BEFORE THE SECRETARY OF THE INTERIOR

PETITION TO LIST NINE SPECIES OF CARIBBEAN SKINKS AS ENDANGERED UNDER THE ENDANGERED SPECIES ACT

Puerto Rican Skink (*Spondylurus nitidus*) at Guajataca State Forest in Quebradilllas, Puerto Rico.
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CENTER FOR BIOLOGICAL DIVERSITY

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Submitted this 11th day of February, 2014

Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. § 1533(b); Section 553(e) of the Administrative Procedure Act, 5 U.S.C. § 553(e); and 50 C.F.R. § 424.14(a), the Center for Biological Diversity and Dr. Renata Platenberg hereby petition the Secretary of the Interior, through the United States Fish and Wildlife Service ("USFWS"), to list nine species of Caribbean skinks as endangered species and to designate critical habitat to ensure recovery. All of these skinks are now extremely rare or absent in significant portions of their ranges in Puerto Rico and the U.S. Virgin Islands, with many species entirely absent from islands where they occurred historically. Nonnative predators and habitat loss are the most important factors in the decline of these reptiles.

The Center for Biological Diversity ("Center") is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center is supported by more than 675,000 members and on-line activists throughout the United States. The Center and its members are concerned with the conservation of endangered species, including Caribbean skinks, and the effective implementation of the ESA.

EXECUTIVE SUMMARY

The Caribbean islands are home to a diversity of plants and animals found nowhere else on Earth, with new species still being discovered. On these islands, scientists recently described dozens of new species of skinks, which are lizards with smooth, snake-like skin. Unfortunately, these newly discovered species face severe threats to their survival and could be lost without federal protection.

The following nine petitioned species of Caribbean skinks warrant listing as endangered species under the Endangered Species Act because they are at risk of extinction within the foreseeable future in all or a significant portion of their ranges: Culebra Skink (*Spondylurus culebrae* Hedges and Conn), Mona Skink (*Spondylurus monae* Hedges and Conn), Monito Skink (*Spondylurus Monitoe* Hedges and Conn), Lesser Virgin Islands Skink (*Spondylurus semitaeniatus* Wiegmann), Virgin Islands Bronze Skink (*Spondylurus sloanii* Daudin), Puerto Rican Skink (*Spondylurus nitidus* Garman), Greater Saint Croix Skink (*Spondylurus magnacruzae* Hedges and Conn), Greater Virgin Islands Skink (*Spondylurus spilonotus* Wiegmann) and Lesser Saint Croix Skink (*Capitellum parvicruzae* Hedges and Conn). These skinks are absent or extremely rare across most of their former ranges, and they are considered Critically Endangered or Endangered by the International Union for Conservation of Nature (IUCN) using Red List criteria.

The petitioned species were recently revised by Hedges and Conn (2012), who identified 38 endemic skink species on Caribbean islands, in contrast to the six endemic species previously recognized from those islands. The scientists found that all of the 38 endemic Caribbean skink species are vulnerable to extinction. Many are extinct or possibly extinct because of human activities during the last two centuries, and the surviving species are near extinction and in need of immediate protection (Hedges and Conn 2012). Of the species identified by Hedges and Conn (2012), we petition for nine species that fall within the jurisdiction of the United States. All the petitioned species were previously considered to be the same species: the Slipperyback Skink (*Mabuya mabouya* or *M. sloanii*).

An analysis of threats facing the skinks demonstrates that observed extirpations and declines will continue unless they receive federal protection. The decline or loss of the petitioned skink species can be largely attributed to predation by the Small Indian Mongoose (*Urva auropunctata*). Other introduced predators, including the Black Rat (*Rattus rattus*) and feral cats (*Felis catus*), have also contributed to the decline of the petitioned species, along with habitat degradation and other threats (Hedges and Conn 2012).

Specifically, the skinks meet at least four of the factors for determining whether a species is threatened:

The present or threatened destruction, modification, or curtailment of the skinks' habitat or range

Clearing of forests on the bigger Caribbean islands for timber and agriculture destroyed skink habitat. Extensive habitat loss has also occurred in coastal areas, where most skinks were

seen in past years, but where developmental pressures and urbanization are greatest today. No virgin forest remains on the U.S. Virgin Islands and likely less than 10 percent of virgin forest remains in Puerto Rico. Secondary forests and coastal areas on these islands face intense pressure from development for housing, tourism, and commercial infrastructure. While habitat on many of the smaller islands and cays is protected as part of nature reserves, these island ecosystems are dramatically altered from the effects of introduced species.

Disease or predation

Nonnative predators, including mongoose, black rats, and feral cats, have decimated populations of the petitioned skinks on islands and cays, leaving reduced numbers and few or no sightings in recent years. As just one example, no skinks likely remain on St. John because of predation by the mongoose. The mongoose and other introduced predators have become established across the Caribbean, and few eradication programs have been successful.

Inadequacy of existing regulatory mechanisms

No laws exist that require control of nonnative predators, which are the biggest threat to the petitioned skinks. The habitat of these skinks is also inadequately protected by federal and territorial laws. Enforcement of existing laws is often nonexistent because the territorial agencies lack sufficient funding and resources.

Other natural or anthropogenic factors

The petitioned skinks are threatened by climate change, which could impact the skinks through habitat destruction from sea level rise or extreme weather events. Pollution is a potential threat, especially in habitats near agricultural areas. The risk of extinction due to stochastic events is a significant threat given that many of these petitioned species are extremely rare with isolated island populations.

In combination, these factors demonstrate that the petitioned species of Caribbean skinks warrant listing as endangered species under the ESA. A prompt decision on listing is required to ensure that the species are not beyond recovery before listing takes place.

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I. INTRODUCTION

This petition seeks Endangered Species Act protection for nine species of Caribbean skinks: Culebra Skink (*Spondylurus culebrae*), Mona Skink (*Spondylurus monae*), Monito Skink (*Spondylurus monitae*), Lesser Virgin Islands Skink (*Spondylurus semitaeniatus*), Virgin Islands Bronze Skink (*Spondylurus sloanii*), Puerto Rican Skink (*Spondylurus nitidus*), Greater Saint Croix Skink (*Spondylurus magnacruzae*), Greater Virgin Islands Skink (*Spondylurus spilonotus*) and Lesser Saint Croix Skink (*Capitellum parvicruzae*).

These Caribbean skinks were recently described by Hedges and Conn (2012), who conducted a systematic revision of Neotropical skinks using both conventional and unconventional morphological characters, supplemented by DNA sequence analyses. The nine petitioned species were previously considered to be the same species, the Slipperyback Skink (*Mabuya mabouya* or *M. sloanii*). All nine species may be extant and are found on lands within the jurisdiction of the United States (U.S. Virgin Islands and Puerto Rico). These surviving species are near extinction and in need of immediate protection. The declines of these skinks are largely the result of predation by introduced predators such as mongoose and black rats, as well as habitat degradation and loss (Hedges and Conn 2012).

The Caribbean is a major biodiversity hotspot – a region rich in endemic species that are threatened with extinction (Myers et al. 2000; Ricketts et al. 2005; Smith et al. 2005; Wilson et al. 2006). The combination of large-scale habitat conversion for agriculture and human settlements, and the intentional or unintentional introduction of mammals such as rats, cats, and mongooses, have resulted in a wave of extirpations and extinctions of herpetofauna in the Caribbean over the past 500 years (Case and Bolger 1991; Corke 1992; Henderson 1992; Wilson et al. 2006).

Globally, the frequency of declines and extirpations of herpetofauna has increased dramatically over the last several decades (Gibbons et al. 2000; Stuart et al. 2004). About 20 percent of reptiles in the world are endangered or vulnerable to extinction (Böhm et al. 2013). Within the Caribbean, herpetofauna likely have levels of endangerment that are at or near the highest levels worldwide (Young et al. 2004; Wilson et al. 2006).

To qualify for listing as a threatened or endangered species, a species does not need to be imperiled across all of its range. The ESA requires listing when a species is threatened with extinction across a significant portion of its range. 16 U.S.C. § 1532(6); 16 U.S.C. § 1532(20). As the petition documents below, these skinks are absent or extremely rare across a significant portion of their ranges with many species lacking from islands on which they historically occurred.

II. TAXONOMY OF THE CARIBBEAN SKINKS

All nine species covered in this petition are within the Family Scincidae, Subfamily Mabuyinae. Mabuyinae is restricted to the Western Hemisphere and is distributed from central Mexico (Colima in the west and Veracruz in the east) throughout Middle America and South America (primarily east of the Andes) as far south as central Argentina and Uruguay (Hedges and Conn 2012). Mabuyinae is a monophyletic and well-defined group that includes all members

of what was previously the Genus *Mabuya*, a clade of American skinks (Mausfeld et al. 2002; Miralles and Carranza 2010).

Among other things, mabuyine lizards are known for their cylindrical bodies, four limbs with five digits each, smooth dorsal scales, and a lower eyelid with a semitransparent disc (Hedges and Conn 2012). Many species have ill-defined necks that, together with their sinuous movements, make them look like stubby snakes.

The reproductive system of these lizards is remarkably similar to that of higher mammals: they develop from embryos attached to their mother by means of a primitive placenta, eventually leading to a live birth. This trait is called placentotrophic viviparity, and although it has been mentioned as a diagnostic character for this group (e.g. Mausfeld et al. 2002), it also occurs in some African species (Flemming and Blackburn 2003).

The subfamily includes 61 species placed in 16 genera (Hedges and Conn 2012). Most species on Caribbean islands are allopatric, single-island endemics. Eight of the nine petitioned species fall within the genus *Spondylurus*, and one falls within the genus *Capitellum*.

The genus *Spondylurus* includes what are now known as the Antillean Four-lined Skinks because of the four major dark stripes (lateral and dorsolateral) that can be readily observed (Hedges and Conn 2012). The presence of dark dorsolateral stripes separates *Spondylurus* from several other genera. Other distinguishing features include the absence of a narrow dark middorsal stripe, two frontoparietals (scales near the frontal and parietal bones of the skull), no prefrontal contact (scales between the frontals and frontal nasals on the snout do not touch), usually two rows of nuchals (distinctly enlarged scales on the nape of lizards), and mostly pale palms and soles (Hedges and Conn 2012).

The Genus *Capitellum* includes what are now known as the Antillean Small-headed Skinks because of the relatively small heads of the three included species (Hedges and Conn 2012). This genus differs from others in having a combination of small hands, small feet, short heads, and lack of dark dorsolateral stripes (Hedges and Conn 2012). They also likely have small maximum body sizes (Hedges and Conn 2012).

All nine petitioned species are identified in a comprehensive study by Hedges and Conn (2012). The scientists initiated their study after finding unusually large genetic differences among individuals of what was considered to be the same species, the Slipperyback Skink (*Mabuya mabouya* or *M. sloanii*), on different islands in the Caribbean. In addition, their analysis of museum specimens revealed major diagnostic character differences that had been overlooked by Dunn (1936) and subsequent authors.

The scientists undertook a comprehensive revision of skinks from Caribbean islands that involved molecular phylogenetic analyses and examination of approximately 750 preserved specimens from 24 museums using both conventional and unconventional morphological characters. A brief summary of their molecular and morphological analyses is provided here with details available in Hedges and Conn (2012).

The molecular data set used by Hedges and Conn (2012) comprised 136 individuals and 2,701 total aligned nucleotide sites from the four genes: 12S ribosomal RNA (rRNA), 16S rRNA, cytochrome b (cyt b), and myosin heavy chain. First, they conducted a phylogenetic analysis of all available sequence data (new and previously collected) using the four genes. A second analysis performed was a linearized tree of cyt b sequence divergence using the same topology as in the four-gene analysis. The third analysis was Bayesian divergence time estimation and estimation of a molecular timetree.

To conduct their morphological analysis, Hedges and Conn (2012) borrowed nearly all museum specimens of Caribbean skinks. They also examined representatives of mainland species for comparison with Caribbean species and for diagnosing genera. In all, they examined approximately 750 preserved specimens from 24 museums. They scored a primary suite of 30 morphological characters used in the diagnoses including six of body proportions, 18 of scalation, and six of pattern and coloration. Those characters included some used in past studies of Neotropical skinks (e.g., head length, number of supraocular scales, supranasal contact, etc.) as well as characters not used previously or commonly. Although some new taxa could be diagnosed by conventional characters alone, the unconventional characters proved to be the most useful in diagnoses, especially for closely related species. They identified non-overlapping, diagnostic, morphological characters that distinguish all species.

In total, Hedges and Conn (2012) identified 38 endemic species on the Caribbean islands, in contrast to the six previously recognized species. Of the 38 Caribbean skinks identified, nine species are included in this petition because they are likely not extinct and occur within the jurisdiction of the United States (U.S. Virgin Islands or Puerto Rico): Culebra Skink (*Spondylurus culebrae*), Mona Skink (*Spondylurus monae*), Monito Skink (*Spondylurus monitae*), Lesser Virgin Islands Skink (*Spondylurus semitaeniatus*), Virgin Islands Bronze Skink (*Spondylurus sloanii*), Puerto Rican Skink (*Spondylurus nitidus*), Greater Saint Croix Skink (*Spondylurus magnacruzae*), Greater Virgin Islands Skink (*Spondylurus spilonotus*) and Lesser Saint Croix Skink (*Capitellum parvicruzae*).

III. SPECIES ACCOUNTS WITH DESCRIPTION, ECOLOGY AND HABITAT, RANGE, POPULATION STATUS, AND THREATS

Little is individually known about the nine petitioned species of Caribbean skinks largely because they were just recently identified by Hedges and Conn (2012). Moreover, the herpetofaunal communities on the cays of Puerto Rico and the U.S. Virgin Islands are often completely undocumented (Heatwole et al. 1981). In each species account, Hedges and Conn (2012) discuss the traits, ecological habits and life history information – some newly obtained – for each of these newly recognized species. This is the primary source for the species accounts provided below and summarized in Table 1. Ranges of the nine species are indicated in the two maps included below.

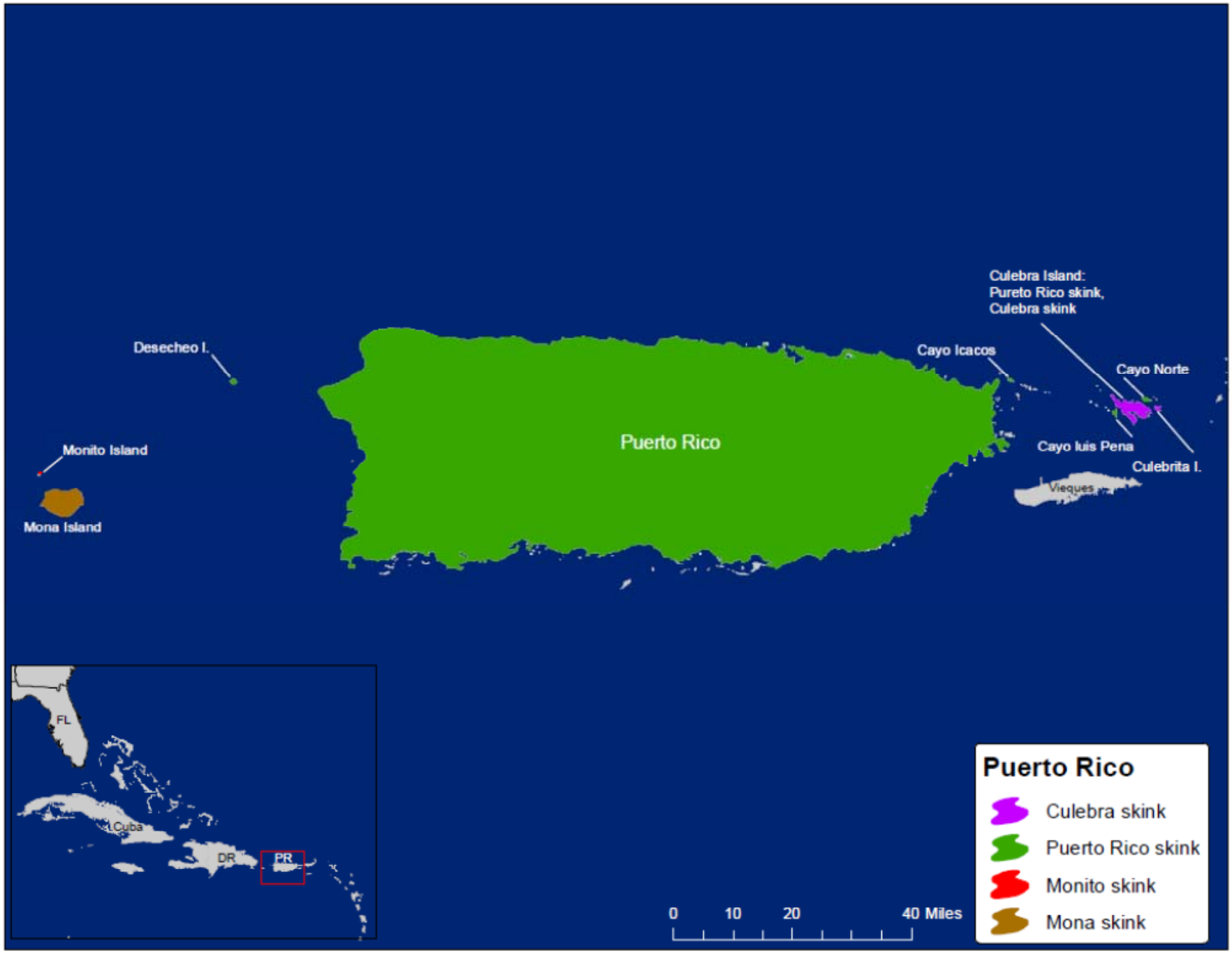
Prior to the work of Hedges and Conn (2012), the petitioned species were considered to be one species, which was referred to in the literature as the Slipperyback Skink (*Mabuya mabouya* or *M. sloanii*). Now, the species *Mabuya mabouya* has been restricted to Martinique, while the species "*Mabuya*" *sloanii* (and other newly recognized and elevated species) are placed

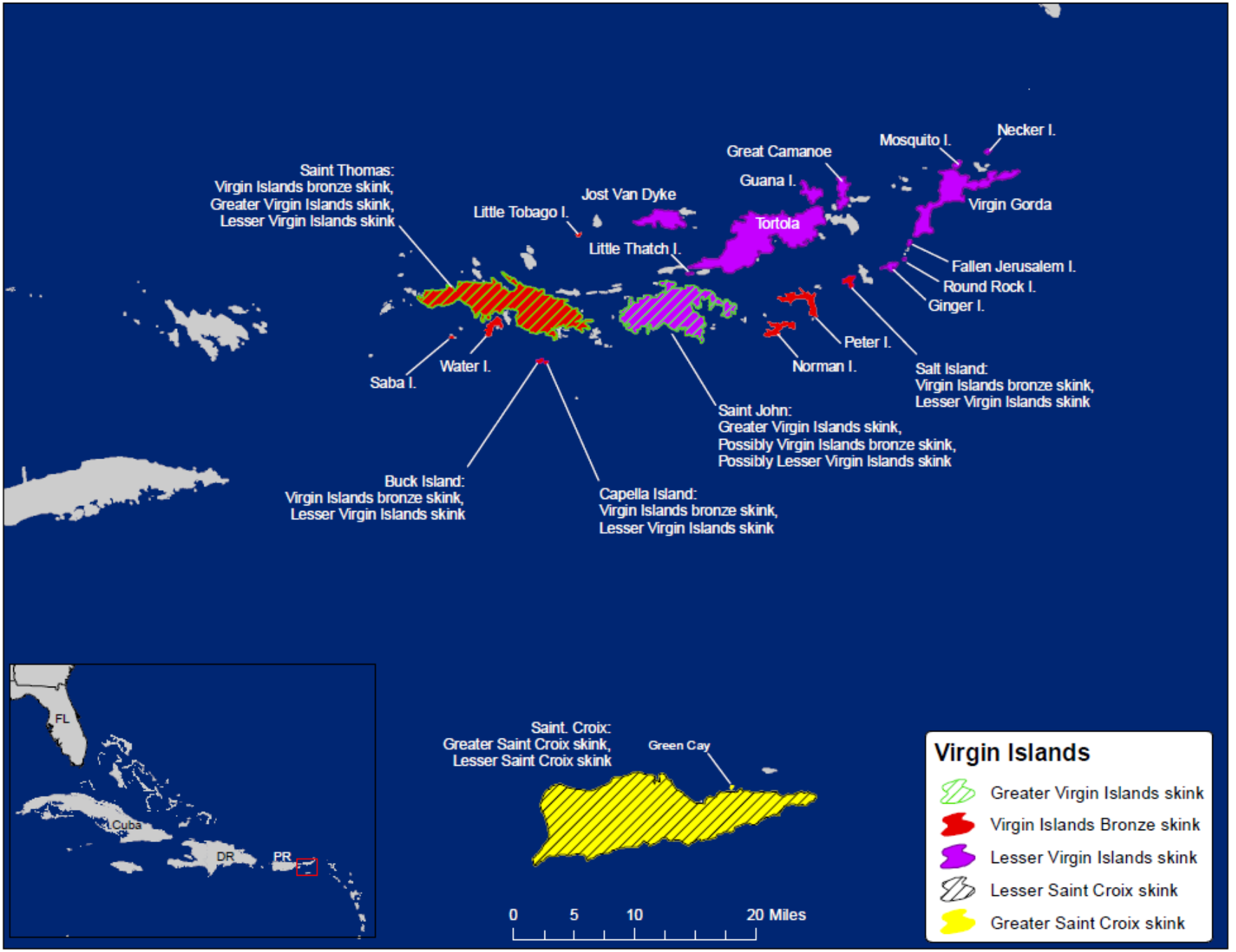
in the genus *Spondylurus*, itself elevated (Hedges and Conn 2012). The species *S. sloanii* was restricted by those authors to the Virgin Islands and given the common name Virgin Islands Bronze Skink. With all of this taxonomic change, the literature of Caribbean skinks before 2012 cannot be used for species-specific information, except as guided explicitly by the species accounts and distributional data in Hedges and Conn (2012). In other words, the species known as the “Slipperyback Skink” no longer exists because it was confused with many different species having different characteristics, body shapes, patterns, and life history traits.

Table 1. Summary of Distribution, Status, and Threats to the Petitioned Skinks -- Information from Hedges and Conn (2012) and Hedges (2013a-i).

Common Name	**Scientific Name**	**Distribution**	**IUCN Red List Status**	**Threats**
Culebra Skink	*Spondylurus culebrae*	Culebra and the adjacent islet of Culebrita (Puerto Rico)	Critically endangered	Introduced predators (black rats, cats) and habitat loss from development and agriculture
Greater Saint Croix Skink	*Spondylurus magnacruzae*	St. Croix and its satellite Green Cay (U.S. Virgin Islands)	Critically endangered	Introduced predators (mongoose, black rats) and habitat loss from development and agriculture
Mona Skink	*Spondylurus monae*	Mona Island (Puerto Rico)	Critically endangered	Introduced predators (black rats, cats), habitat alteration from introduced goats and pigs, habitat loss and disturbance from illegal human presence
Monito Skink	*Spondylurus monitae*	Monito Island (Puerto Rico)	Critically endangered	Habitat loss and disturbance from illegal human presence, threat of black rat re-introduction
Puerto Rican Skink	*Spondylurus nitidus*	Puerto Rico and its satellites of Cayo Luis Peña, Cayo Norte, Culebra, Desecheo, and Icacos	Endangered	Introduced predators (mongoose, black rats) and habitat loss from development and agriculture
Lesser Virgin Islands Skink	*Spondylurus semitaeniatus*	In U.S. Virgin Islands, it is known from St. Thomas and two islets of St. Thomas called Capella and Buck Island. Possibly St. John and Jost van Dyke. In the British Virgin Islands it is known from Fallen Jerusalem, Ginger Island, Great Camanoe Island, Guana Island, Little Thatch Island, Mosquito Island, Necker Island, Round Rock, Salt Island, Tortola, and Virgin Gorda.	Critically endangered	Introduced predators (mongoose, black rats) and habitat loss from development and agriculture

Virgin Islands Bronze Skink	*Spondylurus sloanii*	From the U.S. Virgin Islands it is known from St. Thomas and its islets of Capella Island, Buck Island, Saba Island, and Water Island. Possibly St. John. In the British Virgin Islands it is known from Little Tobago, Norman Island, Peter Island, and Salt Island.	Critically endangered	Introduced predators (mongoose, black rats) and habitat loss from development and agriculture
Greater Virgin Islands Skink	*Spondylurus spilonotus*	St. John and St. Thomas (U.S. Virgin Islands). Possibly the British Virgin Islands.	Critically endangered	Introduced predators (mongoose, black rats) and habitat loss from development and agriculture
Lesser Saint Croix Skink	*Capitellum parvicruzae*	St. Croix (U.S. Virgin Islands)	Critically endangered	Introduced predators (mongoose, black rats) and habitat loss from development and agriculture


Culebra Island:
Pureto Rico skink,
Culebra skink
Desecheo I.
Cayo Icacos
Cayo Norte
Puerto Rico
Monito Island
Cayo luis Pena
Culebrita I.
Vieques
Mona Island
FL
Cuba
DR
PR
0
10
20
40 Miles
Puerto Rico
Culebra skink
Puerto Rico skink
Monito skink
Mona skink


Saint Thomas:
Virgin Islands bronze skink,
Greater Virgin Islands skink,
Lesser Virgin Islands skink
Little Tobago I.
Jost Van Dyke
Little Thatch I.
Great Camanoe
Guana I.
Tortola
Mosquito I.
Necker I.
Virgin Gorda
Fallen Jerusalem I.
Round Rock I.
Ginger I.
Peter I.
Norman I.
Salt Island:
Virgin Islands bronze skink,
Lesser Virgin Islands skink
Saba I.
Water I.
Buck Island:
Virgin Islands bronze skink,
Lesser Virgin Islands skink
Capella Island:
Virgin Islands bronze skink,
Lesser Virgin Islands skink
Saint John:
Greater Virgin Islands skink,
Possibly Virgin Islands bronze skink,
Possibly Lesser Virgin Islands skink
FL
Cuba
DR
PR
Saint. Croix:
Greater Saint Croix skink,
Lesser Saint Croix skink
Green Cay
0
5
10
20 Miles
Virgin Islands
Greater Virgin Islands skink
Virgin Islands Bronze skink
Lesser Virgin Islands skink
Lesser Saint Croix skink
Greater Saint Croix skink

Culebra Skink
Spondylurus culebrae

Species Description

The dorsal background color of the Culebra Skink varies among shades of brown, gray, bluish-green, and green in adults and gray or tan in juveniles (Hedges and Conn 2012). The Culebra Skink is characterized by (1) maximum SVL in males, 88.0 mm; (2) maximum SVL in females, 97.6 mm; (3) snout width, 2.28–3.50% SVL; (4) head length, 16.0–21.6% SVL; (5) head width, 11.4–16.1% SVL; (6) ear length, 1.36–2.36% SVL; (7) toe-IV length, 8.42–12.9% SVL; (8) prefrontals, two; (9) supraoculars, three (14%), four (86%); (10) supraciliaries, three (2%), four (90%), five (6%), six (2%); (11) frontoparietals, two (98%), three (2%); (12) supralabial below the eye, five (16%), six (82%), seven (2%); (13) nuchal rows, one (4%), two (88%), three (8%); (14) dorsals, 57–65; (15) ventrals, 60–70; (16) dorsals + ventrals, 121–134; (17) midbody scale rows, 30–36; (18) finger-IV lamellae, 13–16; (19) toe-IV lamellae, 14–19; (20) finger-IV + toe-IV lamellae, 28–34; (21) supranasal contact, Y (80%), N (20%); (22) prefrontal contact, N; (23) supraocular-1/frontal contact, Y (29%), N (71%); (24) parietal contact, Y (98%), N (2%); (25) pale middorsal stripe, Y; (26) dark dorsolateral stripe, Y; (27) dark lateral stripe, Y; (28) pale lateral stripe, Y; and (29) palms and soles, pale (Hedges and Conn 2012).

Range

The Culebra Skink is distributed on Culebra and the adjacent islet of Culebrita (Hedges and Conn 2012). No data are available on specific localities on the islands where animals were collected (Hedges and Conn 2012), although the most recent surveys suggested that skinks were "often restricted to certain areas" (Kessler 2010). Hedges and Conn (2012) demonstrated a high level of endemism in Caribbean skinks of this genus, and the Culebra Skink's replacement by other species on nearby islands suggests that it is genuinely endemic to Culebra and Culebrita (Hedges 2013a).

Culebra is an island-municipality of Puerto Rico with a land area of 11 km^2. It is located approximately 27 km (17 miles) east of the Puerto Rican mainland, 19 km (12 miles) west of St. Thomas and 14 km (9 miles) north of Vieques. Culebra is an archipelago consisting of the main island and twenty-three smaller islands that lie off its coast. Culebrita to the east is one of the largest of these cays and is fully protected as part of the Culebra National Wildlife Refuge.

Ecology and Habitat

Grant (1931) found specimens among the cactus *Opuntia* "at sea level just above the beaches and among the rocks on the hills." He also stated that they can be found inside houses.

The coast of Culebra is marked by rocky cliffs, sandy coral beaches, and mangrove (*Rhizophora* spp.) and Sea Grape (*Coccoloba uvifera*) forests (Kessler 2010). The vegetation on Culebrita is generally very shrubby, with cactus and Sea Grapes (Kessler 2010). Almost 80

percent of the island's area is volcanic rock mostly used for livestock pasture, as well as some minor agriculture (http://en.wikipedia.org/wiki/Culebra,_Puerto_Rico).

Population Status

While no quantitative data is available, the best available evidence shows that the Culebra Skink's population is declining (Hedges 2013a). Dozens of museum specimens of the species were collected in 1932 by C. Grant (Hedges and Conn 2012), and he found the skinks to be "abundant" (Hedges 2013a, citing S. Hedges pers. comm. 2013). Then, during a year-long survey in Culebra in 1986, in which herpetological surveys were conducted on most days, Kessler (2010) found the skinks to be "less common" than the island's endangered anoles and with a somewhat restricted distribution on the island (Hedges 2013a). An inference of decline is also supported by reports based on collections over the past 50 years that skinks have declined following development (Hedges 2013a, citing R. Thomas, unpubl. data).

The IUCN Red List status is Critically Endangered (Hedges 2013a). Hedges (2013a) explains:

> Listed as Critically Endangered on the basis that this species is confined to an island (and nearby islet) with an area of 11 km^2, and within which its remaining area of occupancy is undoubtedly below 10 km^2, it occurs in a single location defined by a threat mainly from invasive mammals, and it is experiencing a continuing decline in the extent and quality of suitable habitat – and probably also in area of occupancy – due to development, and of mature individuals due to predation by invasive species.

Threats

The major threats to the Culebra Skink are introduced mammals, especially black rats, which are common on Culebra (Hedges and Conn 2012; Kessler 2010). These introduced predators do not recognize the boundaries of the wildlife refuge on Culebra, and therefore the skinks are not actually protected there (Hedges and Conn 2012). Kessler (2010) explains cattle, goats, chickens, and introduced White-tailed Deer (*Odocoileus virginianus*) roam freely throughout the forests. Feral cats are abundant on Culebra and are known to prey on lizards (Kessler 2010). Kessler (2010) reported that Culebra was free of mongoose.

Habitat disturbance may increase the lizard's susceptibility to predation by invasive species (Hedges 2013, citing S.B. Hedges pers. comm. 2013). All of the original, virgin forest on Culebra has been destroyed, including that in the protected area (Kessler 2010). Massive deforestation occurred from clearing land for cattle and construction, military activities, and major hurricanes (Kessler 2010). The military left the island in the 1970s, and afterwards the number of residential homes and businesses increased as people returned to Culebra from the main island of Puerto Rico. To be sure, in the 1980s, there was a boom of retirement/tourism homes in previously undisturbed areas of the island that has continued with the increased interest in both local and international ecotourism. Studies have shown that the area of urban and built-up or bulldozed lands increased by 49 percent during the 1990s (Helmer and Ruefenacht 2005).

Privately owned land on the island remains under pressure for urban and tourism development and habitat modification by deforestation for agriculture (Kessler 2010). Now housing is scattered throughout the island, except within the Culebra National Wildlife Refuge (Kessler 2010). The USFWS attributed extensive deforestation of Culebra Island as the primary threat to the endangered Giant Anole (USFWS 1982).[1] Culebra has a human population of approximately 1,800 (U.S. Census Bureau 2010), and additional pressure on habitat is likely if the human population grows, as is projected for Puerto Rico (U.S. Census Bureau 2012).

Military activities are responsible for much habitat destruction in the past. With the outbreak of WWII in 1939, the Culebra Archipelago became the primary gunnery, firing range, and bombing practice site for the U.S. Navy (Kessler 2010). After WWII, the Navy expropriated 688 ha of land on the main island of Culebra for a bombing range (Kessler 2010). As an example of the impact of military activities, in 1969 alone, Culebra came under naval gunnery fire for 123 days, was hit directly by missiles for 228 days, and planes made more than 35,000 target runs on the island (McCaffrey 2002). These activities lasted until 1976 (Kessler 2010).

Culebra has been hit by hurricanes over the years (Kessler 2010). Hurricane Hugo of September 1989 caused widespread habitat destruction that could have affected lizards by downing numerous trees and defoliating the remainder. However, these episodic weather disturbances are less likely to affect lizard populations than predation, habitat stripping by grazing livestock, or human habitat destruction (Henderson 1992).

Greater St. Croix Skink
Spondylurus magnacruzae

Species Description

The Greater St. Croix Skink most closely resembles the Greater Virgin Islands Skink, *S. spilonotus*, which occurs (or occurred) on St. Thomas and St. John (Hedges and Conn 2012). Both species reach 107 mm SVL in the relatively small samples available, making them the largest species in the Genus *Spondylurus*. They also have a similar general pattern consisting of narrow dark dorsolateral stripes in the anterior portion of the body. A photo of the skink is pasted below.

Locals on St. Croix called the species the “slippery-back” (Günther 1859), a name still used in the English speaking islands of the Caribbean.

The Greater St. Croix Skink is characterized by (1) maximum SVL in males, 92.9 mm; (2) maximum SVL in females, 107 mm; (3) snout width, 2.29–2.97% SVL; (4) head length,

[1] Forest cover on the island is estimated as high, at approximately 88 percent (Brandeis et al. 2007). However, this is misleading because the introduced African Tuliptree (*Spathodea campanulata*) is more than four times as abundant as any native tree species in Puerto Rico in several measures including volume, and the introduced Kiawe Tree (*Prosopis pallid*) dominates dry forests (Brandeis et al. 2007). It is likely that this major change in forest composition has impacted the native animal species.

15.9–18.0% SVL; (5) head width, 11.3–14.3% SVL; (6) ear length, 1.49–1.72% SVL; (7) toe-IV length, 7.01–10.4% SVL; (8) prefrontals, two; (9) supraoculars, four; (10) supraciliaries, four; (11) frontoparietals, two; (12) supralabial below the eye, five (11%), six (89%); (13) nuchal rows, one (44%), two (56%); (14) dorsals, 60–65; (15) ventrals, 59–70; (16) dorsals + ventrals, 119–134; (17) midbody scale rows, 34; (18) finger-IV lamellae, 12–14; (19) toe-IV lamellae, 16–18; (20) finger-IV + toe-IV lamellae, 28–31; (21) supranasal contact, Y (22%), N (78%); (22) prefrontal contact, N; (23) supraocular-1/frontal contact, N; (24) parietal contact, Y; (25) pale middorsal stripe, Y; (26) dark dorsolateral stripe, Y; (27) dark lateral stripe, Y; (28) pale lateral stripe, Y; and (29) palms and soles, pale (Hedges and Conn 2012).

Greater St. Croix Skink (*Spondylurus magnacruzae*). Photo by A. J. Meier

Range

The species is distributed on St. Croix, U.S. Virgin Islands, and its satellite Green Cay (Hedges and Conn 2012). No more specific locality data are available. The species was last recorded from St. Croix in the late nineteenth century, but this species has a well-documented collection history and it is consequently "without dispute" that the species historically occurred on the island (Hedges and Conn 2012).

St. Croix is the largest of the islands in the U.S. Virgin Islands, being 45 by 11 km (28 by 7 miles) (http://en.wikipedia.org/wiki/Saint_Croix,_U.S._Virgin_Islands). Green Cay is a small islet only about 450 m off the northeast coast of Saint Croix. St. Croix has an area of 230 km^2 (Hedges and Conn 2012), and Green Cay has an area of 0.06 km^2 (Hedges 2013b).

Ecology and Habitat

The only available ecological information comes from Hedges and Meier (2013). These authors provide details on the habitat where this skink was photographed in 1987 on Green Cay. The skink was observed in early afternoon after a rain, in woodland habitat (primarily *Cordia rickseckeri*, with some *C. alba*) near the highest point on southern end of the island (Hedges and Meier 2013). The endangered Saint Croix ground lizard (*Ameiva polops*) was found in the same habitat. Trees averaged 14 cm in diameter at breast height, with a density of 5-16 per 100 m^2. Shrubs (*Oplonia*) comprised 5-35 percent cover, and there was no grass cover. The soil was loose and easily dug by hand (Hedges and Meier 2013).

The Greater St. Croix Skink may climb trees, but it lacks adaptations for a scansorial or burrowing lifestyle (Hedges and Conn 2012). More likely, the species climbs on rocks, logs, and cacti, and lives under and among them, but likely does not live high in trees or burrow (Hedges and Conn 2012).

Population Status

A specimen of this species was obtained from the main island of St. Croix in 1883 but has not been observed on the mainland since then (Hedges and Conn 2012). The skink's disappearance from St. Croix coincides with the introduction of mongoose to this island (Hedges and Conn 2012).

The species was found in 1964 on Green Cay, off St. Croix, by Richard Thomas for Albert Schwartz (Hedges and Conn 2012). In addition, the species was photographed in June 1987 on Green Cay (Hedges and Meier 2013).[2] Another sighting of the Greater St. Croix Skink was made on Green Cay in September 2000 (Evans et al. 2010; Hedges and Meier 2013).

[2] Hedges and Meier (2013) explain that the skink in that photo possesses several typical characteristics of the species, including sharp, bold lateral stripes, reduced dorsolateral stripes, and a small ear opening, which distinguishes it from its closest relative, the Greater Virgin Island Skink (*Spondylurus spilonotus*), occurring elsewhere in the Virgin Islands. The individual, a female, was 131 mm total length, 72 mm snout-vent length, and weighed 13 grams. It differs in

The IUCN Red List status is Critically Endangered (Hedges 2013b). Hedges (2013b) explains:

> Listed as Critically Endangered on the basis that this species, if it survives at all, is almost certainly confined to Green Cay, a single location where it is at risk from predation by introduced rats and where its maximum extent of occurrence and area of occupancy are both as low as 0.06 km^2. Its historic extinction from St. Croix will have drastically reduced both its extent of occurrence and area of occupancy, and it is presumed that any surviving population on Green Cay is undergoing a continuing decline in the number of mature individuals as a result of rat predation.

Herpetologists have visited the main island of Saint Croix and its islets, including Green Cay, since the last sightings of skinks (Greater St. Croix Skink and Lesser St. Croix Skink) and no individuals have been seen. However, these surveys have not specifically targeted skinks, and it remains possible that a population survives but has been overlooked (Hedges 2013b). To be sure, these two species were not recognized taxonomically until 2012, and therefore concerted and thorough searches are needed before they should be considered extinct (Hedges and Meier 2013; Hedges 2013). The species may remain on the mainland of St. Croix or on one of the uninhabited cays in the St. Croix archipelago.

Threats

The Greater St. Croix Skink faces a primary threat from the introduced mongoose (Hedges and Conn 2012; Hedges and Meier 2013). This species was collected in low numbers but with some apparent regularity prior to the introduction of Small Indian Mongoose to St. Croix in the late nineteenth century, and predation by this invasive mammal "undoubtedly explains" the absence of records from St. Croix since 1883 despite intensive survey work in the Virgin Islands during the twentieth century (Hedges and Conn 2012).

Several protected areas exist on St. Croix, and all of Green Cay is contained within the Green Cay National Wildlife Refuge. However, introduced predators are a problem even in the protected areas. Specifically, black rats have been a problem on Green Cay, and that may explain the skink's apparent decline there. Moreover, Green Cay may not be able to sustain a substantial population of these large skinks due to the cay's very small size (Hedges 2013b).

Additional secondary threats include habitat destruction from agriculture and urbanization (Hedges and Conn 2012). St. Croix was once an agricultural powerhouse in the Caribbean, but that ended with the rapid industrialization of the island's economy in the 1960s. Like many other Caribbean islands today, St. Croix has tourism as one of its main sources of revenue (http://en.wikipedia.org/wiki/Saint_Croix,_U.S._Virgin_Islands) and is experiencing

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many ways from the other skink on Saint Croix, Lesser Saint Croix Skink (*Capitellum parvicruzae*), which has a short head and greatly reduced hands, feet, and digits (Hedges and Conn 2012).

habitat loss associated with tourism-related development. However, the species is likely already extinct on St. Croix.

Mona Skink
Spondylurus monae

Species Description

The Mona Skink has been described as being distinctly paler than the Puerto Rican Skink (*S. nitidus*) and having white dorsolateral lines instead of iridescent bluish lines (Grant 1931; Rivero 1998). Also, the Mona Skink tends to have triangular-shaped dark spots on the dorsum, whereas such spots are lacking in the Puerto Rican Skink, as noted by Grant (1931). The pale dorsolateral stripes have been described as being cream-colored (Rivero 1998).

The Mona Skink is characterized by (1) maximum SVL in males, 85.9 mm; (2) maximum SVL in females, 85.0 mm; unsexed holotype, 87.0 mm SVL; (3) snout width, 2.25–3.58% SVL; (4) head length, 16.1–20.0% SVL; (5) head width, 11.1–13.9% SVL; (6) ear length, 1.23–2.26% SVL; (7) toe-IV length, 8.09–10.4% SVL; (8) prefrontals, two; (9) supraoculars, three (3%), four (97%); (10) supraciliaries, three (3%), four (91%), five (6%); (11) frontoparietals, two; (12) supralabial below the eye, five (9%), six (91%); (13) nuchal rows, two (74%), three (26%); (14) dorsals, 56–65; (15) ventrals, 60–72; (16) dorsals + ventrals, 119–135; (17) midbody scale rows, 28–34; (18) finger-IV lamellae, 11–16; (19) toe-IV lamellae, 15–19; (20) finger-IV + toe-IV lamellae, 26–33; (21) supranasal contact, Y (60%), N (40%); (22) prefrontal contact, N; (23) supraocular-1/frontal contact, Y (59%), N (41%); (24) parietal contact, Y; (25) pale middorsal stripe, Y; (26) dark dorsolateral stripe, Y; (27) dark lateral stripe, Y; (28) pale lateral stripe, Y; and (29) palms and soles, pale (Hedges and Conn 2012).

Range

The species is distributed on Mona Island (Hedges and Conn 2012). No data are available on specific localities on the island where animals were collected (Hedges and Conn 2012). Hedges and Conn (2012) demonstrated a high level of endemism in Caribbean skinks of this genus, and the Mona Skink's replacement by other species on nearby islands suggests that it is genuinely endemic to Mona (Hedges 2013c).

Mona is the third-largest island of the Puerto Rican archipelago, after the main island of Puerto Rico and Vieques. It is the largest of three islands located in the Mona Passage, a strait between the Dominican Republic and Puerto Rico, the others being Monito Island and Desecheo Island. It measures about 11 km by 7 km (7 miles by 4 miles), and lies 66 km (41 mi) west of Puerto Rico. Mona has a land area of 57 km^2 (Hedges and Conn 2012).

Ecology and Habitat

The island of Mona is a roundish, raised limestone block, flat on top, and covered with mostly dry forest and cacti (Hedges and Conn 2012). It is designated as an ecological reserve by the government of Puerto Rico and has no permanent residents. It is maintained by Puerto Rico's

Department of Natural and Environmental Resources and managed on site by several park rangers (Hedges and Conn 2012).

Grant (1932) made a general comment for the Puerto Rico area that the favorite hiding place of mabuyine skinks was in dense clumps of *Opuntia* cactus but did not explicitly discuss populations on Mona. Rivero (1998) noted that skinks on Mona are common in the Sardinera area where they can be seen "sunning on individual piles of coconut palm trash, apparently not more than one specimen per pile."

Population Status

The last dated collection of the Mona Skink was 51 years ago, but a live skink was recently photographed (Hedges and Conn 2012). Skinks have been observed at Pozo del Portugués in Sardinera area of Mona Island, where it may be common (Rivero 1998).

The IUCN Red List status is Critically Endangered (Hedges 2013c). Hedges (2013c) explains:

> Tentatively listed as Critically Endangered on the basis that this species is confined to an island where its total extent of occurrence cannot exceed 57 km^2 and this island qualifies as a single location defined by a threat primarily from predation by introduced mammals. It is believed that predation by exotic species and forest degradation resulting from both human activities and browsing by goats are leading to reductions in the numbers of mature individuals and in the quality and extent of suitable habitat (thus qualifying for a Critically Endangered listing under Criterion B1ab(iii,v)), but further research into the population status and ecological requirements of this lizard are required to confirm this.

Threats

Although the mongoose is absent, the major threats to the skink are other introduced mammals, especially feral goats, pigs, cats, and rats. Many of the threats to the survival of the endemic Mona Iguana, *Cyclura stejnegeri* (Wiewandt and Garcia 2011), also apply to the Mona Skink.

Feral cats have had a devastating effect on small lizards on Mona Island (García et al. 2001). Cats were introduced to Mona Islands as early as 1898 (Hubener 1898). Cats range throughout the island (USFWS 1984a). From a small sample of cat stomachs, Wiewandt (1977) reported reptiles and a few species of invertebrates. Trapping of feral cats on Mona Island has been carried out since 1978, but trapping has proved difficult because nontarget species tend to spring the traps (USFWS 1984a, p. 11). Efforts to eliminate feral cats intensified from 1996 to 2005, but the predator still has not been eradicated (Joglar et al. 2007; García et al. 2001).

The skink faces a secondary threat from habitat alteration – in part, as a result of destruction by feral mammals (Hedges and Conn 2012). The USFWS has documented that goats and pigs have modified many of Mona Island's plant communities by overbrowsing and

uprooting vegetation (USFWS 1984b). For example, the Mona Iguana (*Cyclura stejnegeri*) and the Mona Boa (*Chilabothrus monensis*) are both threatened by habitat alteration from nonnative mammals (Wiewandt and Garcia 2011; USFWS 1984b). Garcia et al. (2000) explains that browsing pressure by feral goats results in forest trees being unable to propagate successfully and causes a severe reduction in leaf litter. Hunting is permitted in season on Mona Island to attempt to control the population growth of goats, pigs and wild cats, though success is limited (https://en.wikipedia.org/wiki/Isla_de_Mona).

The island is a natural reserve and has no native inhabitants. Rangers from the island's Department of Natural and Environmental Resources reside on the island to manage visitors and take part in research projects. Although lacking permanent settlements, Mona is a haven for recreational activities, including camping, fishing, swimming, scuba diving, beach combing, exploring, and hunting (Garcia et al. 2010). Most of these activities are concentrated along the island's sandy coastal terraces and within sinkhole depressions, and Mona may have already exceeded its carrying capacity for low impact tourist visitation (Garcia et al. 2010).

In addition, Hedges and Conn (2012) explain that the island is now being used by immigrants, especially Cubans (passing through Hispaniola), who use Mona and Monito as points of first contact on U.S. soil, in response to the U.S. government's Cuban Adjustment Act of 1966 and later revisions, now called the "wet feet/dry feet" policy. News reports document that in 2010–2011, dozens of immigrants claimed Mona as home until they were rescued by the U.S. Coast Guard. Given this human presence, it is likely that some habitat has been disturbed, but it is not known how much disturbance is taking place or its effects on the biodiversity (Hedges and Conn 2012).

Monito Skink
Spondylurus monitae

Species Description

Within the Genus *Spondylurus*, the Monito Skink is separated from all other species by having concave (versus parallel) dark dorsolateral stripes on the parietal scales, forming a constriction on the top of the head (Hedges and Conn 2012).

The Monito Skink is characterized by (1) maximum SVL in males, 90.3 mm; (2) maximum SVL in females, 94.5 mm; (3) snout width, 2.42–3.16% SVL; (4) head length, 16.2–17.8% SVL; (5) head width, 11.5–13.8% SVL; (6) ear length, 1.35–1.59% SVL; (7) toe-IV length, 8.34–10.7% SVL; (8) prefrontals, two; (9) supraoculars, three (43%), four (57%); (10) supraciliaries, three (29%), four (43%), five (29%); (11) frontoparietals, two; (12) supralabial below the eye, five; (13) nuchal rows, two; (14) dorsals, 62–64; (15) ventrals, 64–69; (16) dorsals + ventrals, 126–132; (17) midbody scale rows, 32–34; (18) finger-IV lamellae, 12–15; (19) toe-IV lamellae, 16–17; (20) finger-IV + toe-IV lamellae, 29–32; (21) supranasal contact, N; (22) prefrontal contact, N; (23) supraocular-1/frontal contact, Y (86%), N (14%); (24) parietal contact, Y; (25) pale middorsal stripe, Y; (26) dark dorsolateral stripe, Y; (27) dark lateral stripe, Y; (28) pale lateral stripe, Y; and (29) palms and soles, pale (Hedges and Conn 2012).

Range

The Monito Skink is distributed on Monito Island, where the highest elevation is 63 m (Hedges and Conn 2012). Monito Island is a very small, usually uninhabited island located about 5 km northwest of Mona Island. It measures 0.147 km² (0.0566 sq mi, or 36.25 acres) in area (http://en.wikipedia.org/wiki/Monito_Island).

The occurrence of an endemic skink on this tiny islet is "remarkable" (Hedges and Conn 2012), however, morphological data suggest that it is not closely-related to the species found on nearby Mona (Hedges and Conn 2012) and so it does appear to be genuinely restricted to Monito (Hedges 2013d).

Ecology and Habitat

No ecological information is available for this species (Hedges and Conn 2012). Monito Island is similar to Mona in being a raised limestone block with a flat top, although vegetation is more limited in diversity. It has been described as xeric scrub vegetation consisting primarily of cacti, shrubs, and stunted trees growing from cracks in the limestone (Rolle et al. 1964). As with Mona, Monito Island is a Natural Reserve administered by the Puerto Rico Department of Natural and Environmental Resources (Hedges and Conn 2012).

Population Status

The species has not been reported since 1993 and more studies are needed to evaluate the species' status (Hedges and Conn 2012). The IUCN Red List status is Critically Endangered (Hedges 2013d). Hedges (2013d) explains:

> Listed as Critically Endangered on the basis that both its extent of occurrence and area of occupancy are below 0.15 km^2, it is known only from a small island which represents a single location defined by an ongoing threat from human disturbance and a potential threat from invasive species, and there is a continuing decline in the quality of native vegetation on the island, presumed to represent the habitat of this species. It has been suggested that this species, which has not been recorded since 1993, might already be extinct.

There are no data on the number of surveys conducted on Monito since 1993 (Hedges 2013d). Hedges and Conn (2012) raise the possibility that the species may be extinct, recommending that surveys be conducted to determine whether this is the case.

Threats

The mongoose is not present on Monito. Black rats were present until the 1990s, at which time concern was expressed that they were responsible for declines in the endemic Monito Gecko population (*Sphaerodactylus micropithecus* Schwartz). An eradication program for the black rat was successful (Garcia et al. 2002).

One threat to the survival of Monito Skink is from human disturbance, now at an all-time high. As with Mono Island, Monito Island is being used by immigrants, especially Cubans (passing through Hispaniola), who use it as a point of first contact on U.S. soil. Typically, a dozen persons will stay on the small island at one time, often over one or more nights, until they are picked up by the Coast Guard (Hedges and Conn 2012). With this human presence, it is likely that habitat is disturbed and campfires built with some of the few trees on the island (Hedges and Conn 2012). This has resulted in disturbance to the natural vegetation that is exacerbated on Monito by its much smaller size and lower vegetation cover (Hedges and Conn 2012). Black rats could also be brought to the island, unintentionally, on boats carrying immigrants. A reintroduction of black rats could be devastating for the populations of endemic lizard species and is considered a primary threat to the species (Hedges and Conn 2012).

Puerto Rican Skink
Spondylurus nitidus

Species Description

A photo of the Puerto Rican Skink is pasted below.

The Puerto Rican Skink is characterized by (1) maximum SVL in males, 87.1 mm; (2) maximum SVL in females, 95.5; (3) snout width, 2.38–3.57% SVL; (4) head length, 16.6–20.7% SVL; (5) head width, 12.5–14.6% SVL; (6) ear length, 1.32–2.36%; (7) toe-IV length, 9.45–12.7% SVL; (8) prefrontals, two; (9) supraoculars, three (7%), four (93%); (10) supraciliaries, four (93%), five (7%); (11) frontoparietals, two; (12) supralabial below the eye, five (27%), six (73%); (13) nuchal rows, one (7%), two (80%), three (13%); (14) dorsals, 55–63; (15) ventrals, 60–66; (16) dorsals + ventrals, 117–129; (17) midbody scale rows, 28–33; (18) finger-IV lamellae, 12–15; (19) toe-IV lamellae, 14–19; (20) finger-IV + toe-IV lamellae, 26–33; (21) supranasal contact, Y (53%), N (47%); (22) prefrontal contact, N; (23) supraocular-1/frontal contact, Y (7%), N (93%); (24) parietal contact, Y; (25) pale middorsal stripe, Y; (26) dark dorsolateral stripe, Y; (27) dark lateral stripe, Y; (28) pale lateral stripe, Y; and (29) palms and soles, pale (Hedges and Conn 2012).

Puerto Rican Skink (*Spondylurus nitidus*) at Guajataca State Forest in Quebradilllas, Puerto Rico.
© Puerto Rico Wildlife: Alfredo Colón. Http://alfredocolon.zenfolio.com.

Range

The Puerto Rican Skink is distributed on Puerto Rico and the following Puerto Rican satellites: Cayo Luis Peña (just west of Culebra), Cayo Norte (just north of Culebra), Culebra (just east of the Puerto Rican mainland, north of the island of Vieques), Desecheo (just west of the Puerto Rican mainland), and Icacos (a small, uninhabited island just off the coast of the Puerto Rican city of Fajardo, which is in the eastern region of Puerto Rico) (Hedges and Conn 2012). Genetic studies are needed to confirm the taxonomic status of populations of *Spondylurus* on the satellite islands of Puerto Rico, but Hedges and Conn (2012) assigned them to the Puerto Rican Skink.[3]

In Puerto Rico itself, the skink has been reported from several localities close to and along the island's northern and southern coasts (Hedges and Conn 2012). A recent report from the northwest side of the island in the Guajataca State Forest is at 221 m above sea level (Sanchez 2013). Anecdotal observations suggest that the Puerto Rican Skink may occur slightly

[3] Hedges (2013) explain that the identity of a presumably extinct skink from Vieques is unknown, as multiple species are now known to occur in Puerto Rico (Hedges and Conn 2012). A reference to mabuyine skinks being "relatively common" on Vieques (Rivero 1998), is thought likely to be in error, as no specimens exist or have been reported in extensive recent surveys, and mabuyine skinks were unknown to the island's inhabitants in 1931 (Hedges and Conn 2012).

more widely in the Quebradillas area (where Guajataca is located), but recent surveys in several other parts of the island have failed to record it (Hedges 2013e, citing A. Sanchez pers. comm. 2013). The skink has an estimated extent of occurrence of approximately 750 km^2 (Hedges 2013e).

Ecology and Habitat

The Puerto Rican Skink prefers dense clumps of *Opuntia* cactus (Grant 1932). Rivero (1998) observed that skinks found on Puerto Rico seem "to be more partial to arid and semi-arid regions" and that most specimens have been collected at the base of coconut palms, under rocks or in rock fissures, or under clumps of cacti (*Opuntia*).

Consistent with these observations, the skink has been observed in thorny cactus-scrub habitat in Desecheo Island (http://prgap.org/species/mabuya-sloanei/) and in tidal wracks towards the eastern end (Meier and Noble 1990). Other collecting locations noted included a knot hole in a fence post, trees 1–3 m above ground, on the leaf of a terrestrial bromeliad (*Bromelia pinguin*), and inside a house (Hedges and Conn 2012). However, the skink has also been observed in a humid limestone forest in northwestern Puerto Rico (Sanchez 2013). There, the skinks were most easily observed in the morning, usually basking in the sun on limestone boulders, leaf litter, and fallen tree trunks; when approached the skinks often retreated into crevices, holes, and deep leaf litter (Sanchez 2013). Meier and Noble (1990) observed that the skink occurs at elevations of 20 m, 180 m, and 240 m, as well as near the tidal wrack at sea level.

Population Status

The population appears to be declining and severely fragmented, primarily due to introduced predators, and, to a lesser extent, habitat loss (Hedges 2013e). Stejneger (1904) remarked about the rarity of skinks in Puerto Rico, noting "its present scarcity is probably due to the mongoose." Later, Rivero (1978) noted, "The chances of seeing this species in Puerto Rico proper are quite remote." Intensive general herpetological survey efforts by resident herpetologists in the last half-century have yielded only a few specimens, which were examined by Hedges and Conn (2012). Few specimens are located in museum collections from all years with the most recent being collected in 1980 (Hedges and Conn 2012). It was observed on Desecheo Island 1987 (Meier and Noble 1990). In 2012 and 2013, the skinks were photographed in the Guajataca State Forest in northwestern Puerto Rico (Sanchez 2013).

The IUCN Red List status is Endangered (Hedges 2013e). Hedges (2013e) explains:

> Listed as Endangered on the basis that this species has an estimated extent of occurrence of approximately 750 km^2, it occurs as a severely fragmented population, and is subject to a continuing (but not presently quantifiable) decline in the number of mature individuals, and presumably in its extent of occurrence and area of occupancy, mainly as a result of predation by introduced mongoose. Recent surveys across much of Puerto Rico have recorded this species only in one locality and further research into its distribution and rates of population decline may justify listing this species as Critically Endangered.

Threats

The Puerto Rican Skink faces a primary threat from the introduced mongoose, which has greatly reduced its numbers. While a significant reduction in population levels was seen after the mongoose was introduced (Stejneger 1904), the Puerto Rican Skink continued to survive, perhaps because of its ability to climb trees. No mongooses were observed in northwestern Puerto Rico's Guajataca State Forest, where the skink was recently photographed (Sanchez 2013). Predation from other introduced mammals, including black rats, is also a threat, and black rats are found in all habitats and elevations of Puerto Rico (Hedges and Conn 2012).

Secondary threats include habitat destruction from agriculture and urbanization (Hedges and Conn 2012). The mainland of Puerto Rico has experienced severe habitat loss and landscape fragmentation. In fact, by the 1930s only 6-15 percent of the surface area of the island was covered by forest (Puerto Rico DENR 2005). Towards the latter part of the twentieth century, forested acreage increased in Puerto Rico to about 35 percent (Birdsey and Weaver 1982). The status of Puerto Rican forests is analyzed by Brandeis and others (2007). They explain that forest cover in Puerto Rico is still increasing overall as forest replaces abandoned agricultural land and pastures (López et al. 2001), but urban expansion is replacing forests adjacent to cities and towns at an increasing rate (Cruz-Báez and Boswell 1997). Forest cover is now 57 percent for mainland Puerto Rico (Brandeis et al. 2007). However, this is misleading because the introduced African Tuliptree is more than four times as abundant as any native tree species in Puerto Rico in several measures, including volume, and the introduced Kiawe Tree dominates dry forests (Brandeis et al. 2007). It is likely that this major change in forest composition has impacted the native animal species. To be sure, habitat loss and alteration on Puerto Rico is a threat to other endangered wildlife on the island, including the Puerto Rican Boa (*Epicrates inornatus*) (Joglar et al. 2007; USFWS 1986b). Additional loss and degradation of habitat is expected as a result of the growing human population of Puerto Rico. While Puerto Rico contains wildlife refuges and national parks protected from agriculture and urbanization, introduced predators are a threat in all areas (Hedges and Conn 2012).

Lesser Virgin Islands Skink
Spondylurus semitaeniatus (Wiegmann 1837)

Species Description

The Lesser Virgin Islands Skink is most likely to be confused with the Virgin Islands Bronze Skink because the two species appear superficially similar and occur in close proximity and sympatry in the Virgin Islands. The best way to distinguish these bronze colored lizards is that in the Virgin Islands Bronze Skink, the dark dorsolateral stripes start tapering more quickly, before the forelimbs (Hedges and Conn 2012). A live Lesser Virgin Islands Skink from Virgin Gorda shows a tan or reddish tan dorsum with orange anteriorly in the zone of the dark lateral stripe (which appears broken and spotty) (Hedges and Conn 2012). A photo of this skink is pasted below.

The Lesser Virgin Islands Skink is characterized by (1) maximum SVL in males, 74.7 mm; (2) maximum SVL in females, 82.9 mm; (3) snout width, 1.99–3.27% SVL; (4) head length, 15.8–19.4% SVL; (5) head width, 11.9–16.2% SVL; (6) ear length, 0.953–2.27% SVL; (7) toe-IV length, 8.33–12.0% SVL; (8) prefrontals, two (98%), four (2%); (9) supraoculars, three (1%), four (99%); (10) supraciliaries, three (2%), four (98%); (11) frontoparietals, two; (12) supralabial below the eye, five (28%), six (72%); (13) nuchal rows, one (14%), two (80%), three (6%); (14) dorsals, 57–65; (15) ventrals, 59–70; (16) dorsals + ventrals, 119–134; (17) midbody scale rows, 31–34; (18) finger-IV lamellae, 10–15; (19) toe-IV lamellae, 13–19; (20) finger-IV + toe-IV lamellae, 23–33; (21) supranasal contact, Y (96%), N (4%); (22) prefrontal contact, N; (23) supraocular-1/frontal contact, Y (38%), N (62%); (24) parietal contact, Y (98%), N (2%); (25) pale middorsal stripe, Y; (26) dark dorsolateral stripe, Y; (27) dark lateral stripe, Y; (28) pale lateral stripe, Y; and (29) palms and soles, pale (Hedges and Conn 2012).

Lesser Virgin Islands Skink (*Spondylurus semitaeniatus*) at Gorda Peak National Park, Virgin Gorda, British V.I. Photo by Alejandro J. Sánchez Muñoz.

Range

The Lesser Virgin Islands Skink is widely distributed in the U.S. and British Virgin Islands (Hedges and Conn 2012).

In the U.S. Virgin Islands, it is known to occur on St. Thomas and two of its islets (Capella and Buck Island) (Hedges and Conn 2012). On St Thomas, the Lesser Virgin Islands Skink is known only from historical records without locality data (Hedges and Conn 2012). The most recent record appears to be an 1885 specimen (Hedges 2013f, citing S.B. Hedges pers. comm. 2013). Although the skink may be extinct on St. Thomas (Hedges and Conn 2012; Platenberg and Bouton 2006), it is possible that a very small remnant subpopulation survives on this large island (Hedges 2013f, citing S.B. Hedges pers. comm. 2013).

A historical report of skinks from St. John and Jost Van Dyke (Reinhardt and Lütken 1863) may refer to this species or the larger, Greater Virgin Islands Skink (Hedges 2013f). Two specimens of the Greater Virgin Islands Skink are from St. John, collected in 1846, and that species has not been recorded there since, almost certainly having been extirpated there by the mongoose. The same fate could be assumed for the Lesser Virgin Islands Skink if it occurred on St. John (Hedges and Conn 2012).

In the British Virgin Islands, the Lesser Virgin Islands Skink is known from Fallen Jerusalem, Ginger Island, Great Camanoe Island, Guana Island, Little Thatch Island, Mosquito Island, Necker Island, Round Rock, Salt Island, Tortola, and Virgin Gorda (MacLean et al. 1977; MacLean 1982; Lazell 1983; Schwartz and Henderson 1991; Lazell 1995; Hedges and Conn 2012).

The total extent of occurrence of the Lesser Virgin Islands Skink, based on the land area of islands where it survives, is at most around 100 km^2 (Hedges 2013f).

Ecology and Habitat

This lizard is found in low, dense vegetation on the beaches and lower slopes of cays, sheltering in grass and brush litter, under rocks and other surface debris, in rocky fissures, and on branches of low shrubs (Platenberg and Boulon 2006). On the small islets of St. Thomas (Buck Island, Capella Island) where Lesser Virgin Islands Skink occurs, the habitat is mostly coastal shrub with introduced Guinea Grass (*Panicum maximum*), Turks Cap Cactus (*Melocactus intortus*), and the shrub *Oplonia spinosa*, interspersed with Sea Grape (*Coccoloba uvifera*) – the same as the habitat of Virgin Islands Bronze Skink. This habitat has been described as low shrubby vegetation or grass, including exposed rocky areas and occasional beaches (Hedges and Conn 2012, citing R. Platenberg, pers. comm.).

Population Status

The Lesser Virgin Islands Skink was likely extirpated from St. Thomas (and possible St. John, if it occurred there) due to mongoose predation (Hedges and Conn 2012). It has been observed in recent decades on mongoose-free islands such as Virgin Gorda, Guana, Buck, and Mosquito as well as mongoose-inhabited Tortola (Hedges and Conn 2012). Unidentified skinks have been recently observed on the following islands off the coast of St. Thomas: Buck Island, Saba Island, and Great St. James (R. Platenberg, pers. comm. 2013). With the likely extinction of the skinks from the larger islands, the remaining range is severely fragmented with known surviving populations confined to numerous, mostly small islands (Hedges 2013f).

There is general acceptance that the Lesser Virgin Islands Skink has declined in numbers across its range in the Virgin Islands, mostly because of nonnative predators (Carey 1972; Perry and Gerber 2006; Platenberg and Boulon 2006; Hedges 2013f). Continued development of the islands will reduce available habitat of a species already living a fragile existence (Hedges and Conn 2012).

The IUCN Red List status is Critically Endangered (Hedges 2013f). Hedges (2013f) explains:

> Listed as Critically Endangered on the basis that this species has a maximum extent of occurrence of approximately 100 km^2; it is considered to occur as a severely fragmented population as it survives on 11 mostly small islands and its historical extinction on larger, adjacent islands presents an additional barrier to recolonization; and remaining habitat in the British Virgin Islands is undergoing a continuing decline due to agricultural and urban development. On Tortola, a continuing decline in the number of mature individuals is likely as a result of predation by introduced mongoose.

Threats

Recent reviews of the herpetofauna of the Virgin Islands implicate the mongoose in declines and extirpations of skinks, especially from the large islands (Perry and Gerber 2006; Platenberg and Boulon 2006; Carey 1972). Indeed, the Lesser Virgin Islands Skink faces a primary threat from the introduced mongoose, which probably led to its extirpation on St. Thomas, and probably other islands where there are no museum records as evidence, such as St. John (Hedges and Conn 2012). Most recent records of this species are from mongoose-free islands, although there are recent records from Tortola, where mongoose are found (Hedges and Conn 2012). Introduction of mongoose, either deliberately or by storm transport, to these remaining islands is a "significant probability" (Hedges 2013, citing S.B. Hedges pers. comm. 2013).

Because feral cats are present on St. Thomas and are known to prey upon on the endangered Virgin Islands Tree Boa (*Epicrates monensis granti*), feral cats are also a likely predator of this species on St. Thomas if it still exists there (USFWS 2009; Tolson 1996). In addition, black rats are found on Great St. James, off the coast of St. Thomas, where they may threaten the skinks if they occur there (R. Platenberg, pers. comm. 2013). As such, a secondary threat to the Lesser Virgin Islands Skink is predation from other introduced mammals, including black rats and cats (Hedges and Conn 2012).

Habitat destruction from agriculture and urbanization is another threat to these skinks (Hedges and Conn 2012). This species is found in the Buck Island National Wildlife Reserve and other areas protected from habitat destruction, but the threat of introduced predators exists even on protected lands (Hedges 2013f).

Virgin Islands Bronze Skink
Spondylurus sloanii (Daudin 1803)

Species Description

The Virgin Islands Bronze Skink is most likely to be confused with the Lesser Virgin Islands Skink because the two species appear superficially similar and occur in close proximity and sympatry in the Virgin Islands. The best way to distinguish these bronze colored lizards is that in the Virgin Islands Bronze Skink, the dark dorsolateral stripes start tapering more quickly, before the forelimbs (Hedges and Conn 2012).

The Virgin Islands Bronze Skink is characterized by (1) maximum SVL in males, 71.6 mm; (2) maximum SVL in females, 88.9 mm; (3) snout width, 2.10–3.11% SVL; (4) head length, 15.2–19.2% SVL; (5) head width, 11.8–13.9% SVL; (6) ear length, 1.12–1.73% SVL; (7) toe-IV length, 8.05–11.2% SVL; (8) prefrontals, two (95%), four (5%); (9) supraoculars, three (2%), four (98%); (10) supraciliaries, three (5%), four (95%); (11) frontoparietals, two; (12) supralabial below the eye, five (18%), six (77%), seven (5%); (13) nuchal rows, one (15%), two (75%), three (10%); (14) dorsals, 59–64; (15) ventrals, 58–68; (16) dorsals + ventrals, 118–131; (17) midbody scale rows, 32–34; (18) finger-IV lamellae, 10–13; (19) toe-IV lamellae, 14–17; (20) finger-IV + toe-IV lamellae, 24–30; (21) supranasal contact, Y (95%), N (5%); (22) prefrontal contact, Y (33%), N (67%, although nearly all in near contact); (23) supraocular-1/frontal contact, Y (38%), N (62%); (24) parietal contact, Y (95%), N (5%); (25) pale middorsal stripe, Y; (26) dark dorsolateral stripe, Y; (27) dark lateral stripe, Y; (28) pale lateral stripe, N (or weak); and (29) palms and soles, pale (Hedges and Conn 2012).

Range

The Virgin Islands Bronze Skink is known from the British and U.S. Virgin Islands. In the British Virgin Islands it is known from Little Tobago, Norman Island, Peter Island, and Salt Island. From the U.S. Virgin Islands it is known from St. Thomas and its islets of Capella Island, Buck Island, Saba Island, and Water Island (Hedges and Conn 2012). Records of the skink are infrequent and it may have been lost from islands with mongoose, including the largest island within its range, St. Thomas, where the most recent known collection was in 1862 (Hedges 2013g). In addition, it might historically have occurred on St. John, where at least one species of *Spondylurus* (Greater Virgin Islands Skink, *S. spilonotus*) is known to have become extinct following the introduction of mongoose (Hedges and Conn 2012). Unidentified skinks have been recently observed on the following islands off the coast of St. Thomas: Buck Island, Saba Island, and Great St. James (R. Platenberg, pers. comm. 2013).

Hedges and Conn (2012) caution that molecular phylogenetic analyses are needed to determine whether the skinks from these diverse islands all belong to the Virgin Islands Bronze Skink, as they appear to be based on morphology. The scientists further caution that the current existence of the skink on Water Island, known from a single specimen collected in 1964, should be verified in that the mongoose apparently was released there between 1930 and 1983 (Barbour 1930a; Horst et al. 2001). However, it appears that the mongoose is no longer present on Water Island (R. Platenberg, pers. comm. 2013).

The combined land area of the islands where the species is known to, or may, survive (including Water Island but excluding St Thomas) is approximately 25 km^2 (Hedges 2013g).

Ecology and Habitat

This lizard is found in low, dense vegetation on the beaches and lower slopes of cays, sheltering in grass and brush litter, under rocks and other surface debris, in rocky fissures, and on branches of low shrubs (Platenberg and Boulon 2006). Peter Island specimens were found under objects (leaves, rocks) near the coast, and the Water Island specimen under driftwood on a cobble beach (Hedges and Conn 2012).

The most recent sighting of the species was in 2004 on Saba Island, where the habitat is mostly coastal shrub with introduced Guinea Grass (*Panicum maximum*), Turks Cap Cactus (*Melocactus intortus*), and the shrub *Oplonia spinosa*, interspersed with Sea Grape (*Coccoloba uvifera*) (Hedges and Conn 2012). This habitat can be described as low shrubby vegetation or grass, including exposed rocky areas and occasional beaches (Hedges and Conn 2012, citing R. Platenberg, pers. comm.).

Population Status

The Virgin Islands Bronze Skink has a decreasing population trend and appears to survive on eight very small islands at most (Hedges 2013g). It has not been recorded from St. Thomas since 1862, and any surviving subpopulation on St. Thomas is likely to have an extremely restricted distribution as numerous twentieth century surveys of this island have failed to record it (Hedges 2013, citing S.B. Hedges pers. comm. 2013). Although it still likely occurs on the smaller mongoose-free islands within its distribution (Hedges and Conn 2012), the population is considered "severely fragmented" (Hedges 2013g).

The most recent record is from Saba Island in 2004 (Hedges and Conn 2012). Saba is a wildlife refuge, but its small size – essentially constituting one population of the skink – and presence of introduced mice pose threats (Hedges and Conn 2012, citing R. Platenberg, pers. comm.).

The IUCN Red List status is Critically Endangered (Hedges 2013g). Hedges (2013g) explain:

> Listed as Critically Endangered on the basis that this species is known to survive only on 8 islands with a combined land area of 25 km^2, it occurs as a severely fragmented population following its apparent extinction from larger islands within its range, and there are continuing declines in the extent and quality of suitable habitat and probably in the number of mature individuals as a result of development of the remaining islands where this species is found and predation by introduced mammals.

Threats

The Virgin Islands Bronze Skink faces a primary threat from the introduced mongoose, which probably led to its extirpation on St. Thomas and many other islands on which it may have occurred (e.g., St. John) but that are now inhabited by the mongoose (Hedges and Conn 2012).

Secondary threats include habitat destruction from agriculture and urbanization, and predation from other introduced mammals, including black rats (Hedges and Conn 2012). For example, black rats are found on Great St. James, off the coast of St. Thomas, where they may threaten the skinks if they occur there (R. Platenberg, pers. comm. 2013). In addition, mice are known to have been introduced to the Saba wildlife refuge (Hedges and Conn 2012). Because feral cats are present on St. Thomas and are known to prey upon on the endangered Virgin Islands Tree Boa (*Epicrates monensis granti*), feral cats are also a likely predator of this species on St. Thomas (USFWS 2009; Tolson 1996), if the skink still occurs there.

Greater Virgin Islands Skink
Spondylurus spilonotus (Weigmann 1837)

Species Description

The Greater Virgin Islands Skink most closely resembles the Greater St. Croix Skink, which occurs (or occurred) on St. Croix (Hedges and Conn 2012). Both species reach 107 mm SVL in the relatively small samples available, making them the largest species in the Genus *Spondylurus*. They also have a similar general pattern consisting of narrow dark dorsolateral stripes in the anterior portion of the body (Hedges and Conn 2012). However, the Greater Virgin Islands Skink has more dorsal body spots, a shorter supraciliary-1 scale, and a larger ear (Hedges and Conn 2012). Also, the stripe pattern of the Greater Virgin Islands Skink appears faded and with more irregular edges to the stripes compared with that of the Greater St. Croix Skink (Hedges and Conn 2012).

The Greater Virgin Islands Skink is characterized by (1) maximum SVL in males, 91.7 mm; (2) maximum SVL in females, 106.5 mm; (3) snout width, 2.74–3.05% SVL; (4) head length, 15.4–18.5% SVL; (5) head width, 12.0–13.9% SVL; (6) ear length, 1.76–2.05% SVL; (7) toe-IV length, 7.30–10.5% SVL; (8) prefrontals, two; (9) supraoculars, four; (10) supraciliaries, four; (11) frontoparietals, two; (12) supralabial below the eye, six; (13) nuchal rows, two (67%), three (33%); (14) dorsals, 62–64; (15) ventrals, 63–68; (16) dorsals + ventrals, 125–132; (17) midbody scale rows, 34; (18) finger-IV lamellae, 13–15; (19) toe-IV lamellae, 16–18; (20) finger-IV + toe-IV lamellae, 29–33; (21) supranasal contact, N; (22) prefrontal contact, N; (23) supraocular-1/frontal contact, Y (17%), N (83%); (24) parietal contact, Y; (25) pale middorsal stripe, Y; (26) dark dorsolateral stripe, Y; (27) dark lateral stripe, Y; (28) pale lateral stripe, Y; and (29) palms and soles, pale (Hedges and Conn 2012).

Range

This species was historically distributed in the U.S. Virgin Islands on St. John and St. Thomas (Hedges and Conn 2012). It is possible that the Greater Virgin Islands Skink occurred in

the British Virgin Islands as well. Hedges and Conn (2012) explain that very little collecting was done on islands other than St. Thomas and St. Croix prior to the introduction of the mongoose in the late nineteenth century, so it could have been easily extirpated from many islands without any record.

St. Thomas and St. John have a combined land area of 129 km^2; however, the species' historical extent of occurrence cannot be determined in the absence of locality data for either island (Hedges 2013h). Any surviving population will occur over a much smaller area, as both islands are well-surveyed and possible refuges where this species could have survived overlooked are therefore limited (Hedges 2013h).

Ecology and Habitat

The Greater Virgin Islands Skink was sympatric with the Lesser Virgin Islands Skink and the Virgin Islands Bronze Skink on St. Thomas and possibly with both species on St. John (Hedges and Conn 2012). No information is available on its ecology or habitat (Hedges and Conn 2012).

Population Status

The Greater Virgin Islands Skink has not been seen since the last specimen was cataloged in 1877. The presence of the introduced mongoose on the two large islands where the skink is known to have occurred (St. John and St. Thomas) explains the absence of the skink on those islands today (Hedges and Conn 2012). Black rats also occur throughout the region and may have preyed on this species. Habitat alteration from agriculture and urbanization, another threat to the species, is a continuing problem on these islands and their islets (Hedges and Conn 2012). Any surviving population is believed to be both severely fragmented and declining (Hedges 2013h).

Although the species has not been observed in many decades, more studies are needed to determine if the species still exists. Evidence from elsewhere in the Caribbean indicates that *Spondylurus* species can persist as very small, restricted-range populations (as is the case for the Puerto Rican Skink, *S. nitidus*, in Puerto Rico) or survive on small offshore islets (as with the Greater St. Croix Skink, *S. magnacruzae*, on Green Cay) (Hedges 2013h, citing S.B. Hedges pers. comm. 2013; Hedges and Conn 2012).

The IUCN Red List status is Critically Endangered (Hedges 2013h). Hedges (2013h) explains:

> This species has not been seen since 1877 despite its historical occurrence on two well-surveyed islands, and may well be extinct. Nevertheless it is tentatively listed as Critically Endangered on the basis that a remnant population may persist, but if so it will have an extent of occurrence below 100 km^2 (and probably an area of occupancy below 10 km^2), any population will presumably be severely fragmented, and a continuing decline in the number of mature individuals is

inferred from the continuing presence of invasive mongoose. Targeted surveys are needed to confirm whether the species should indeed be listed as Extinct.

Threats

The Greater Virgin Islands Skink faces a primary threat from the introduced mongoose, which has possibly led to its extinction. Secondary threats include habitat destruction from agriculture and urbanization, and predation from other introduced mammals, including black rats (Hedges and Conn 2012). Because feral cats are present on St. Thomas and are known to prey upon on the endangered Virgin Islands Tree Boa (*Epicrates monensis granti*), feral cats are also a likely predator of this species on St. Thomas (USFWS 2009; Tolson 1996), if it still occurs there.

Lesser St. Croix Skink
Capitellum parvicruzae

Species Description

As the only member of the Genus *Capitellum* in the northern Caribbean, the Lesser St. Croix Skink differs from all other species of skinks in that region in its generic-level characters. Thus, the combination of small hands and feet, a short head, six supraciliaries, a single row of nuchals, and absence of dark dorsolateral stripes will distinguish it from other skinks in the region (Hedges and Conn 2012).

The Lesser St. Croix Skink is characterized by (1) maximum SVL in males, not available; (2) maximum SVL in females, 68.1 mm (only known specimen); (3) snout width, 3.04% SVL; (4) head length, 16.3% SVL; (5) head width, 13.0% SVL; (6) ear length, 1.38% SVL; (7) toe-IV length, 10.4% SVL; (8) prefrontals, two; (9) supraoculars, four; (10) supraciliaries, six; (11) frontoparietals, two; (12) supralabial below the eye, 6–7; (13) nuchal rows, one; (14) dorsals, 63; (15) ventrals, 63; (16) dorsals + ventrals, 126; (17) midbody scale rows, 30; (18) finger-IV lamellae, 11; (19) toe-IV lamellae, 15; (20) finger-IV + toe-IV lamellae, 26; (21) supranasal contact, Y; (22) prefrontal contact, N; (23) supraocular-1/frontal contact, N; (24) parietal contact, N; (25) pale middorsal stripe, N; (26) dark dorsolateral stripe, N; (27) dark lateral stripe, Y; (28) pale lateral stripe, Y; and (29) palms and soles, dark (Hedges and Conn 2012).

Range

The Lesser St. Croix Skink is known from St. Croix in the U.S. Virgin Islands, and the only known specimen was reported with no more precise locality data (Hedges and Conn 2012). Because skinks in the Genus *Capitellum* apparently were decimated by the mongoose before extensive herpetological collections were made in the twentieth century, it is possible that the genus was even more widely distributed on Caribbean islands, with one or more extinctions and extirpations occurring before any specimens were collected (Hedges and Conn 2012).

Ecology and Habitat

The skinks within the Genus *Capitellum* have a slender form and unusually small heads, which suggests that they have terrestrial (ground-dwelling) and possibly cryptozoic (subterranean-dwelling) habits (Hedges and Conn 2012). No other information is available on the ecology of this species.

Population Status

This species is known from a single specimen collected in 1875, approximately 135 years ago (Hedges and Conn 2012). The mongoose was introduced to St. Croix at about that time, which may explain the subsequent lack of records. In addition, forest habitats on St. Croix are limited because of occupation by humans and habitat loss (Hedges and Conn 2012). Any surviving population is believed to be both severely fragmented and declining (Hedges 2013i).

The IUCN Red List status is Critically Endangered (Hedges 2013i). Hedges (2013i) explains:

> Listed as Critically Endangered on the basis that, while this species is known from a single specimen collected more than 135 years ago from an unspecified locality apparently on St. Croix, any surviving population is presumed to occur at a single location defined by a threat from mongoose predation and where it is expected to occur as a severely fragmented population, and to be undergoing a continuing decline as a result of predation by invasive mongoose. Both its extent of occurrence and area of occupancy are unknown, however while St. Croix has an area of 230 km^2 this large island is well-surveyed and any surviving population will undoubtedly occur over an area considerably below 100 km^2, and possibly below 10 km^2.

The Lesser St. Croix Skink should not be assumed extinct without additional studies. Hedges (pers. comm. 2013) explains that scientists have found several species on Caribbean islands after decades without observations, and that the Lesser St. Croix Skink "could still be extant, perhaps on a small islet of St. Croix, or in the mountains, even though it has not been seen since the 1800s." This species was long overlooked in collections and its ecological requirements are unknown (Hedges and Conn 2012), and so no targeted surveys to rediscover it have previously been possible (Hedges 2013i).

Threats

The Lesser St. Croix Skink faces a primary threat from the introduced mongoose, which may have led to its extinction (Hedges and Conn 2012). Secondary threats include habitat destruction from agriculture and urbanization, and predation from other introduced predators, including black rats (Hedges and Conn 2012). Forest habitats on St. Croix are now limited as a result of development; however in the complete absence of ecological information, it is unknown whether it was reliant on forest habitats at risk from these pressures (Hedges and Conn 2012).

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In summary, substantial declines in all nine petitioned skinks have occurred with many of these species on the brink of extinction due to introduced predators and habitat loss and alteration. The analysis of threats provided below demonstrates that these declines will continue unless these skinks receive federal protection. As such, all nine petitioned species are at risk of extinction in all or a significant portion of their ranges in the foreseeable future and qualify as endangered species.

IV. THREATS ANALYSIS

Section 4 of the Endangered Species Act and its implementing regulations (50 C.F.R. Part 424) set forth the procedures for adding species to the federal list of endangered and threatened species. USFWS may determine a species is endangered or threatened due to one or more of the five factors described in section 4(a)(1) of the Act. Each of these factors is discussed below.

A. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Habitat Loss from Human Activities

Habitat loss or degradation is a threat to all of the petitioned skinks, even those found on smaller islets and cays (Hedges and Conn 2012). The petitioned skinks use both coastal and interior island habitats (Hedges and Conn 2012), and both habitat types are being lost due to development or other human activities in the Caribbean. Wilson and others (2006) explain that human-induced habitat degradation has had "disastrous consequences" for Caribbean herpetofauna. If current rates of habitat conversion persist, the Caribbean is "likely to witness many more extirpations and extinctions in the coming decades" (Wilson et al. 2006). Moreover, without sufficient habitat, much needed re-introduction programs are likely unrealistic (Perry and Gerber 2006).

Urban development is a primary driver of habitat modification and fragmentation in the Caribbean, particularly in larger islands such as Puerto Rico and St. Thomas (USFWS 1986c). Urban development results in earth movement and destruction or modification of vegetation, as well as habitat fragmentation that may interrupt the connection between subpopulations, affecting the genetic variability and population numbers of the impacted species (USFWS 2004; Platenberg et al. 2005). In addition to urbanization, other causes of the skinks' habitat loss are agriculture, timber extraction, military and other human activities, and habitat alteration from nonnative mammals (discussed below).

Likely less than ten percent of the original forest persists in the Caribbean, with most remaining original forest only found in remote areas that are difficult to access (Hedges 2006).[4]

[4] Hedges (2006) explains why there has been confusion over the amount of forest cover, with some estimates being higher than ten percent. The main difference is the method used to assess what qualifies as forest canopy. Most methods consider as little as ten percent forest canopy, of

Higher reported percentages of recent forest cover for Puerto Rico derive in large part from introduced species such as the African Tuliptree (Brandeis et al. 2007). Although the skinks are not dependent on forests, the extent of forest coverage reflects a general trend of land conversion in the Caribbean resulting in a loss of native habitats (R. Platenberg, pers. comm. 2013).

On the U.S. Virgin Islands and Puerto Rico, virtually all of the primary tropical forest was cleared for agricultural purposes by the early twentieth century (Little et al. 1974). A large portion of these agricultural lands was thereafter abandoned, allowing their reversion to secondary forest (Thomlinson et al. 1996, Rudel et al. 2000). Forest recovery in deforested areas can be slow, however, and the regenerated forest may not resemble the original forest in terms of dominant tree species, overall species diversity, or ecological function (Aide et al. 1995; Rivera and Aide 1998; Rivera et al. 2000; Hedges 2006).

In recent decades, the development of sprawling residential communities, commercial centers, and a vast network of roads has resulted in considerable deforestation and excessive degradation and fragmentation of the remaining forests (Platenberg et al. 2005). Interior and often more mountainous habitats receive little attention from conservation efforts (Wilson et al. 2006). These areas are now frequently viewed by governments as less valuable land, and legislation to protect such areas has tended to lag behind legislation protecting coastal areas (Wilson et al. 2006). Monitoring and enforcement objectives are also more difficult to achieve in interior areas, which helps to explain why such efforts have tended to be inadequate or even nonexistent (Wilson et al. 2006). Even within protected areas, habitat is degraded by abundant introduced species, so there are no "pristine" forests in the Caribbean (Hedges 2006).

Coastal areas, especially those adjacent to white sand beaches, are under extreme threat from development for resorts, condominium complexes, and private residences (Platenberg et al. 2005). To be sure, few natural or semi-natural coastal habitats remain in the Caribbean (Wilson et al. 2006). The extensive development of coastal and low elevation areas has also displaced, degraded, or fragmented vast areas of shrublands (Platenberg et al. 2005), which are particularly important for the petitioned skinks. The economic rewards associated with tourism makes it very challenging to convince governments and private landowners to conserve coastal habitats (Wilson et al. 2006). Opportunities for land acquisition for conservation are limited by the high cost of even small land parcels, the level of fragmentation, and the overall poor quality of habitat on land available for purchase (Platenberg et al. 2005).

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any species of tree, as 100 percent forest. Therefore, an estimate of 50 percent forest could, in reality, be as low as five percent of the area covered by trees, and all of those trees could be introduced species (Hedges 2006). Hedges (2006) argues that the best estimate of forest cover, meaningful for biodiversity, is the Food and Agricultural Organization ("FAO") category "primary forest," which refers to forests having no, or no visible, indications of past or present human activity (FAO 2005). Relatively few islands in the Caribbean have been assessed for primary forest, but the ones that have show levels below three percent in some cases, and always considerably less than the normal forest cover estimate (Hedges 2006). This indicates that considerable care should be taken when using forest cover estimates for conservation purposes (Hedges 2006).

The effects of urbanization are particularly severe on St. Thomas, where habitat is declining due to development for resorts, condos, and related infrastructure, and remaining habitats are becoming more constricted and isolated (USFWS 1986c). One third of St. Thomas is classified as "developed" (Platenberg et al. 2005, citing Caribbean Data Center 2003, unpubl. data), but this statistic does not take into consideration the level of fragmentation or the integrity of remaining habitat. Most offshore cays of St. Thomas, however, are protected as wildlife refuges (USFWS 1986c). If any skinks still remain on St. Thomas, habitat loss should be considered a threat to them (Greater Virgin Islands Skink, Virgin Islands Bronze Skink, and Lesser Virgin Islands Skink) (Hedges and Conn 2012).

Skinks on the British Virgin Islands (the Lesser Virgin Islands Skink, Virgin Islands Bronze Skink, and possibly Greater Virgin Islands Skink) are also threatened by habitat loss. The ongoing threat of habitat destruction from development in the British Virgin Islands is discussed by Perry and Gerber (2006). They explain that habitat loss threatens many species of amphibians and reptiles on the British Virgin Islands, including skinks.

Even smaller islands in the Caribbean are threatened by habitat destruction. For example, habitat degradation has been documented on Mona Island and Monito Island, which are home to the Mona Skink and Monito Skink. On Mona Island, planting of nonnative trees and agricultural practices have altered the natural conditions of the coastal plain, and the USFWS has documented that land use on Mona Island is a threat to the Mona Ground Iguana (USFWS 1984a). Nearby Monito Island was in the past used as a bombing range by U.S. military forces. The USFWS observed that the large amounts of scattered debris suggest significant habitat destruction and modification (USFWS 1986a). More recently, immigrants fleeing Cuba have been using both islands as a place of first contact on U.S. soil, and such use may be causing some habitat alteration and loss (Hedges and Conn 2012).

Impacts of Nonnative Species

The introduction of feral goats and pigs and the spread of nonnative plants have had a major impact on wildlife habitat in the Caribbean (Westermann 1953; Platenberg and Boulon 2006). Habitat modification from nonnative species is a secondary threat to all the petitioned skinks that share their habitats with these introduced species (Hedges and Conn 2012).

Feral goats (*Capra hircus*) forage on native vegetation on several small cays near St. Thomas (Platenberg et al. 2005). Goats significantly impact coastal shrublands by converting them to a monoculture of *Croton* shrubs, which alters the vertical structure and may make the habitat unsuitable for skinks (R. Platenberg, pers. comm. 2013). Goats are periodically hunted, and there has been a concerted effort to exterminate them from Dutchcap Cay (Platenberg et al. 2005). The Lesser Virgin Islands Skink and Virgin Islands Bronze Skink (and maybe the Greater Virgin Islands Skink) occur on cays near St. Thomas, but it is unknown whether these skinks occupy those cays inhabited by goats.

Black rats can also alter vegetation and harm skink habitat. Black rats can modify entire plant communities by hindering regeneration and killing sapling and small adult trees (Courchamp et al. 2003; Clark 1981). Rats can also alter vegetation by spreading seeds of

invasive plants (Shiels 2011; Drake and McConkey 2001). Black rats are present and may be affecting habitats of the following petitioned skinks: Culebra Skink, Greater St. Croix Skink, Mona Skink, Puerto Rican Skink, Lesser Virgin Islands Skink, Virgin Islands Bronze Skink, Greater Virgin Islands Skink, and Lesser St. Croix Skink.

Feral pigs are a significant problem in Virgin Islands National Park, St. John (Platenberg et al. 2005), where the Greater Virgin Islands Skink was known to occur and might still occur. Under normal rainfall years, number of feral pigs has been estimated to be as high as 800 animals, impacting approximately 55 percent of Virgin Islands National Park (Platenberg et al. 2005). The effects of feral pigs on natural resources result from their movements, habitat utilization and food habits (Ackerman et. al. 1978; Barrett and Stone 1983; Bratton 1974, 1975). Plants are eaten, trampled or uprooted by pigs (Bratton 1975). Rooting in dry evergreen woodlands, dry evergreen scrub, thorn and cactus scrub, moist forest formations, early successional vegetation, and coastal wetlands may reduce understory cover by as much as 95 percent of normal ground density, resulting in changes in forest structure and composition (Platenberg et al. 2005). Areas uprooted by pigs undergo notable declines in small mammal and reptile populations (Platenberg et al. 2005). Feral pigs could also compete with the skinks for insects and other invertebrates. Donkeys are also found on St. John and present similar impacts to natural ecosystems as feral pigs with their trampling and grazing (Platenberg et al. 2005).

Damage from feral pigs, feral goats, and black rats occurs wherever the nonnative mammals are found, but it is unclear to what extent such habitat alteration affects most of the petitioned skinks. For example, introduced deer and feral goats are found on Culebra Island – where the Culebra Skink occurs – but it is unknown the extent of that threat on the skink, especially given the more direct impact on the Culebra Skink from black rat predation. In addition, feral pigs are found more often in the forested areas than the coastal shrublands preferred by skinks. Nevertheless, habitat alteration from these introduced species should be considered a potential threat.

Invasive plants, like invasive herbivores, can also alter habitats and prey bases (Wilson et al. 2006). These nonnative plant invasions have affected the distribution and abundance of amphibian and reptile populations in the Caribbean, but the extent of this threat is unknown, as it has received little research or conservation attention (Wilson et al. 2006). Nevertheless, invasive plants may be a more significant threat to skinks than invasive herbivores (R. Platenberg pers. comm. 2013). The extent of displacement by nonnative vegetation is significant in some areas of the Caribbean (Platenberg et al. 2005). For example, an estimated 21 percent of the flora of Virgin Islands National Park (in St. John, where the Greater Virgin Islands Skink was known to occur and might still occur) is comprised of exotic species (Clark 2003), including many grasses and shrubs. Some efforts are underway to rid the cays surrounding the Virgin Islands National Park mainland of invasive exotic plant species, but the problem is widespread and difficult to address (Clark 2003).

Human Population Growth

The growth of the human population is the ultimate cause of most habitat loss, and habitat destruction will continue to threaten the petitioned skinks as the human population in the Caribbean grows.

In 2000, the population of Puerto Rico was estimated at 3.8 million people with a density of 1,112 persons per square mile (U.S. Census Bureau 2000). From 2000 to 2010, Puerto Rico grew by four percent (adding 165,000 people in ten years for a total estimated population of 3,979,000 in 2010) (U.S. Census Bureau 2012). The U.S. Virgin Islands grew by one percent over that period (adding 1,000 people in ten years for a total estimated population of 110,000 in 2010) (U.S. Census Bureau 2012). An additional 76,000 people are estimated to join the Puerto Rican population by 2025, but the population of the U.S. Virgin Islands is expected to decline slightly during that time frame (U.S. Census Bureau 2012). Although the population of the U.S. Virgin Islands will likely remain approximately stable, the territory faces enormous development pressure due to the tourism economy, as explained by Platenberg and Boulon (2006). The territory receives two million visitors annually, with up to 18,000 arriving daily on cruise ships alone (Platenberg and Boulon 2006).

The human population in the British Virgin Islands has doubled in the last three decades, and is expected to double again in the next 35 years (Perry and Gerber 2006). Population pressures are particularly severe on Tortola (which has more than 80 percent of the total population on less than 40 percent of the British Virgin Islands land area), where the Lesser Virgin Islands Skink can be found. The second largest island, Virgin Gorda (also home to the Lesser Virgin Islands Skink), doubled its population between 1960 and 1980 and saw an increase of almost 75 percent from 1980 to 1991 (Perry and Gerber 2006). Growth in population and tourism has resulted in ongoing construction throughout the islands, with roads and buildings being added on a regular basis, natural habitats increasingly being lost and fragmented, and increasing problems with trash disposal (Perry and Gerber 2006).

In sum, habitat loss and degradation are important factors in the decline of the petitioned skinks throughout their range (Hedges and Conn 2012). These habitat losses are expected to continue in the future because of inadequate regulations, as described below.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

It appears that significant herpetological collection of the petitioned species occurred historically given that Hedges and Conn (2012) examined approximately 750 individuals found in 24 museums. Now, given the rarity of the petitioned species, it is unlikely that significant collection still occurs. As such, overutilization for scientific or educational purposes is not considered a present threat. It is unknown whether any commercial or recreational collection of the petitioned species occurs, but given the rarity of the species, individuals would likely be highly prized in the pet trade (Dodd 1993; Tolson and Henderson 2006). Collection of native wildlife in the U.S. Virgin Islands is prohibited without a permit, 12 V.I.C. § 105, but collection of the skinks is allowed in non-protected areas of Puerto Rico.

C. Disease or Predation

Although disease is a threat to many reptiles (Schumacher 1996; Gibbons et al. 2000), it is unknown whether disease threatens any of the petitioned species.

Predation from introduced species, however, is the primary threat to nearly all of the petitioned species (with the exception of the Monito Skink). As explained below, black rats, feral cats, and, in particular, mongoose, all prey on skinks and have had a strong negative impact on them (Hedges and Conn 2012). Island endemic species have proven to be extremely vulnerable to such introduced predators, due in part to their long isolation from such unnatural predation, and a corresponding lack of evolved anti-predator adaptations (Lewis et al. 2010; Courchamp et al. 2003). Most previous anti-invasive species efforts in the Caribbean have focused on the eradication of mammals on small, offshore islets; control efforts on the larger main islands have been considerably less frequent (Wilson et al. 2006). In addition, new introductions of plants and animals are occurring frequently (Platenberg et al. 2005).

Mongoose

More than any other factor, predation by the small Indian mongoose (*Herpestes auropunctatus*) is responsible for the extinction and extirpation of the skink fauna of the Caribbean islands (Hedges and Conn 2012).

The mongoose is a voracious and opportunistic omnivore that has been identified as one of the world's 100 worst invasive species because of its role in the decline and extirpation of native mammals, birds, reptiles, and amphibians (Lowe et al. 2000; Barun et al. 2011). Its impact on native bird and reptile populations, particularly ground foraging forms, has been devastating (Case and Bolger 1991). The animal has flourished in most habitats where it has been introduced (Horst et al. 2001; Nellis and Everard 1983).

The mongoose was deliberately introduced to the Caribbean (specifically, Jamaica) from India in 1872 as a biological control agent against black rats in sugar cane fields (Hays and Conant 2007). The mongooses had negligible impact on the rats, instead preying on the more easily captured endemic species (Daltry 2006; Lowe et al. 2000). In the years following its establishment in Jamaica, the mongoose was spread to many other Caribbean islands and has had similar devastating impacts on their biodiversity.

In their review of the effects of the mongoose on native species, Hays and Conant (2007) found that greatest impacts were on native fauna with no past experience with predatory mammals, which is the case for the Caribbean skinks. Several studies have documented the biology and environmental impact of the Small Indian Mongoose in the Caribbean (Seaman 1952; Seaman and Randall 1962; Nellis 1982; Coblentz 1983; Nellis and Everard 1983; Coblentz and Coblentz 1985). Most authors have considered the mongoose to be a major, if not the major, cause of extirpations and extinctions of Caribbean island reptiles (Barbour 1910, 1930b; Henderson 1992; Breuil 2002; Powell and Henderson 2005; Lorvelec et al. 2007; Daltry 2009; Lewis et al. 2011). On Caribbean islands, there are accounts of the high abundance of reptiles

before the mongoose introductions (Gosse 1851) and low abundance after the introductions (Fielden 1889; Stejneger 1904; Barbour 1910; Grant 1940).

In Jamaica, for example, the mongoose has been linked to the extinction of five endemic species: one lizard (*Celestus occiduus*), one snake (*Hypsirhynchus ater*), two birds (*Siphonorhis americanus* and *Pterodroma caribbaea*), and one rodent (*Oryzomys antillurum*) (Kairo et al. 2003). On the main island of St. Croix, it has been implicated in the extirpation of the St. Croix Ground Lizard (*Ameiva polops*) (Seaman and Randall 1962) and the extinction of the St. Croix Racer (*Borikenophis sanctaecrucis*) (Baskin and Williams 1966). Pacific islands that have been studied show a 100-fold negative impact from the mongoose on the abundance of diurnal lizards (Case and Bolger 1991).

Hedges and Conn (2012) document a dramatic loss of skink island-lineages following the introductions of the mongoose but relatively few losses of lineages on mongoose-free islands. By 1900, less than 50 percent of those mongoose islands still had their skinks (Science Daily 2012). Today, skinks are missing from almost all islands with mongooses, and the few species still extant are rare (Hedges and Conn 2012). The ground-dwelling and diurnal habits of skinks have made them particularly susceptible to mongoose predation.

Many of the Caribbean islands have no mongoose control programs but some efforts are being made (Barun et al. 2011). In Puerto Rico, the US Forest Service and USDA APHIS Wildlife Services live-trapped in El Yunque National Forest to protect the critically endangered Puerto Rican parrot (*Amazona vittata*) (Barun et al. 2011). The mongoose has been eradicated on Buck Island near St. Croix (Platenberg et al. 2005). However, the mongoose has been nearly impossible to eradicate except from the smallest (< 100 hectares) of islands (McNair 2003); therefore, many large islands in the Caribbean, including St. Thomas, St. John, and St. Croix, have had resident mongoose populations now for more than 100 years.

The mongoose is the principal threat to the Lesser Saint Croix Skink and Greater Saint Croix Skink on the island of St. Croix (Hedges and Conn 2012). It is also likely the primary reason for the scarcity of the Puerto Rican Skink on Puerto Rico and five of its satellite islands, and the Lesser Virgin Islands Skink on St. Thomas (and two of its islets) (Hedges and Conn 2012). The Virgin Islands Bronze Skink also faces a primary threat from the mongoose, which probably led to its extirpation on St. Thomas and other mongoose-occupied islands on which it may have occurred (e.g., St. John, St. Croix) (Hedges and Conn 2012). The presence of the mongoose on St. John and St. Thomas explains the likely absence of the Greater Virgin Islands Skink on those islands today (Hedges and Conn 2012).

Black Rats

Black rats began arriving in the Caribbean region in the fifteenth century, transported from the Old World by European ships and explorers (Varnham 2003; Amori et al. 2008). Having evolved in the tropics of Southeast Asia, the black rat was well suited to the new environment and rapidly became established in the Caribbean (Atkinson 1985; Cooper 2008). Many of the small islands lacked native ground predators, leaving many species extremely vulnerable to rat attack (Varnharm 2003).

Like the mongoose, the black rat is on the IUCN list of 100 of the world's worst invasive species (Lowe et al. 2000). Predation by this ubiquitous rodent has caused the extinction or extirpation of several species of reptiles (and other wildlife) in the Caribbean (Garcia et al. 2002; Lever 1994). Several studies have documented the negative environmental consequences of black rats (Campbell 1991; Witmer et al. 1998, 2002).

Rat eradication efforts have occurred on several cays in the U.S. Virgin Islands (Platenberg et al. 2005), including Buck Island near St. Thomas and (the other) Buck Island near St. Croix (Witmer et al. 2002). Efforts to eradicate black rats have been successful in some areas, including Monito Island, where the Monito Skink is found (Garcia et al. 2002). Rats have also been eradicated from Saba Island off the coast of St. Thomas, where skinks are also present (R. Platenberg, pers. comm. 2013). Most eradication efforts to date have been limited to small islands (<100 ha) due to the cost (Phillips 2010; Donlan and Wilcox 2008).

The black rat is a primary threat to the Culebra Skink on Culebra and the adjacent islet of Culebrita and the Mona Skink on Mona Island (Hedges and Conn 2012). Although the mongoose has had more devastating impacts, the black rat is a secondary threat to the Lesser St. Croix Skink, Greater St. Croix Skink, Puerto Rico Skink, Virgin Islands Bronze Skink, Lesser Virgin Islands Skink, and Greater Virgin Islands Skink (Hedges and Conn 2012). The illegal presence of humans on Monito Island poses the threat of possible black rat re-introduction, which would likely devastate the Monito Skink and is considered a potential threat to that species (Hedges and Conn 2012).

Feral Cats

Feral cats (*Felis catus*) are among the most successful and damaging invaders on islands and a significant driver of extinction and endangerment of native species (Bonnaud et al. 2011). Their success is due to their high fecundity, ready adaptability to new environments, and generalist predatory behaviors that allow them to feed on the most available prey species (Bonnaud et al. 2011). Due to their negative effects on biodiversity, the cat is included in the list of the 100 worst invasive species (Lowe et al. 2000).

Predation by cats has been directly responsible for numerous island extinctions of mammals, reptiles, and birds (Barbour 1930b; Westermann 1953; Nogales et al. 2004). Examples of reptile extinctions due to cat predation are iguanas (*Brachylophus* spp.) and skinks (*Emoia* spp.) in the Fiji Islands and iguanas (*Cyclura* spp.) on islands in the Caribbean (Nogales et al. 2004). Feral cats are a primary threat to the Mona Skink on Mona Island (Hedges and Conn 2012).

Feral cats are present on St. Thomas where they are known to prey on the endangered Virgin Islands Tree Boa (*Epicrates monensis granti*), and feral cats are also a likely predator of any skinks that may still be found on St. Thomas (USFWS 2009; Tolson 1996). This includes the Lesser Virgin Islands Skink, Virgin Islands Bronze Skink, and Greater Virgin Islands Skink (Hedges and Conn 2012).

In summary, introduced predators are a significant threat to all of the petitioned species of skinks.

D. Inadequacy of Existing Regulatory Mechanisms

Federal Laws

Each of the petitioned species is found within territories of the United States (Puerto Rico or the U.S. Virgin Islands) and is therefore subject to U.S. federal laws. There are three federal laws with the potential to provide some benefit to the petitioned species: the Clean Water Act, Coastal Zone Management Act, and Endangered Species Act.

The Clean Water Act provides some protection for wetlands in Puerto Rico and the U.S. Virgin Islands. However, that law is unlikely to protect habitat for the petitioned skinks, which are associated with more arid habitats and are unlikely to utilize wetlands.

The Coastal Zone Management Act of 1972 (CZMA) restricts activities that are detrimental to habitats and species in coastal areas. Many of the petitioned species are found within coastal areas, such as the Culebra Skink that is found at sea level just above the beaches (Hedges and Conn 2012). Although the CZMA provides some benefit to the petitioned skinks found in coastal areas, that law has been unable to stop the rapid pace of development of coastal areas throughout Puerto Rico and the U.S. Virgin Islands. For example, on the U.S. Virgin Islands, the Department of Fish and Wildlife provides input on building permits for certain lands within the coastal zone, but when granted, such permits frequently do not require compliance with the agency's recommendations (Platenberg et al. 2005). Moreover, the CZMA does nothing to address the impacts from nonnative predators, which are the primary threat to nearly all of the petitioned skinks.

Some of the petitioned skinks receive some benefit from the fact that they live on the same islands as other federally-protected species. The Endangered Species Act protects several other reptiles and amphibians within the range of the petitioned skinks:[5]

- Mona Island (Mona Skink): Mona Iguana and Mona Boa
- Monito Island (Monito Skink): Monito Gecko
- Culebra Island (Culebra Skink): Culebra Island Giant Anole (*Anolis roosevelti*)
- Puerto Rico mainland (Puerto Rican Skink): Puerto Rican Boa, Puerto Rican Crested Toad (*Peltophryne lemur*) (both with no designated critical habitat)

[5] In addition, there are some listed frogs within Puerto Rico, but these are unlikely to provide any benefit to the Puerto Rican Skink. The Guajon (*Eleutherodactylus cooki*) and Llanero Coqui (*Eleutherodactylus juanariveroi*) require more mesic habitats that are unlikely to overlap with habitats of the Puerto Rican Skink. The Golden Coqui (*Eleutherodactylus jasperi*) is found on mountain tops in Puerto Rico that are likely higher in elevation than the skink; plus, the range of the Golden Coqui is extremely narrow (approximately 24 ha), so it cannot serve as an umbrella species for the Puerto Rican Skink.

- St. Thomas (Greater Virgin Islands Skink, Lesser Virgin Islands Skink, and Virgin Islands Bronze Skink): Virgin Islands Tree Boa (no designated critical habitat)
- St. Croix (Lesser St. Croix Skink, Greater St. Croix Skink): St. Croix Ground Lizard

The protection of these listed species and their designated critical habitat likely provides some benefit to the overlapping habitats of the petitioned skinks. For example, the USFWS explains that the agency is providing technical assistance to project developers to modify project plans to avoid destruction of suitable Virgin Island Tree Boa habitat and ensure conservation of these areas (USFWS 1986c). Joglar and others (2007) summarize conservation efforts that have been made to protect endangered Puerto Rican herpetofauna, such as captive breeding programs, reintroductions, educational outreach, and protection and restoration of existing habitats.

In addition, the USFWS recently announced a new coalition dedicated to conserving Caribbean island iguanas. This coalition is collaborating "on more than 20 projects focused on alleviating threats to iguanas, changing public perceptions, and ensuring long-term financial, government, and public support for iguana conservation" (USFWS 2014). Such efforts are likely to have some benefit to Caribbean skinks that share iguana habitats.

Despite these conservation actions, conservation efforts for other species have not been adequate to prevent the decline of the petitioned species. To be sure, Wilson and others (2006) explain that "successful conservation efforts have been rare." They further explain that "not a single West Indian species listed as threatened on the IUCN Red List has been re-classified to a reduced threat status; rather, a large number of species have been either elevated to a higher threat category or have been added to the threatened list with each revision." In addition, it is uncertain whether conservation efforts will occur in the future because nearly all of these efforts lack legally binding commitments or dedicated funding.

For these reasons, any protections that the petitioned species receive from currently listed species must be considered inadequate to prevent their extinction. An Endangered Species Act listing for the skinks, especially with a critical habitat designation, would help prompt development of practices specifically aimed at recovering the skinks.

Puerto Rican Laws

In 1999, the Commonwealth of Puerto Rico approved Law No. 241, known as the "Nueva Ley de Vida Silvestre de Puerto Rico" (New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve, and enhance both native and migratory wildlife species; declare as property of Puerto Rico all wildlife species within its jurisdiction; regulate permits, hunting activities, and exotic species; and to avoid certain modifications of habitat, among other activities.

Based on this law, in 2004, the Puerto Rico Department of Natural and Environmental Resources (DNER) approved the "Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico" (Regulation 6766 to Regulate the Management of Threatened and Endangered Species in Puerto Rico) (http://app.estado.gobierno.pr/ReglamentosOnLine/Reglamentos/6766.pdf). This regulation

explicitly prohibits the possession, transportation, taking, destruction, hunting, and killing, of any wildlife species listed as threatened or endangered. Article 4.05 of Regulation 6766 also prohibits modifications of habitat designated by the Puerto Rico DNER as critical.

Prior to the work of Hedges and Conn (2012), the nine skink species found in Puerto Rico and adjacent islands, petitioned here, were considered to be a single species: Slipperyback Skink (*Mabuya mabouya sloanei*). The Slipperyback Skink was considered "vulnerable" in Puerto Rico (Regulation 6766 to Regulate the Management of Threatened and Endangered Species in Puerto Rico, *available at* http://app.estado.gobierno.pr/ReglamentosOnLine/Reglamentos/6766.pdf). But regulation 6766 only prohibits taking of species listed as threatened or endangered. Thus, the petitioned skinks do not receive protection under Regulation 6766. In addition, neither the Slipperyback Skink nor any of the petitioned skinks have critical habitat designated under Puerto Rican law.

Puerto Rican law provides some protection from destruction of habitat for the petitioned skinks found within its territory because Law No. 241 prohibits the modification of natural habitat without a mitigation plan approved by the Puerto Rico DNER. Yet protection from Law No. 241 is minimal given the lack of funding and resources for implementation, monitoring, and enforcement.

As an example, for the guajón, the USFWS observed that: "The lack of enforcement of regulations to protect the guajón, and governmental measures to prevent destruction of its habitat, threaten the survival of the guajón. The Commonwealth of Puerto Rico and the Service have adequate laws in place to protect endangered and threatened species; however, insufficient funding and personnel to properly administer and enforce existing wildlife laws, may result in violations that impact the guajón and its habitat" (USFWS 2004).

Indeed, the Puerto Rico DNER explains that state listing is insufficient to provide for the conservation of species. As the agency states in the Puerto Rico Comprehensive Wildlife Conservation Strategy: "State-listed species, whose conservation and recovery is mandated under the Regulation to Govern the Threatened and Endangered Species in the Commonwealth of Puerto Rico (Regulation No. 6766), have not been well protected, unless they are also included in the Federal list" (Puerto Rico DENR 2005). The agency further explains that the status of most Puerto Rican native wildlife is mostly unknown, and that "the lack of funding to determine their population status and distribution has delayed the development of priority actions and proactive management to avoid the endangerment of these species" (Puerto Rico DENR 2005).

U.S. Virgin Islands Laws

The Virgin Islands Indigenous and Endangered Species Act of 1990 protects all native wildlife in the territory from taking except by permit. 12 V.I.C. § 105(a) ("No person may take . . . any indigenous species . . . except that persons holding valid fishing or hunting licenses, scientific or aquarium collecting permits, or indigenous species retention permits, may operate within the scope and under the terms and conditions expressed in those licenses and permits."). Moreover, the Slipperyback Skink (*Mabuya sloanei*) is listed as "threatened" (Platenberg et al. 2005), which provides additional protection from taking. 12 V.I.C. § 105(a) ("No person may

take, catch, or possess, or attempt to take, catch or possess, any specimen of an endangered or threatened species."). The Virgin Islands Indigenous and Endangered Species Act also prohibits the importation of nonnative organisms without a permit. 12 V.I.C. § 105(d).

While the petitioned species found on the U.S. Virgin Islands are protected from take, existing laws are nevertheless inadequate because they provide no protection against habitat destruction. In addition, the territorial government never promulgated an official list of protected native species, which makes implementation of the law difficult. The prohibition on importation of exotics is important, but much of the damage from importation of exotics has already been done.

Moreover, enforcement of these regulations is inconsistent, and violations often go unreported, uninvestigated, or not penalized (Platenberg et al. 2005; Platenberg and Boulon 2006). Environmental officers are in short supply, and they frequently lack adequate training to identify environmental violations and take appropriate actions, and confusion over jurisdictional matters happens frequently (Platenberg et al. 2005). Issues where lack of enforcement have led to significant environmental violations include non-compliance of conditions attached to building and earth-change permits; industrial, household, and sewage pollution violations; wildlife poaching; and importation of exotics into the territory (Platenberg et al. 2005).

In addition to the scarcity of resources for enforcement, cultural issues within the territory make enforcement difficult. Distrust of governmental and other authority figures mean violations often go unreported or witnesses are not willing to testify (Platenberg et al. 2005). The public perception that no enforcement occurs further perpetuates the degradation of the environment (Platenberg et al. 2005).

Proactive conservation activities on the U.S. Virgin Islands are also poorly funded. The Department of Fish and Wildlife relies solely on federal funding in the form of Federal Aid grants for specific activities (Platenberg et al. 2005). The absence of local funding discourages pilot studies prior to grant applications, so many suitable research ideas are not adequately explored (Platenberg et al. 2005).

Invasive Species Control Programs

Some efforts have been made to eradicate introduced species within the range of the petitioned species. For example, as explained above, black rats were successfully removed from Monito Island, which has helped the Monito Skink (assuming it is still present). Various efforts have been made to eradicate rats and goats on cays in the U.S. Virgin Islands, including from Saba Island, where the Virgin Islands Bronze Skink occurs (Platenberg et al. 2005). In 2005, the National Park Service ("NPS") initiated a project to remove exotic plants from nine cays around St. John, and the NPS has initiated efforts to reduce numbers and control populations of nonnative cats, mongooses, hogs, goats, and sheep in Virgin Islands National Park (Platenberg et al. 2005). In addition to small eradication efforts, there is also now an invasive species management program for the Caribbean (Kraus 2013).

Unfortunately, these programs are entirely voluntary and are sharply limited by the ability of partners to fund these costly eradication programs. Even programs with sustained eradication efforts are often inadequate, as was seen with unsuccessful eradication programs for feral cats on Mona Island (USFWS 1984; Joglar et al. 2007; García et al. 2001).

In short, existing programs to control invasive species are insufficient. While efforts have been made to eliminate introduced predators on some of the small islands, it is very difficult on the larger islands and has not been attempted on many small islands even where feasible. Even if introduced predators are eliminated, without additional conservation efforts, it is unclear whether the skinks could recover on those lands given their extreme rarity.

Areas with Protected Habitats

All of the petitioned skinks receive some benefit from areas where habitat is protected from development. The extent of these protected areas varies across the islands.

In Puerto Rico, skink habitat includes 12 percent (106,920 ha) of the island, of which 18 percent occurs in protected areas (Puerto Rican Gap Analysis, undated). A list of protected areas in Puerto Rico is available here: http://www.drna.gobierno.pr/ordenes-administrativas/OA-2013-05.pdf. Despite the presence of these protected areas, approximately 85 percent of Puerto Rico is privately owned, and within these private lands, landscape changes are taking place rapidly (Puerto Rico DENR 2005).

Puerto Rico DNER has identified several areas within Puerto Rico and its satellites as "Critical Wildlife Areas" (Puerto Rico DENR 2005). Many of these areas provide habitat for skinks, including Flamenco Peninsula (Culebra Island); Culebra's surrounding cays; Toro Negro, Los Tres Picachos, Guánica, and Guajataca State Forests; and Mona, Monito, and Desecheo islands (Puerto Rico DENR 2005). The level of protection for the Critical Wildlife Areas varies but all have been identified as priorities for conservation. Yet future conservation efforts remain voluntary and limited by funding.

In Culebra, the Culebra Skink likely benefits from the protection of habitat from the Culebra National Wildlife Refuge (CNWR). The CNWR consists of approximately 610 ha, including all of the 22 smaller public islands and cays (~ 280 ha) of this 2800 ha archipelago. The largest of these are Culebrita to the east, and Cayo Luis Peña and Cayo Lobo to the west (Kessler 2010).

The Mona Skink benefits from the fact that the Puerto Rico DNER has managed Mona Island since 1973 (USFWS 1984a). Rangers and resident biologists have resided on the island to educate visitors and provide law enforcement (USFWS 1984a). Camping has been restricted to designated areas, which likely reduces harassment of wildlife (USFWS 1984a).

Monito Island is protected as a nature reserve, which benefits the Monito Skink. Visits to the island are prohibited, and its inaccessibility reduces the threat of human interference (USFWS 1986a). However, Hedges and Conn (2012) explain that unauthorized use from people fleeing Cuba now poses a threat of habitat disturbance.

The U.S. Virgin Islands contains several protected areas. Owned by the NPS, the Virgin Islands National Park extends across approximately 56 percent of St. John (2,816 ha of land and 2,287 ha of water), comprised of forests and watersheds that extend into the marine environment (Platenberg and Boulon 2006). Protected areas within St. John provide some benefit to Lesser Virgin Islands Skink and the Greater Virgin Islands Skink, if skinks still occur there. The Lesser Virgin Islands Skink, Virgin Islands Bronze Skink, and the Greater Virgin Islands Skink likely receive some benefit from protected areas on St. Thomas and off its coast, where these skinks have been found and may still occur. And the Greater St. Croix Skink is found on Green Cay National Wildlife Refuge. In total on the U.S. Virgin Islands, 41 cays (owned by the territorial government, NPS, or USFWS) are protected as wildlife reserves (a complete list of protected areas can be found in Platenberg et al. 2005). Many of the islands around St. Thomas and St. John where the skinks occur or potentially occur are with these protected areas. Yet outside these protected areas, most of the land within the U.S. Virgin Islands is divided into small privately-owned parcels that make the implementation of habitat conservation measures difficult (Platenberg and Boulon 2006).

Importantly however, even habitats within the protected areas are often severely degraded. For example, there are no primary forests on Culebra or any of the adjacent islands, and most of the main island of Culebra was deforested for its valuable *Lignum vitae* and then used for livestock grazing until it became a military bombardment zone (Kessler 2010). Even in areas where habitat is adequately protected in reserves, these reserves still contain introduced species, which are the primary threat to nearly all of the petitioned skinks (except the Monito Skink) (Hedges and Conn 2012).

In conclusion, the petitioned skinks are threatened by inadequate regulatory protections and will continue to decline without federal protections.

E. Other Natural and Anthropogenic Factors

Climate Change

Climate change is an anthropogenic factor that is likely responsible for observed population declines in some reptile species (Pounds et al. 1999; Araújo et al. 2006) and may impact the petitioned skinks in the future. These skink species are restricted to small island environments with no ability to migrate as habitat conditions change and could be susceptible to extirpation from habitat lost from sea level rise or extreme weather events (like hurricanes) that are predicted to become more frequent with climate change.

Climate change is already causing a rise in temperatures across the United States and an increase in extreme weather events, such as droughts and floods (Parmesan et al. 2000; NSC 2003; CCSP 2008; Karl et al. 2009). This is particularly problematic for reptile populations because they are ectothermic. As such, they are sensitive to changes in air and water temperature, precipitation, and the hydroperiod (length of time and seasonality of water presence); their body temperatures and activity cycles are dependent on the presence of optimal environmental conditions (Lind 2008).

By altering both temperatures and precipitation regimes, global climate change will alter habitats such that many areas will no longer be capable of sustaining the reptile populations they now support (Wilson et al. 2006). In general, particular ecological communities are expected to move upward in both elevation and latitude in response to climate change (Walther et al. 2002), and montane and higher-latitude populations of reptiles are most at risk (Root et al. 2003). All of the petitioned species have narrow ranges and may experience range collapse under a climatic warming scenario because suitable environmental conditions no longer exist locally (see Early and Sax 2011). And while some currently unsuitable habitats may become suitable due to altered climatic regimes, the generally poor dispersal abilities of reptiles will probably prevent the petitioned skinks from colonizing those areas (see Gibbons et al. 2000).

Climate-driven changes are likely to combine with other human-induced stresses to further increase the vulnerability of the petitioned species. Most importantly, in a changing climate, populations of some pests such as rodents, which are better adapted to a warmer climate, are projected to increase (Karl et al. 2009).

Rising sea levels due to climate change may also inundate some occupied habitat for the species. Many Caribbean islands are small and low in elevation; coastal lowland habitats on such islands will be devastated by even a modest rise in sea level (Wilson et al. 2006). For example, the Culebra Skink is found at sea level just above the beaches (Hedges and Conn 2012) and could be impacted by sea level rise due to the loss of the beach interface, which, among other impacts, may result in a loss of food availability for the skinks that forage in beach wrack.

Pollutants

Pollutants (e.g., metals, pesticides, herbicides, nitrates, and phosphates) can impact reptile populations through both direct and indirect pathways (Gibbons et al. 2000) and are another potential threat to the petitioned skinks. However, studies addressing the impacts of pollutants on herpetofauna in the Caribbean, and on tropical faunas generally, are rare (Wilson et al. 2006).

Puerto Rico and the U.S. Virgin Islands have a long history of extensive plantation agriculture, with heavy pesticide use on crops such as sugar cane and bananas, even up to modern times (Wilson et al. 2006). Even if pesticides are not used in the precise areas where the skinks are found, pesticides can be dispersed many miles through runoff and drift (Sparling et al. 2001; Fellers et al. 2004; Smalling et al. 2013).

In addition, use of rodenticides to control introduced black rats or use of herbicides to control exotic plants may have indirect impacts on the skinks. Research suggests that important changes in an ecological community's food web can result from pesticide and herbicide exposure, which influence the susceptibility to contaminants (Boone and James 2003).

Some of the larger Caribbean islands have significant industrial or urban development, with associated problems of chemical pollution (Wilson et al. 2006). For example, human development in the U.S. Virgin Islands has led to increased pollution from sources such as illegal

garbage dumping, improper disposal of industrial waste, and disposal of untreated sewage (Platenberg and Boulon 2006; Platenberg et al. 2005). Exposure to such pollutants may also pose a threat to the skinks.

Isolation and Stochastic Events

Isolation is a threat to all of the petitioned species, which have low dispersal abilities and often exist in remnants of suitable habitat on their island environments. For species with single-island distributions, the risk of extinction as a result of stochastic events is a major concern, especially given that global climate change will likely result in more frequent extreme weather events, such as severe storms and droughts (Goldenberg et al. 2001; Emanuel 2005; Perry and Gerber 2006). For example, a direct hit by a hurricane to the remaining habitat for one of the skink species could lead to species extinction (e.g., Wiley and Wunderle 1993).

In addition, isolated populations are unlikely to be recolonized following a local extinction (Semlitsch and Bodie 1998). As such, small and isolated populations are more susceptible to extirpations due to stochastic events, human impacts, and environmental factors (Soulé 1987; Begone et al. 1990; Hanski 1999). In addition, lack of gene flow may cause loss of genetic variability due to random genetic drift (Wright 1931), and inbreeding depression may occur (Franklin 1980). And the loss of genetic diversity can affect a population's ability to respond to environmental changes, confounding the effects of climate change, contaminants, and introduced species.

Synergies and Multiple Causes

Some of the threats discussed in this petition could work in concert with one another to cumulatively create situations that potentially impact the petitioned skinks beyond the scope of the individual threats that we analyzed. For example, climate change could intensify impacts from introduced species such as rodents, which are better adapted to a warmer climate and are projected to increase with climate warming (Karl et al. 2009). Indeed, many studies have shown that most species face multiple threats that interact and magnify each other (see, e.g. Kiesecker et al. 2001; Gendron et al. 2003; Pounds et al. 2006).

V. CRITICAL HABITAT

Section 4(a)(3) of the Endangered Species Act and implementing regulations (50 C.F.R. § 424.12) require that, to the maximum extent prudent and determinable, USFWS designate critical habitat at the time the species is determined to be endangered or threatened. 16 U.S.C. § 1533(a)(3)(A)(i); *see also id*. at § 1533(b)(6)(C). The Endangered Species Act defines the term "critical habitat" to mean:

i. the specific areas within the geographical area occupied by the species, at the time it is listed . . . , on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and

ii. specific areas outside of the geographical area occupied by the species at the time it is listed . . . , upon a determination by the Secretary that such areas are essential for the conservation of the species.

Id. at § 1532(5)(A).

Survival of the nine petitioned species depends in large part upon lands set aside and managed for conservation. As such, Petitioner urges USFWS to comply with the ESA's unambiguous mandate and designate critical habitat concurrently with the listing of the skinks. Because of their very limited ranges, all habitats utilized for breeding, shelter, movement, and foraging meet the definition of critical habitat and therefore must be designated as such.

VI. CONCLUSION

The best scientific information available regarding the past, present, and future threats faced by the nine petitioned species of Caribbean skinks clearly shows that each of the species is likely to become extinct throughout all or a significant portion of their range. Specifically, the nine petitioned skinks are threatened by the following factors: present or threatened destruction, modification, or curtailment of habitat or range; predation by introduced predators; inadequate regulatory mechanisms; climate change; pollutants; and isolation and stochastic events. Based on this information, these animals must be listed as endangered species under the Endangered Species Act.

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