 7 | 3 | 15 | H |
| *Holcosus chaitzami* | DD | 4 | 7 | 3 | 14 | H |
| *Holcosus festivus* | NE | 2 | 5 | 3 | 10 | M |
| *Holcosus leptophrys** | NE | 5 | 8 | 3 | 16 | H |
| *Holcosus quadrilineatus** | LC | 5 | 8 | 3 | 16 | H |
| *Holcosus undulatus* | LC | 1 | 2 | 3 | 6 | L |
| **Family Xantusiidae (4 species)** | | | | | | |
| *Lepidophyma flavimaculatum* | LC | 2 | 5 | 2 | 9 | L |
| *Lepidophyma mayae* | NT | 4 | 7 | 2 | 13 | M |
| *Lepidophyma reticulatum** | LC | 5 | 6 | 2 | 13 | M |
| *Lepidophyma smithii* | LC | 3 | 4 | 2 | 9 | L |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| **Family Xenosauridae (1 species)** | | | | | | |
| *Xenosaurus grandis* | VU | 3 | 1 | 3 | 7 | L |
| **Family Anomalepididae (3 species)** | | | | | | |
| *Anomalepis mexicanus* | DD | 2 | 8 | 1 | 11 | M |
| *Helminthophis frontalis** | DD | 5 | 6 | 1 | 12 | M |
| *Liotyphlops albirostris* | NE | 3 | 5 | 1 | 9 | L |
| **Family Boidae (4 species)** | | | | | | |
| *Boa imperator* | NE | 1 | 1 | 6 | 8 | L |
| *Corallus annulatus* | NE | 1 | 8 | 2 | 11 | M |
| *Corallus ruschenbergerii* | NE | 3 | 8 | 2 | 13 | M |
| *Epicrates maurus* | NE | 1 | 5 | 2 | 8 | L |
| **Family Charinidae (2 species)** | | | | | | |
| *Ungaliophis continentalis* | NE | 2 | 5 | 2 | 9 | L |
| *Ungaliophis panamensis* | NE | 4 | 6 | 2 | 12 | M |
| **Family Colubridae (74 species)** | | | | | | |
| *Chironius exoletus* | NE | 3 | 5 | 4 | 12 | M |
| *Chironius flavopictus* | DD | 4 | 7 | 4 | 15 | H |
| *Chironius grandisquamis* | NE | 1 | 6 | 4 | 11 | M |
| *Coluber constrictor* | LC | 3 | 6 | 3 | 12 | M |
| *Dendrophidion apharocybe* | NE | 5 | 7 | 4 | 16 | H |
| *Dendrophidion crybelum** | NE | 5 | 8 | 4 | 17 | H |
| *Dendrophidion clarkii* | NE | 4 | 6 | 4 | 14 | H |
| *Dendrophidion paucicarinatum** | LC | 5 | 7 | 4 | 16 | H |
| *Dendrophidion percarinatum* | NE | 1 | 6 | 4 | 11 | M |
| *Dendrophidion rufiterminorum** | NE | 5 | 7 | 4 | 16 | H |
| *Dendrophidion vinitor* | LC | 3 | 7 | 3 | 13 | M |
| *Drymarchon melanurus* | LC | 1 | 1 | 4 | 6 | L |
| *Drymobius chloroticus* | LC | 1 | 3 | 4 | 8 | L |
| *Drymobius margaritiferus* | NE | 1 | 1 | 4 | 6 | L |
| *Drymobius melanotropis** | LC | 5 | 7 | 4 | 16 | H |
| *Drymobius rhombifer* | LC | 3 | 7 | 4 | 14 | H |
| *Ficimia publia* | LC | 4 | 3 | 2 | 9 | L |
| *Lampropeltis abnorma* | NE | 1 | 3 | 5 | 9 | L |
| *Lampropeltis micropholis* | NE | 4 | 1 | 5 | 10 | M |
| *Leptodrymus pulcherrimus** | LC | 5 | 4 | 4 | 13 | M |
| *Leptophis ahaetulla* | NE | 3 | 3 | 4 | 10 | M |
| *Leptophis depressirostris* | NE | 3 | 7 | 4 | 14 | H |
| *Leptophis mexicanus* | LC | 1 | 1 | 4 | 6 | L |
| *Leptophis modestus* | VU | 3 | 7 | 4 | 14 | H |
| *Leptophis nebulosus** | LC | 5 | 5 | 4 | 14 | H |
| *Leptophis riveti* | NE | 3 | 7 | 4 | 14 | H |
| *Masticophis mentovarius* | NE | 1 | 1 | 4 | 6 | L |
| *Mastigodryas alternatus** | LC | 5 | 3 | 4 | 12 | M |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Mastigodryas dorsalis** | LC | 5 | 5 | 4 | 14 | H |
| *Mastigodryas melanolomus* | LC | 3 | 4 | 4 | 11 | M |
| *Mastigodryas pleei* | NE | 3 | 7 | 4 | 14 | H |
| *Oxybelis aeneus* | NE | 1 | 1 | 3 | 5 | L |
| *Oxybelis brevirostris* | NE | 1 | 7 | 4 | 12 | M |
| *Oxybelis fulgidus* | NE | 1 | 2 | 4 | 7 | L |
| *Oxybelis wilsoni** | EN | 5 | 8 | 4 | 17 | H |
| *Phrynonax poecilonotus* | LC | 1 | 3 | 3 | 7 | L |
| *Pituophis lineaticollis* | LC | 4 | 2 | 4 | 10 | M |
| *Pseudelaphe flavirufa* | LC | 4 | 4 | 4 | 12 | M |
| *Rhinobothryum bovallii* | LC | 3 | 8 | 5 | 16 | H |
| *Scolecophis atrocinctus** | LC | 5 | 3 | 5 | 13 | M |
| *Senticolis triaspis* | LC | 3 | 1 | 3 | 7 | L |
| *Spilotes pullatus* | NE | 1 | 1 | 4 | 6 | L |
| *Stenorrhina degenhardtii* | NE | 3 | 3 | 3 | 9 | L |
| *Stenorrhina freminvillii* | LC | 1 | 2 | 4 | 7 | L |
| *Symphimus mayae* | LC | 4 | 7 | 3 | 14 | H |
| *Tantilla albiceps** | DD | 6 | 8 | 2 | 16 | H |
| *Tantilla alticola* | NE | 4 | 5 | 2 | 11 | M |
| *Tantilla armillata** | LC | 5 | 4 | 2 | 11 | M |
| *Tantilla bairdi** | DD | 6 | 8 | 2 | 16 | H |
| *Tantilla brevicauda** | LC | 5 | 6 | 2 | 13 | M |
| *Tantilla cuniculator* | LC | 4 | 7 | 2 | 13 | M |
| *Tantilla hendersoni** | DD | 6 | 8 | 2 | 16 | H |
| *Tantilla impensa* | LC | 2 | 5 | 2 | 9 | L |
| *Tantilla jani** | VU | 4 | 8 | 2 | 14 | H |
| *Tantilla lempira** | EN | 5 | 7 | 2 | 14 | H |
| *Tantilla melanocephala* | NE | 3 | 7 | 2 | 12 | M |
| *Tantilla moesta* | LC | 4 | 7 | 2 | 13 | M |
| *Tantilla olympia** | NE | 6 | 8 | 2 | 16 | H |
| *Tantilla psittaca** | VU | 5 | 8 | 2 | 15 | H |
| *Tantilla reticulata* | NE | 4 | 7 | 2 | 13 | M |
| *Tantilla rubra* | LC | 3 | 1 | 2 | 6 | L |
| *Tantilla ruficeps** | LC | 5 | 5 | 2 | 12 | M |
| *Tantilla schistosa* | LC | 2 | 3 | 2 | 7 | L |
| *Tantilla supracincta* | NE | 4 | 7 | 5 | 16 | H |
| *Tantilla taeniata** | LC | 5 | 5 | 2 | 12 | M |
| *Tantilla tecta** | DD | 6 | 8 | 2 | 16 | H |
| *Tantilla tritaeniata** | CR | 6 | 8 | 2 | 16 | H |
| *Tantilla vermiformis** | LC | 5 | 7 | 2 | 14 | H |
| *Tantilla vulcani** | LC | 5 | 6 | 2 | 13 | M |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Tantillita brevissima* | LC | 4 | 3 | 2 | 9 | L |
| *Tantillita canula* | LC | 4 | 6 | 2 | 12 | M |
| *Tantillita lintoni* | LC | 4 | 6 | 2 | 12 | M |
| *Trimorphodon biscutatus* | NE | 3 | 1 | 4 | 8 | L |
| *Trimorphodon quadruplex** | LC | 5 | 5 | 4 | 14 | H |
| **Family Dipsadidae (144 species)** | | | | | | |
| *Adelphicos daryi** | EN | 6 | 8 | 2 | 16 | H |
| *Adelphicos ibarrorum** | EN | 5 | 8 | 2 | 15 | H |
| *Adelphicos quadrivirgatum* | LC | 4 | 4 | 2 | 10 | M |
| *Adelphicos sargii* | LC | 4 | 6 | 2 | 12 | M |
| *Adelphicos veraepacis** | VU | 5 | 7 | 2 | 14 | H |
| *Amastridium sapperi* | LC | 4 | 4 | 2 | 10 | M |
| *Amastridium veliferum* | LC | 4 | 7 | 2 | 13 | M |
| *Atractus clarki* | NE | 4 | 8 | 2 | 14 | H |
| *Atractus darienensis** | DD | 6 | 8 | 2 | 16 | H |
| *Atractus depressiocellus** | DD | 6 | 7 | 2 | 15 | H |
| *Atractus hostilitractus** | DD | 6 | 8 | 2 | 16 | H |
| *Atractus imperfectus** | DD | 6 | 8 | 2 | 16 | H |
| *Chapinophis xanthocheilus** | EN | 5 | 8 | 3 | 16 | H |
| *Clelia clelia* | NE | 1 | 5 | 4 | 10 | M |
| *Clelia equatoriana* | NE | 4 | 6 | 4 | 14 | H |
| *Clelia scytalina* | LC | 3 | 5 | 4 | 12 | M |
| *Coniophanes bipunctatus* | LC | 2 | 5 | 3 | 10 | M |
| *Coniophanes fissidens* | NE | 1 | 3 | 3 | 7 | L |
| *Coniophanes imperialis* | LC | 3 | 3 | 3 | 9 | L |
| *Coniophanes joanae** | DD | 5 | 7 | 3 | 15 | H |
| *Coniophanes piceivittis* | LC | 1 | 3 | 3 | 7 | L |
| *Coniophanes quinquevittatus* | LC | 4 | 6 | 3 | 13 | M |
| *Coniophanes schmidti* | LC | 4 | 6 | 3 | 13 | M |
| *Conophis lineatus* | LC | 4 | 3 | 4 | 11 | M |
| *Conophis vittatus* | LC | 3 | 5 | 4 | 12 | M |
| *Crisantophis nevermanni** | LC | 5 | 7 | 4 | 16 | H |
| *Cubophis brooksi* | NE | 3 | 8 | 3 | 14 | H |
| *Diaphorolepis wagneri* | NE | 3 | 8 | 3 | 14 | H |
| *Dipsas articulata** | LC | 5 | 8 | 2 | 15 | H |
| *Dipsas bicolor** | LC | 5 | 7 | 5 | 17 | H |
| *Dipsas brevifacies* | LC | 4 | 7 | 4 | 15 | H |
| *Dipsas nicholsi** | LC | 5 | 8 | 2 | 15 | H |
| *Dipsas temporalis* | NE | 3 | 8 | 2 | 13 | M |
| *Dipsas tenuissima** | NT | 5 | 7 | 2 | 14 | H |
| *Dipsas viguieri** | LC | 4 | 7 | 2 | 13 | M |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Enuliophis sclateri* | NE | 4 | 7 | 2 | 13 | M |
| *Enulius bifoveatus** | CR | 6 | 8 | 2 | 16 | H |
| *Enulius flavitorques* | NE | 1 | 1 | 2 | 4 | L |
| *Enulius roatanensis** | EN | 6 | 8 | 2 | 16 | H |
| *Erythrolamprus bizona* | LC | 3 | 4 | 5 | 12 | M |
| *Erythrolamprus mimus* | LC | 4 | 6 | 5 | 15 | H |
| *Geophis bellus** | DD | 6 | 8 | 2 | 16 | H |
| *Geophis brachycephalus** | LC | 5 | 4 | 2 | 11 | M |
| *Geophis cancellatus* | LC | 4 | 6 | 2 | 12 | M |
| *Geophis carinosus* | LC | 3 | 4 | 2 | 9 | L |
| *Geophis championi** | DD | 6 | 8 | 2 | 16 | H |
| *Geophis damiani** | CR | 6 | 8 | 2 | 16 | H |
| *Geophis downsi** | DD | 6 | 8 | 2 | 16 | H |
| *Geophis dunni** | DD | 6 | 8 | 2 | 16 | H |
| *Geophis fulvoguttatus** | EN | 5 | 7 | 2 | 14 | H |
| *Geophis godmani** | LC | 5 | 7 | 2 | 14 | H |
| *Geophis hoffmanni** | NE | 5 | 5 | 2 | 12 | M |
| *Geophis immaculatus* | LC | 4 | 8 | 2 | 14 | H |
| *Geophis nasalis* | LC | 4 | 3 | 2 | 9 | L |
| *Geophis nephodrymus** | VU | 6 | 8 | 2 | 16 | H |
| *Geophis rhodogaster* | LC | 2 | 7 | 2 | 11 | M |
| *Geophis ruthveni** | LC | 5 | 7 | 2 | 14 | H |
| *Geophis talamancae** | EN | 5 | 8 | 2 | 15 | H |
| *Geophis tectus** | LC | 5 | 6 | 2 | 13 | M |
| *Geophis zeledoni** | LC | 5 | 8 | 2 | 15 | H |
| *Hydromorphus concolor** | LC | 5 | 5 | 2 | 12 | M |
| *Hydromorphus dunni** | DD | 6 | 8 | 2 | 16 | H |
| *Imantodes cenchoa* | NE | 1 | 3 | 2 | 6 | L |
| *Imantodes gemmistratus* | NE | 1 | 3 | 2 | 6 | L |
| *Imantodes inornatus* | LC | 4 | 6 | 2 | 12 | M |
| *Imantodes phantasma** | DD | 6 | 8 | 2 | 16 | H |
| *Imantodes tenuissimus* | LC | 4 | 7 | 2 | 13 | M |
| *Leptodeira frenata* | LC | 4 | 4 | 4 | 12 | M |
| *Leptodeira maculata* | LC | 3 | 1 | 4 | 8 | L |
| *Leptodeira nigrofasciata* | LC | 1 | 3 | 4 | 8 | L |
| *Leptodeira rhombifera** | LC | 5 | 3 | 4 | 12 | M |
| *Leptodeira rubricata** | LC | 5 | 8 | 4 | 17 | H |
| *Leptodeira septentrionalis* | NE | 1 | 2 | 4 | 7 | L |
| *Liophis epinephelus* | NE | 1 | 4 | 5 | 10 | M |
| *Liophis lineatus* | NE | 3 | 8 | 4 | 15 | H |
| *Ninia atrata* | NE | 3 | 8 | 2 | 13 | M |
| *Ninia celata** | NT | 5 | 8 | 2 | 15 | H |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Ninia diademata* | LC | 1 | 3 | 2 | 6 | L |
| *Ninia espinali** | NT | 5 | 7 | 2 | 14 | H |
| *Ninia maculata** | LC | 5 | 5 | 2 | 12 | M |
| *Ninia pavimentata** | LC | 5 | 8 | 2 | 15 | H |
| *Ninia psephota** | LC | 5 | 6 | 2 | 13 | M |
| *Ninia sebae* | LC | 1 | 1 | 2 | 4 | L |
| *Nothopsis rugosus* | LC | 1 | 7 | 2 | 10 | L |
| *Omoadiphas aurula** | VU | 6 | 8 | 2 | 16 | H |
| *Omoadiphas cannula* | CR | 6 | 8 | 2 | 16 | H |
| *Omoadiphas texiguatensis** | CR | 6 | 8 | 2 | 16 | H |
| *Oxyrhopus petolarius* | NE | 1 | 6 | 5 | 12 | M |
| *Phimophis guianensis* | NE | 3 | 8 | 2 | 13 | M |
| *Pliocercus elapoides* | LC | 4 | 1 | 5 | 10 | M |
| *Pliocercus euryzonus* | LC | 1 | 6 | 5 | 12 | M |
| *Pseudoboa neuwiedii* | NE | 3 | 6 | 5 | 14 | H |
| *Rhadinaea calligaster** | LC | 5 | 7 | 2 | 14 | H |
| *Rhadinaea decorata* | NE | 1 | 6 | 2 | 9 | L |
| *Rhadinaea pulveriventris** | NE | 5 | 7 | 2 | 14 | H |
| *Rhadinaea sargenti** | LC | 5 | 7 | 2 | 14 | H |
| *Rhadinaea stadelmani** | EN | 5 | 6 | 2 | 13 | M |
| *Rhadinaea vermiculaticeps** | NT | 5 | 8 | 2 | 15 | H |
| *Rhadinella anachoreta** | LC | 5 | 7 | 2 | 14 | H |
| *Rhadinella godmani* | LC | 2 | 5 | 2 | 9 | L |
| *Rhadinella hannsteini* | DD | 4 | 5 | 2 | 11 | M |
| *Rhadinella hempsteadae** | EN | 5 | 6 | 2 | 13 | M |
| *Rhadinella kinkelini** | LC | 5 | 6 | 2 | 13 | M |
| *Rhadinella lachrymans* | LC | 4 | 2 | 2 | 8 | L |
| *Rhadinella montecristi** | VU | 5 | 7 | 2 | 14 | H |
| *Rhadinella pegosalyta** | VU | 6 | 8 | 2 | 16 | H |
| *Rhadinella pilonaorum** | NE | 5 | 8 | 2 | 15 | H |
| *Rhadinella posadasi* | EN | 4 | 8 | 2 | 14 | H |
| *Rhadinella rogerromani** | NT | 6 | 8 | 2 | 16 | H |
| *Rhadinella serperaster** | LC | 5 | 6 | 2 | 13 | M |
| *Rhadinella tolpanorum** | CR | 6 | 8 | 2 | 16 | H |
| *Sibon annulatus** | LC | 5 | 7 | 2 | 14 | H |
| *Sibon anthracops** | LC | 5 | 5 | 5 | 15 | H |
| *Sibon argus** | LC | 5 | 7 | 4 | 16 | H |
| *Sibon carri** | NE | 5 | 7 | 2 | 14 | H |
| *Sibon dimidiatus* | LC | 1 | 5 | 4 | 10 | M |
| *Sibon lamari** | EN | 6 | 8 | 2 | 16 | H |
| *Sibon longifrenis** | LC | 5 | 7 | 2 | 14 | H |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Sibon manzanaresi** | NT | 5 | 8 | 2 | 15 | H |
| *Sibon merendonensis** | CR | 6 | 8 | 2 | 16 | H |
| *Sibon miskitus** | NT | 5 | 8 | 2 | 15 | H |
| *Sibon nebulatus* | NE | 1 | 2 | 2 | 5 | L |
| *Sibon noalamina** | NE | 5 | 8 | 2 | 15 | H |
| *Sibon perissostichon** | DD | 6 | 8 | 2 | 16 | H |
| *Sibon sanniolus* | LC | 4 | 6 | 2 | 12 | M |
| *Siphlophis cervinus* | NE | 3 | 8 | 5 | 16 | H |
| *Siphlophis compressus* | LC | 3 | 8 | 5 | 16 | H |
| *Tretanorhinus mocquardi** | NE | 5 | 8 | 2 | 15 | H |
| *Tretanorhinus nigroluteus* | NE | 2 | 5 | 2 | 9 | L |
| *Trimetopon barbouri** | DD | 5 | 8 | 2 | 15 | H |
| *Trimetopon gracile** | LC | 5 | 7 | 2 | 14 | H |
| *Trimetopon pliolepis** | LC | 5 | 5 | 2 | 12 | M |
| *Trimetopon simile** | EN | 5 | 6 | 2 | 13 | M |
| *Trimetopon slevini** | NT | 5 | 7 | 2 | 14 | H |
| *Trimetopon viquezi** | CR | 5 | 8 | 2 | 15 | H |
| *Tropidodipsas fasciata* | NE | 4 | 4 | 4 | 12 | M |
| *Tropidodipsas fischeri* | LC | 4 | 3 | 2 | 9 | L |
| *Tropidodipsas sartorii* | LC | 3 | 2 | 5 | 10 | M |
| *Urotheca decipiens* | NE | 2 | 6 | 2 | 10 | M |
| *Urotheca fulviceps* | NE | 3 | 8 | 2 | 13 | M |
| *Urotheca guentheri** | LC | 5 | 5 | 2 | 12 | M |
| *Urotheca myersi** | DD | 5 | 8 | 2 | 15 | H |
| *Urotheca pachyura** | LC | 5 | 7 | 2 | 14 | H |
| *Xenodon rabdocephalus* | NE | 1 | 5 | 5 | 11 | M |
| **Family Elapidae (18 species)** | | | | | | |
| *Hydrophis platurus* | LC | — | — | — | — | — |
| *Micrurus alleni** | LC | 5 | 6 | 5 | 16 | H |
| *Micrurus ancoralis* | NE | 3 | 7 | 5 | 15 | H |
| *Micrurus browni* | LC | 3 | 1 | 5 | 9 | L |
| *Micrurus clarki** | NE | 5 | 7 | 5 | 17 | H |
| *Micrurus diastema* | LC | 3 | 1 | 5 | 9 | L |
| *Micrurus dissoleucus* | LC | 3 | 7 | 5 | 15 | H |
| *Micrurus dumerilii* | NE | 3 | 8 | 5 | 16 | H |
| *Micrurus elegans* | LC | 4 | 4 | 5 | 13 | M |
| *Micrurus hippocrepis** | LC | 5 | 8 | 5 | 18 | H |
| *Micrurus latifasciatus* | LC | 4 | 4 | 5 | 13 | M |
| *Micrurus mipartitus* | NE | 3 | 7 | 5 | 15 | H |
| *Micrurus mosquitensis** | LC | 5 | 7 | 5 | 17 | H |
| *Micrurus multifasciatus** | LC | 5 | 5 | 5 | 15 | H |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Micrurus nigrocinctus* | NE | 2 | 3 | 5 | 10 | M |
| *Micrurus ruatanus** | CR | 5 | 8 | 5 | 18 | H |
| *Micrurus stewarti** | LC | 5 | 7 | 5 | 17 | H |
| *Micrurus stuarti** | LC | 5 | 7 | 5 | 17 | H |
| **Family Leptotyphlopidae (5 species)** | | | | | | |
| *Epictia ater** | LC | 5 | 4 | 1 | 10 | M |
| *Epictia goudotii* | NE | 3 | 1 | 1 | 5 | L |
| *Epictia magnamaculata* | NE | 4 | 7 | 1 | 12 | M |
| *Epictia phenops* | NE | 3 | 1 | 1 | 5 | L |
| *Trilepida macrolepis* | NE | 3 | 8 | 1 | 12 | M |
| **Family Loxocemidae (1 species)** | | | | | | |
| *Loxocemus bicolor* | LC | 1 | 5 | 4 | 10 | M |
| **Family Natricidae (5 species)** | | | | | | |
| *Storeria dekayi* | LC | 3 | 4 | 2 | 9 | L |
| *Thamnophis cyrtopsis* | LC | 3 | 1 | 4 | 8 | L |
| *Thamnophis fulvus* | LC | 4 | 5 | 4 | 13 | M |
| *Thamnophis marcianus* | LC | 1 | 5 | 4 | 10 | M |
| *Thamnophis proximus* | LC | 3 | 2 | 4 | 9 | L |
| **Family Sibynophiidae (2 species)** | | | | | | |
| *Scaphiodontophis annulatus* | LC | 1 | 5 | 5 | 11 | M |
| *Scaphiodontophis venustissimus* | NE | 1 | 7 | 5 | 13 | M |
| **Family Tropidophiidae (1 species)** | | | | | | |
| *Trachyboa boulengeri* | NE | 3 | 5 | 3 | 11 | M |
| **Family Typhlopidae (5 species)** | | | | | | |
| *Amerotyphlops costaricensis** | LC | 5 | 5 | 1 | 11 | M |
| *Amerotyphlops microstomus* | LC | 4 | 7 | 1 | 12 | M |
| *Amerotyphlops stadelmani** | NE | 5 | 6 | 1 | 12 | M |
| *Amerotyphlops tenuis* | LC | 4 | 6 | 1 | 11 | M |
| *Amerotyphlops tycherus** | VU | 5 | 8 | 1 | 14 | H |
| **Family Viperidae (32 species)** | | | | | | |
| *Agkistrodon bilineatus* | NT | 3 | 5 | 5 | 13 | M |
| *Agkistrodon howardgloydi** | NE | 5 | 7 | 5 | 17 | H |
| *Agkistrodon russeolus* | NE | 4 | 6 | 5 | 15 | H |
| *Atropoides indomitus** | EN | 5 | 8 | 5 | 18 | H |
| *Atropoides mexicanus* | LC | 2 | 4 | 5 | 11 | M |
| *Atropoides occiduus* | LC | 4 | 6 | 5 | 15 | H |
| *Atropoides olmec* | LC | 4 | 6 | 5 | 15 | H |
| *Atropoides picadoi** | LC | 5 | 6 | 5 | 16 | H |
| *Bothriechis aurifer* | VU | 4 | 6 | 5 | 15 | H |
| *Bothriechis bicolor* | LC | 4 | 5 | 5 | 14 | H |
| *Bothriechis guifarroi* | NE | 6 | 8 | 5 | 19 | H |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| **Species** | **IUCN Ratings** | **Environmental Vulnerability Scores** | | | | **EVS Category** |
|---|---|---|---|---|---|---|
| | | **Geographic Distribution** | **Ecological Distribution** | **Degree of Human Persecution** | **Total Score** | |
| *Bothriechis lateralis** | LC | 5 | 6 | 5 | 16 | H |
| *Bothriechis marchi** | EN | 5 | 6 | 5 | 16 | H |
| *Bothriechis nigroviridis** | NE | 5 | 7 | 5 | 17 | H |
| *Bothriechis schlegelii* | NE | 2 | 4 | 5 | 11 | M |
| *Bothriechis supraciliaris** | NE | 5 | 7 | 5 | 17 | H |
| *Bothriechis thalassinus** | NE | 5 | 7 | 5 | 17 | H |
| *Bothrops asper* | NE | 1 | 4 | 5 | 10 | M |
| *Bothrops punctatus* | NE | 3 | 8 | 5 | 16 | H |
| *Cerrophidion godmani* | LC | 4 | 3 | 5 | 12 | M |
| *Cerrophidion sasai** | NE | 5 | 6 | 5 | 16 | H |
| *Cerrophidion wilsoni** | NE | 5 | 5 | 5 | 15 | H |
| *Crotalus simus* | LC | 2 | 2 | 5 | 9 | L |
| *Crotalus tzabcan* | LC | 4 | 7 | 5 | 16 | H |
| *Lachesis acrochorda* | NE | 3 | 6 | 5 | 14 | H |
| *Lachesis melanocephala** | NE | 5 | 7 | 5 | 17 | H |
| *Lachesis stenophrys** | NE | 5 | 7 | 5 | 17 | H |
| *Porthidium lansbergii* | NE | 3 | 7 | 5 | 15 | H |
| *Porthidium nasutum* | LC | 1 | 6 | 5 | 12 | M |
| *Porthidium ophryomegas** | LC | 5 | 4 | 5 | 14 | H |
| *Porthidium porrasi** | LC | 5 | 8 | 5 | 18 | H |
| *Porthidium volcanicum** | DD | 5 | 8 | 5 | 18 | H |
| **Order Testudines (24 species)** | | | | | | |
| **Family Cheloniidae (5 species)** | | | | | | |
| *Caretta caretta* | EN | — | — | — | — | — |
| *Chelonia mydas* | EN | — | — | — | — | — |
| *Eretmochelys imbricata* | CR | — | — | — | — | — |
| *Lepidochelys kempii* | CR | — | — | — | — | — |
| *Lepidochelys olivacea* | VU | — | — | — | — | — |
| **Family Chelydridae (2 species)** | | | | | | |
| *Chelydra acutirostris* | NE | 1 | 4 | 6 | 11 | M |
| *Chelydra rossignonii* | VU | 4 | 7 | 6 | 17 | H |
| **Family Dermatemydidae (1 species)** | | | | | | |
| *Dermatemys mawii* | CR | 4 | 7 | 6 | 17 | H |
| **Family Dermochelyidae (1 species)** | | | | | | |
| *Dermochelys coriacea* | CR | — | — | — | — | — |
| **Family Emydidae (2 species)** | | | | | | |
| *Trachemys grayi* | NE | 4 | 8 | 6 | 18 | H |
| *Trachemys ornata* | NE | 1 | 4 | 6 | 11 | M |
| **Family Geoemydidae (5 species)** | | | | | | |
| *Rhinoclemmys annulata* | NT | 2 | 7 | 3 | 12 | M |
| *Rhinoclemmys areolata* | NT | 4 | 6 | 3 | 13 | M |

**Appendix 2 (continued).** Comparison of IUCN Ratings from the Red List website (updated to 16 July 2014) and Environmental Vulnerability Scores for 559 Central American crocodilians, squamates, and turtles. See text for explanation of IUCN and EVS rating systems. EVS category abbreviations: L = low; M = medium; H = high. * = species endemic to Central America.

| Species | IUCN Ratings | Environmental Vulnerability Scores | | | | EVS Category |
|---|---|---|---|---|---|---|
| | | Geographic Distribution | Ecological Distribution | Degree of Human Persecution | Total Score | |
| *Rhinoclemmys funerea** | NT | 5 | 8 | 3 | 16 | H |
| *Rhinoclemmys melanosterna* | NE | 4 | 8 | 3 | 15 | H |
| *Rhinoclemmys pulcherrima* | NE | 1 | 4 | 3 | 8 | L |
| **Family Kinosternidae (4 species)** | | | | | | |
| *Kinosternon acutum* | NT | 4 | 7 | 3 | 14 | H |
| *Kinosternon angustipons** | VU | 5 | 8 | 3 | 16 | H |
| *Kinosternon leucostomum* | NE | 1 | 4 | 3 | 8 | L |
| *Kinosternon scorpioides* | NE | 1 | 4 | 3 | 8 | L |
| **Family Staurotypidae (3 species)** | | | | | | |
| *Claudius angustatus* | NT | 4 | 7 | 3 | 14 | H |
| *Staurotypus salvinii* | NT | 4 | 6 | 3 | 13 | M |
| *Staurotypus triporcatus* | NT | 4 | 7 | 3 | 14 | H |
| **Family Testudinidae (1 species)** | | | | | | |
| *Chelonoidis carbonarius* | NE | 3 | 8 | 6 | 17 | H |