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Review of the Jamaican Boa (*Chilabothrus subflavus*): Biology, Ecology, and Conservation Management of a Vulnerable Species

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Abstract.—**Jamaican Boas, *Chilabothrus subflavus* (synonym *Epicrates subflavus*), comprise one of 13 endemic species of boas distributed throughout the Greater Antillean Islands and Lucayan Archipelago with many of these snake species facing an uncertain future in the wild. Habitat loss and fragmentation, invasive species, and human persecution have led to population declines, and therefore produced a need for an up-to-date assessment of the conservation status of the species. Although the true conservation status of *Chilabothrus subflavus* is unknown, it is currently listed as a Protected Animal under the Wild Life Protection Act of Jamaica, as Vulnerable by the International Union for the Conservation of Nature, and as an Endangered Foreign Species by the U.S. Fish and Wildlife Service. Habitat loss and fragmentation, coupled with introduced invasive species and human persecution, make it difficult to implement *in situ* management strategies to conserve the largest native snake species of Jamaica. Much of the information concerning *Chilabothrus subflavus* is challenging to obtain because it occurs within government documents and reports; therefore, no synthesis on the current state of knowledge of this species exists. Herein, we summarize the available published information on the biology, natural history, and ecology of *Chilabothrus subflavus* as well as review all data from captive breeding programs as it relates to the preservation and maintenance of genetic diversity in wild populations. We also discuss major threats this species faces in Jamaica and provide a multi-faceted list of research needs and recommendations to wildlife managers and researchers to enhance the conservation and protection of *Chilabothrus subflavus*.**

Key Words.—Caribbean; fragmentation; habitat loss; invasive species; Jamaica; reptile; snake

***Resumen*.—La boa Jamaicana, *Chilabothrus subflavus* (sinónimo *Epicrates subflavus*), comprende uno de las 13 especies endémicas de boas distribuidas por las Antillas Mayores y el archipiélago de Lucayan, y muchos de estas especies de serpientes enfrentan un futuro incierto en la naturaleza. La pérdida y fragmentación del hábitat, las especies invasoras, persecución humana y las enfermedades han llevado a la disminución de la población y, por lo tanto, a la evaluación actualizada del estado de conservación específico de la especie. Aunque se desconoce el verdadero estado de conservación de *Chilabothrus subflavus*, actualmente está catalogado como un Animal Protegido en la Wild Life Protection Act de Jamaica y como Vulnerable por la Unión Internacional para la Conservación de la Naturaleza, así como una especie extranjera en peligro de extinción por los U.S. Fish and Wildlife Service. Con la pérdida y fragmentación del hábitat, junto con las especies invasoras introducidas y la persecución humana, es difícil a la implementar estrategias de manejo in situ para conservar la especie de serpiente nativa más grande de Jamaica. Mucha de la información sobre *Chilabothrus subflavus* es difícil de obtener porque se encuentra dentro documentos e informes del gobierno Jamaiquino, por lo tanto, no existe una síntesis sobre el estado actual del conocimiento de esta especie. Aquí, resumimos toda la información publicada disponible sobre la biología, historia natural y la ecología de *Chilabothrus subflavus* así como discutimos las principales amenazas de esta especie en Jamaica. También proporcionamos una lista de necesidades de investigación y recomendaciones a los administradores e investigadores de vida silvestre por garantizar que se mejore la conservación y protección de *Chilabothrus subflavus*.**

Palabras Clave.—Caribe; especies invasoras introducidas; fragmentación; Jamaica; pérdida de hábitat; reptil; serpiente

Figure 1. Juvenile female Jamaican Boa (*Chilabothrus subflavus*) actively foraging for bats, Trelawny Parish, Jamaica. (Photographed by Brent C. Newman).

Introduction

West Indian boas, genus *Chilabothrus* (Reynolds et al. 2013a), at present comprise 13 endemic species distributed throughout the Greater Antilles (Cuba, Hispaniola, Jamaica, Puerto Rico, and the U.S. Virgin Islands), Turks and Caicos Islands, and the Bahamas (Reynolds and Henderson 2018). Due to relatively small species-range-size distributions (i.e., island ecosystems; Gaston 1998), and imperiled by habitat loss, fragmentation, and introduced invasive species, more than half of *Chilabothrus* snakes are listed under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (www.iucnredlist.org; Table 1). Furthermore, IUCN assessments for more than half of the species have not been updated for > 20 y (e.g., Cuban Boa, *C. angulifer,* Jamaican Boa, *C. subflavus,* Virgin Islands Boa, *C. granti,* and Mona Island Boa, *C. monensis*). To protect remaining habitat and implement effective management strategies vital to boid conservation in the West Indies, a better understanding of the general biology, distribution, and ecology of these snakes, especially species lacking up-to-date conservation assessment, should be a high priority (Attademo et al. 2004; Knapp and Owens 2004; Puente-Rolón et al. 2013; Newman et al. 2016). We focus on *C. subflavus* (Figs. 1 and 2) because (1) it was once abundant throughout Jamaica but now occurs in small, isolated pockets scattered throughout the island; (2) it is elusive and cryptic, making it difficult to perform fieldwork; and (3) its conservation is seriously hindered by a lack of *in-situ* ecological research crucial for the design and implementation of adaptive management strategies.

Figure 2. Neonate Jamaican Boa (*Chilabothrus subflavus*) from Runaway Bay, St. Ann Parish, Jamaica. (Photographed by Wendy Lee).

Once distributed island-wide (Gosse 1851), the largest native terrestrial predator in Jamaica, *C. subflavus*, now occurs only in isolated pockets on Jamaica (Fig. 3; Oliver 1982; Gibson 1996b; Newman et al. 2016). Although little is known about wild *C. subflavus* due to cryptic coloration, nocturnality, and overall lack of field research, this species has received a considerable amount of conservation attention (Diesel 1992; Tzika et al. 2008). Currently, the Jamaican Boa is listed as a Protected Animal under the Wild Life Protection Act of Jamaica (Government of Jamaica 1945), an Endangered Foreign Species by the U.S. Fish and Wildlife Service (USFWS; 1975), an Appendix I species by the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora (https://cites.org/sites/default/files/eng/app/2017/E-Appendices-2017-10-04.pdf), and a Vulnerable species by the IUCN in need of research to determine its present status (Gibson 1996a). Given the high rate of deforestation (Eyre 1987; Evelyn and Camirand 2003; Aide et al. 2013) and decline of *C. subflavus* populations in Jamaica (Oliver 1982; Gibson 1996b; Tzika et al. 2008; Newman et al. 2016), a comprehensive review is needed to assess the vulnerability of this species to landscape change and its current status, as well as provide information critical for future research and management actions. Herein we (1)

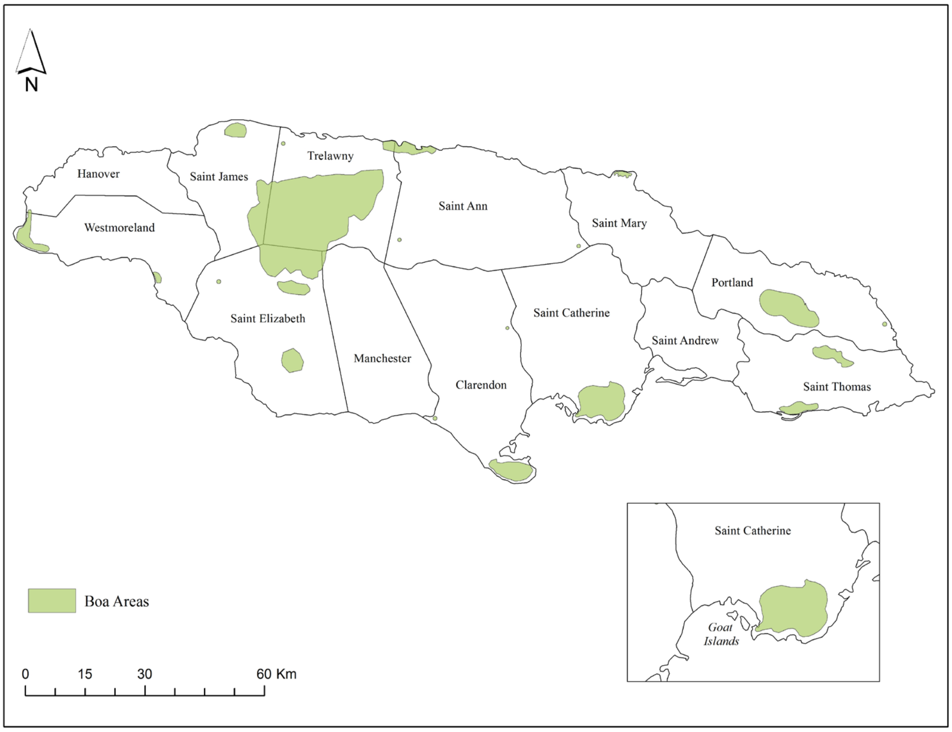

Figure 3. Distribution of Jamaican Boas (*Chilabothrus subflavus*) in Jamaica adapted from Newman et al. (2016).

compile all available information to provide the first literature review of the biology, ecology, and natural history of *C. subflavus*, (2) reevaluate the conservation status of this species, and (3) provide a multi-faceted list of research needs and management recommendations for the conservation of this species in Jamaica.

Materials and Methods

We searched the Web of Science, WorldCat, Directory of Open Access Journals, SciELO, EBSCOhost Academic Search Premier™, Science & Technology Collection™, and Google Scholar to find published scientific papers from international and regional (e.g., Caribbean) journals, books, historical documents and travel accounts of naturalists, unpublished government reports, and university theses published in English and Spanish to compile the available literature relevant to *C. subflavus*. Our search strategy included a combination of key words: Jamaican Boa, *Chilabothrus subflavus*, *Epicrates subflavus*, Jamaica + herpetofauna, boa + Caribbean, Conservation + Caribbean + reptiles. We supplemented all searches by reviewing bibliographies of literature obtained for additional references. Our findings are summarized and presented herein.

Table 1. *Chilabothrus* snakes recognized by the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. Citations are 1Day and Tolson 1996, 2Reynolds and Henderson 2018, 3Gibson 1996a, 4Reynolds and Buckner 2016, 5Tolson 1996a, 6Tolson 1996b, and 7Reynolds 2017.

Species	Common Name	Citation	Geographic Range	Conservation Status
Chilabothrus angulifer	Cuban Boa	Bibron 1840	Cuba	Near Threatened[1]
Chilabothrus chrysogaster	Turks & Caicos Island Boa	Cope 1871	Bahamas, Turks and Caicos Islands	Near Threatened[2]
Chilabothrus subflavus	Jamaican Boa	Stejnegar 1901	Jamaica	Vulnerable[3]
Chilabothrus exsul	Northern Bahamas Boa	Netting and Goin 1944	Bahamas	Vulnerable[4]
Chilabothrus granti	Virgin Islands Boa	Stull 1933	Puerto Rico, U.S. Virgin Islands, British Virgin Islands	Endangered[5]
Chilabothrus monensis	Mona Island Boa	Zenneck 1898	Isla de Mona	Endangered[6]
Chilabothrus argentum	Conception Bank Silver Boa	Reynolds et al. 2016a	Conception Island	Critically Endangered[7]

Biology

Morphology.—*Chilabothrus subflavus* is known by the common name Jamaican Boa, as well as Yellow-snake and Nanka. The earliest description of *C. subflavus* can be found in the original manuscripts of British observer John Taylor (1687), who described the snake as "being found chiefly in the silent woods…their skin of silver colour, curiously spoted with green and yellow spots… This serpent is of noe poisonus quality but of a prodigious strength." Two decades later, Sloane (1707) created the first engraving of *C. subflavus* using a 2.1-m long Yellow Snake brought to him by a local. Adult *C. subflavus* measure approximately 2.0 m in total length (TL) and exhibit sexual dimorphism as males possess pelvic spurs lateral to the vent and tend to be slightly smaller than females (Schwartz and Henderson 1991; Tolson and Henderson 1993). A historical report from Grant (1940) measured an adult male specimen at the Institute of Jamaica collected from Port Morant, St. Thomas Parish, Jamaica, at 218 cm in TL, 190 cm snout-vent length (SVL) and tail 28 cm. Included in Grant (1940) is an anecdotal report provided by a lighthouse keeper at Portland Point, Clarendon Parish, Jamaica, in which the man states "that he killed many nankas in 1935, fewer in 1936, and only three in 1937…the largest specimen measured nine and one-half feet, but the average was six and one-half feet." The aforementioned observation was never confirmed; however, *C. subflavus* is recognized as one of five large-bodied boa species in the genus *Chilabothrus* (Reynolds et al. 2016b). Reynolds et al. (2016b) report a maximum SVL of 2.05 m (n = 6) for *C. subflavus*. Other measurements of wild-caught *C. subflavus* are reported by Miersma (2010), of which males (n = 4) had a mean SVL = 152 ± (standard deviation) 24.93 cm and weight = 1,725 ± 636.57 g and females (n = 8) had a mean SVL = about 155 ± 22.54 cm and weight = about 1,952 ± 627.62 g. Newman et al. (2019) reported that females (n = 7) had a mean SVL = 149 ± 4 cm and weight = 1,823 ± 155 g. Neonate *C. subflavus* range in SVL from 36 to 53 cm (Reynolds et al. 2016b) and are commonly referred to as the red switchy-tail (Grant 1940).

The first morphological diagnosis and description for *C. subflavus* is based on examination of an adult of unknown sex about 153 cm SVL from Jamaica, holotype 14507, U.S. National Museum of Natural History Stejneger (1901) provided. Detailed descriptions also are provided by Grant (1940), Schwartz and Henderson (1991), and Tolson and Henderson (1993). Kluge (1991) describes osteological characters of boine snakes and discusses various aspects of their external and internal soft anatomy of which he provides a detailed illustration of bone structure (lower mandible) of *C. subflavus*. A brief description of *C. subflavus* scale morphology is as follows: dorsal scale rows on the neck numbering 33–41, at midbody 41–47, ventrals 277–283, subcaudals 78–79, and a formula of 2–1–2 at the dorsal and lateral head scales anterior to the parietal region (Grant 1940; Kluge 1991; Tolson and Henderson 1993). Adult coloration varies from yellow, tan, or light to dark orange on the dorsal and ventral scales (Fig. 1). Coloration also is influenced by age such that older *C. subflavus* may display physiological color change from light phase (i.e., yellow) to dark phase (i.e., orange), which has been documented in other mainland and island boas (Hedges et al. 1989; Boback and Siefferman 2010). Black banding occurs on the dorsal scales expanding posteriorly to form an almost completely iridescent black tail that is stippled with yellow. Adults have a greenish yellow chin and an orange venter with occasional black spots and two black stripes at the temporal scales (Grant 1940; Tolson and Henderson 1993). Neonate coloration varies from amber, marigold, or light tan on the dorsal and ventral surfaces with dark yellow to brown cross banding and a cream-colored venter (Fig. 2; Tolson and Henderson 1993). Captive neonate *C. subflavus* exhibit ontogenetic color change to develop adult coloration between one and two years of age, which has been observed in other West Indian boa species (Ferri 2000). *Chilabothrus subflavus* can be distinguished from all other congeners by scale count as well as their iridescent black tail.

Systematics.—Historically, *C. subflavus* was mistakenly classified as *C. inornatus* (Puerto Rican Boa; e.g., *Boa inornata* Reinhardt 1843; *Chilabothrus inornatus* Duméril and Bibron 1844; Gray 1849; Gosse 1850; Hallowell 1856; Jan and Sordelli 1860; Cope 1868; Garman 1883; Cockerell 1893; Bocourt 1909; *Epicrates inornatus* Boulenger 1893; Orcutt 1928). Based on coloration and morphological distinctness criteria such as (1) preocular in contact with prefrontals; (2) two pairs of parietals instead of one; and (3) greater number of ventrals, *C. subflavus* was elevated to species status and classified as *Epicrates subflavus* Stejneger 1901.

Once part of the genus *Epicrates* Wagler 1830, West Indian boas were considered congeners of the *Epicrates cenchria* complex from mainland Central and South America (McDiarmid et al. 1999; Rodríguez-Robles et al. 2015). Initiated by Sheplan and Schwartz (1974), investigations into the phylogenetic relationships and systematics of the West Indian boas continued for much of the 20th Century (see Underwood 1976; McDowell 1979; Dessauer et al. 1987; Tolson 1987; Kluge 1988, 1989, 1991; Crother 1999). Recent examination of West Indian *Epicrates* phylogeny using sequence data from the mitochondrial cytochrome *b* gene (Cyt-*b*; Campbell 1997; Burbrink 2005), Cyt-*b* sequence data supplemented with portions of five nuclear loci (Noonan and Chippendale 2006), and Cyt-*b* sequence data analyzed in parallel with three other nuclear genes plus environmental niche models (Rivera et al. 2011) concluded that *Epicrates* is paraphyletic in relation to *Eunectes* Wagler 1830 (anacondas). Further molecular investigations by Reynolds et al. (2013a) not only corroborated the above-mentioned results but also established evidence for a taxonomic revision for the West Indian boa clade to *Chilabothrus* Duméril and Bibron 1844 and restricted genus *Epicrates* to the five mainland boa species endemic to Central and South America (Pyron et al. 2014; Rodríguez-Robles et al. 2015). Based on evidence presented in Reynolds et al. (2013a), the change in nomenclature from *Epicrates subflavus* to *Chilabothrus subflavus* is now widely accepted (e.g., IUCN Red List of Threatened Species, Association of Zoos and Aquariums (AZA), the United Nations Environment Programme World Conservation Monitoring Centre (https://cites.org/sites/default/files/eng/com/ac/28/E-AC28-21-01-Annex9.pdf), and The Reptile Database: www.reptile-database.org). At present, no subspecies have been identified for *C. subflavus.*

***Population genetics*.—**Molecular investigations related to the biogeographic and evolutionary relationships of West Indian *Chilabothrus* are ongoing; however, based on the first multilocus phylogenetic analysis (two mitochondrial and eight nuclear loci) of the West Indian clade, Reynolds et al. (2013a) estimated a mean divergence time of 30.2 Mya for *Chilabothrus* boas from mainland *Epicrates* and *Eunectes.* Results from Reynolds et al. (2013a) also suggest that *C. angulifer* represents the most basal lineage of the West Indian *Chilabothrus* radiation and *C. subflavus* split from the clade at an estimated mean divergence time of 17.3 Mya. Despite many detailed phylogenetic studies of West Indian boid snakes (referenced above and thoroughly discussed in Reynolds et al. (2013a, 2014), only one population level genetic analysis conducted by Tzika et al. (2008) exists *apropos* of genetic structure and diversity of wild and/or wild-born *C. subflavus*. Using nine polymorphic nuclear microsatellite loci, a fragment of Cyt-*b* gene sequence for *C. subflavus* (647 bp; National Center for Biotechnology Information U69803), and Bayesian model-based clustering methodology, Tzika et al. (2008) inferred *C. subflavus* population genetic structure via tissue and blood samples obtained from 87 individuals (GenBank accession nos EU138894-EU138905). Analysis of microsatellite data by Tzika et al. (2008) indicate a clustering of samples into three groups (i.e., assigned populations) corresponding to west (group 1), west+central (group 2) and east (group 3) Jamaica. Additional network inference analysis of Cyt-*b* sequence data by Tzika et al. (2008) also revealed two well differentiated haplogroups partially supportive of their microsatellite-based population results. Combined, these results illustrate that haplogroup I is primarily characterized by snake samples obtained from west (group 1) Jamaica and haplogroup II corresponds to samples from east (group 3) Jamaica with west+central (group 2) samples distributed throughout haplogroups I and II. The moderately large phylogeographic gap corresponding to an eastern and western+central division among wild *C. subflavus* also suggests a pattern of genetic divergence parallel to the geological history of Jamaica (see Tzika et al. 2008 for map of *C. subflavus* population genetic structure in Jamaica).

***Captive breeding in North America*.**—Founded in 1964, the AZA maintains a *C. subflavus* captive breeding program distributed and maintained among 19 AZA member facilities as well as three non-AZA facilities via the AZA Species Survival Plan® (SSP). At present, the SSP population consists of 91 snakes (27 males, 30 females, and 34 unknown sex) descended from 36 founders with two potential founders remaining (Snider and Andrews 2019). Assuming Hardy-Weinberg equilibrium (Hardy 1908; Weinberg 1908), calculations based on allele frequencies and heterozygosity expected in progeny produced by random mating estimate that current genetic diversity of the *C. subflavus* SSP population is about 90.41% (Snider and Andrews 2019). Therefore, the AZA *C. subflavus* SSP population is classified as a Yellow SSP Program, which is defined as a captive population size of ≥ 50 animals that cannot retain 90% gene diversity for 100 y or 10 generations (Snider and Andrews 2019). Other SSP management designations include Green, Red, and Candidate programs. Management designations are based on captive population size, participating AZA member facilities, and projected gene diversity information obtained from published AZA studbooks (AZA 2020). Overall, the goal of SSP program management is to maintain an Ideal (or target) number of captive breeding animals that would have the same rate of inbreeding or decrease in genetic diversity due to genetic drift as a compared to a naturally occurring population (i.e., the same genetically effective population size).

Critical to maintaining a healthy and genetically diverse captive breeding population, the AZA Snake Taxon Advisory Group (TAG) has made it a short- to long-term goal of attaining a target population size of 100–150 individuals for the AZA SSP population of *C. subflavus* (2016 Regional Collection Plan). Based on the Snake TAG recommended lower target population size of 100 individuals, as well as data from the North American Regional *C. subflavus* Studbook (1976 to 2018), Snider and Andrews (2019) devised the fifth formal Breeding and Transfer Plan for the *C. subflavus* SSP via demographic and genetic analyses software (PopLink 2.4, PMx 1.5.20180429, and MateRx). Assuming a 1.1% growth rate and population target of

100 individuals, Snider and Andrews (2019) determined that the *C. subflavus* SSP population can maintain 59.5% gene diversity at the end of 100 y; however, if effective population size increases, gene diversity can be retained at 78.5% over 10 generations (i.e., 100 y time period). In addition, Snider and Andrews (2019) estimate if gene diversity falls below 90% of that in the founding population, overall *C. subflavus* SSP population fitness may experience significant negative effects (e.g., increase in mortality and/or reduced health in neonates), which has significant implications if captive bred individuals are needed to re-establish or recover *C. subflavus* populations in the wild (Fraser 2008).

Captive breeding in Europe.—Initiated by the Durrell Wildlife Conservation Trust (Jersey, UK) in 1976, seven *C. subflavus* (four males and three females) were brought from Hope Zoo (Kingston, Jamaica) to Europe, providing a wild founder population to establish a captive breeding program among European zoological and private institutes (Tzika et al. 2009). To maximize gene diversity and limit inbreeding, an additional four wild-born *C. subflavus* (three females and one male) were incorporated into the founder population in 1993 and in 2002, respectively. Pedigree information on captive breeding *C. subflavus* populations was formerly compiled and cataloged in the European Endangered Species Program (EEP), European Association of Zoos and Aquaria (EAZA) studbook (Tzika et al. 2009). As of 2009, the EAZA-EEP *C. subflavus* breeding program has produced about 600 offspring of which 80 individuals are still alive and distributed among 14 European institutions, but three male and four female founders have died (Tzika et al. 2009).

To maintain an up-to-date studbook as well as sustain a genetically diverse EAZA-EEP captive population, Tzika et al. (2009) conducted a molecular genetic analysis of *C. subflavus* (n = 47 sampled individuals) collected from 13 European zoos. Using DNA extracted from blood, scale, and shed skin samples, Tzika et al. (2009) analyzed mitochondrial DNA fragment (Cyt-*b*) and nine nuclear microsatellite loci showing that (1) all living, first generation EAZA-EEP captive *C. subflavus* likely originated from two female and two male founders, (2) parental assignment and sire identity data from the original studbook was incorrect for some first generation individuals within the program, (3) a revised breeding and transfer plan for the EEP-EAZA *C. subflavus* captive population is necessary to maximize genetic diversity (see also Witzenberger and Hochkirch 2011); and (4) all founders of the EEP-EAZA *C. subflavus* captive population originated from one of the three genetic clusters within wild *C. subflavus* populations identified in Tzika et al. (2008).

Reproduction and longevity.—*Chilabothrus subflavus* is viviparous. Based on anecdotal reports, the breeding season of this species in the wild is believed to take place in March and April just before the rainy season, with gestation occurring in the warmest months, May to August, and parturition at the end of the rainy season, September and October (Miersma 2010). The aforementioned seasonal reproductive activity for wild *C. subflavus* is unconfirmed; however, similar seasonal reproductive activity patterns have been observed for *C. angulifer* (see Rodríguez-Cabrera et al. 2016) as well as other *Chilabothrus* snakes reviewed in Henderson and Powell (2009). Size and age at which wild male and female *C. subflavus* reach sexual maturity is unknown (but see captive breeding data below). During courtship, *C. subflavus* often pair and twist themselves into knots while maintaining cloacal contact (Gosse 1851). As these snakes pair and begin courtship, other males of the same species frequently approach and exhibit balling behavior in an attempt to mate with the female (Gosse 1851; Henderson and Powell 2009). Characteristic in males of the family Boidae, *C. subflavus* use their spurs to stimulate females (Hanlon 1964; Mattison 2007; Senter et al. 2014) as well as for intermale aggression/combat activities prior to mating (Carpenter et al. 1978; Tolson 1992; Senter et al. 2014).

Information on the reproductive biology of *C. subflavus* is primarily derived from captive observations. According to data from the North American Regional studbook (1976 to present), captive *C. subflavus* begin to breed at about 7 y of age for both males and females. Many factors influence snake development and reproductive output (e.g., environmental conditions and prey availability); therefore, size at sexual maturity is also important to consider when discussing/comparing the reproductive biology of captive and wild *C. subflavus* (Ford and Seigel 1989; Cardiff 1996; Brown and Shine 2007; Madsen and Shine 2008; Hill et al. 2019). Litter sizes range from one to 30 individuals with an average of six to seven snakes per litter weighing 12.3–19.0 g and measuring 36–53 cm snout-to-tail at parturition (Grant 1940; Tolson and Henderson 1993; Snider and Andrews 2019). Copulation is facilitated by putting at least two males in the presence of a single female (Tzika et al. 2009), after which one male will pair and mate with the female. Captive *C. subflavus* have been observed mating from January until June (Bloxam and Tonge 1981), though the breeding season is generally from March to June (Snider and Andrews 2019). Copulation can last 3–14 h with gestation periods lasting between 160 and 220 d, the variation due to environmental conditions as well as sperm storage by females (Tolson and Henderson 1993). Parturition of captive animals often occurs between September and

October (Bloxam and Tonge 1981; Snider and Andews 2019). Like other *Chilabothrus* species, *C. subflavus* are believed to be biennial in relation to breeding frequency (Tolson and Henderson 1993). A breeding group of *C. subflavus* housed at the Jersey Wildlife Preservation Trust, however, engaged in annual reproduction during a 3 y period from 1977–1979, which may have been due to readily available food allowing the females to regain enough mass to reproduce annually (Bloxam 1977; Tolson and Henderson 1993). During breeding activity at the Columbus Zoo (Ohio, USA), a female *C. subflavus* killed and ate a male placed in her cage, but to date, this is the only observed occurrence of cannibalism in *C. subflavus* (Tolson and Henderson 1993). Ophiophagy has been observed in other captive West Indian boas (*Chilabothrus striatus strigilatus*; Mittermeier 2011), however.

No information exists regarding the lifespan of wild *C. subflavus*. Based on data from the North American Regional Studbook (1976–2019), however, median life expectancy (MLE) for captive male *C. subflavus* is 23.7 y, of which the oldest recorded age for a captive male is 38 y old and maximum recorded breeding age is 30 y old (Snider and Andrews 2019). For captive female *C. subflavus* the MLE is 15.8 y, of which the oldest recorded age is 31 y old and maximum recorded breeding age is 22 y old (Snider and Andrews 2019). Furthermore, recent MLE estimates by Che-Castaldo et al. (2019) using individual demographic data derived from AZA studbooks (1980–2017) for *C. subflavus* (n = 206) determined overall MLE = 17.4 y (95% confidence interval [CI] = 15.7–19.0 y). For captive males (n = 93), Che-Castaldo et al. (2019) report an MLE of 21.3 y (95% CI = 16.6–24.8 y) and for females (n = 78), an MLE of 15 y (95% CI = 11.8–17.4 y).

Ecology

***Distribution*.**—Historically, *C. subflavus* was found in considerable abundance throughout Jamaica (Beckford 1790; Stewart 1808; Phillippo 1843; Vernon 1848; Gosse 1851), especially in rural areas (Browne and Ehret 1756) and nearby outlying islands, in particular, the Goat Islands (Cockrell 1893; Barbour 1910, 1922). Subsequent to the introduction of *Herpestes auropunctatus*, the Small Indian Mongoose (Hodgson 1836; Bennett et al. 2011), to Jamaica in 1872, Espeut (1882), Eric (1897), and Barbour (1910) noted the absence of boas on the mainland. It is recognized, however, that the species is naturally secretive and difficult to detect (Diesel 1992; Gibson 1996b). More recent surveys also have failed to confirm the presence of *C. subflavus* on Great Goat Island, which encompasses 190 ha of dry limestone forest (Gibson 1996b; Lazell 1996).

Island-wide distributional surveys have been conducted by Oliver (1982) and Gibson (1996b). Based on three months of field surveys and interviews with local residents, Oliver (1982) constructed a rough distributional map. Gibson (1996b) revisited sites from the survey of Oliver (1982) during a five-week period and observed *C. subflavus* in Trelawny, St. Anne, Westmoreland, and Hanover Parishes. Gibson (1996b) also documented a handful of boa localities by examining the Hope Zoo acquisition and disposal diaries for 1990–1995. Using the distributional maps created by Gibson (1996b) and Oliver (1982), as well as other previous published reports for this species, Newman et al. (2016) developed the most up-to-date distributional map of *C. subflavus* on Jamaica (Fig. 3). Results from Newman et al. (2016) showed that current *C. subflavus* distribution constitutes only 1,000.6 km² of Jamaica (approximately 9% of the island), with observed areas ranging in size from 0.6–668.9 km² with much of the populations now localized and severely disjointed due to habitat fragmentation and anthropogenic landscape changes (Tzika et al. 2008; Newman et al. 2016). Newman et al. (2016) also determined that cumulatively, Cockpit Country, Blue Mountains, Yallah Mountains, Hellshire Hills, and Portland Bight account for 93% (about 930.5 km²) of known areas of boa occurrence, suggesting these areas may constitute the remaining strongholds for *C. subflavus* within Jamaica.

Behavior*.—Chilabothrus subflavus* is primarily nocturnal and arboreal (Newman et al. 2019). This species also may exhibit crepuscular activity patterns possibly influenced by environmental conditions (e.g., ambient temperature, weather, etc.), prey abundance, and seasonal activities (e.g., reproduction), which is consistent with other research (Marques and Puorto 1998; Brown and Shine 2002; Maciel et al., 2003; Sperry et al. 2013). During the day, *C. subflavus* shelter in epiphytes, trees, rock crevices, termite nests, or caves. In one instance, boas were observed at the extreme back passage of Portland Cave (Fig. 4; Grant

Figure 4. Adult Jamaican Boa (*Chilabothrus subflavus*; sex unknown) resting, Trelawny Parish, Jamaica. (Photographed by Brent C. Newman).

Table 2. Dietary items known to be eaten by Jamaican Boas (*Chilabothrus subflavus*).

Prey Items		
Scientific Name	Common Name	Author Citation
Rattus spp.	Rats	Bain and Hurst 1982; Miersma 2010
Herpestes auropunctatus	Small Indian Mongoose	Bain and Hurst 1982
Molossus molossus	Velvety Free-tailed Bat	Miersma 2010
Artibeus jamaicensis	Jamaican Fruit Bat	Koenig and Schwartz 2003
Melanerpes radiolatus	Jamaican Woodpecker	Miersma 2010
Corvus jamaicensis	Jamaican Crow	Schafer et al. 2018
Eupsittula nana	Olive-throated Parakeet	Koenig et al. 2015
Amazona agilis	Black-billed Parrot	Cruz and Gruber 1981; Koenig 2001; Koenig et al. 2007
Amazona collaria	Yellow-billed Parrot	Cruz and Gruber 1981; Koenig 2001; Koenig et al. 2007
Myiarchus barbirostris	Sad Flycatcher	Grant 1940
Columba spp.	Pigeons	Grant 1940
Gallus gallus domesticus	Domestic Chicken	Gosse 1851
Cyclura collei	Jamaican Iguana	Wilson and Van Veen 2006
Anolis valencienni	Jamaican Twig Anole	Singhal et al. 2007
Rhinella marina	Cane Toad	Wilson et al. 2011
Anurans	Frogs	Tolson and Henderson 1993

1940; Schwartz and Henderson 1991; Henderson and Powell 2009). *Chilabothrus subflavus* also bask on rocks after heavy rains in the morning as well as rest on roads and trails in the evenings (Gosse 1851; Grant 1940; Schwartz and Henderson 1991; Henderson and Powell 2009). This behavior further suggests that the species will exhibit crepuscular behavior under certain circumstances, which is similar to observations made on other congeners (Henderson and Powell 2009).

Foraging and diet.—Foraging behavior of wild *C. subflavus* is not well documented; however, this species is considered an ecological generalist that will kill (via constriction) and consume a variety of prey items (Table 2; Reynolds et al. 2016b). Brief field observations suggest *C. subflavus* will engage in both active and ambush strategies at ground, understory, or at canopy level dependent on habitat structure, available food resources at foraging site, and ontogeny (Prior and Gibson 1997; Koenig et al. 2007; Newman et al. 2019) as has been observed in other West Indian *Chilabothrus* species (Lillywhite and Henderson 1993; Tolson et al. 2007; Henderson and Powell 2009). For example, at three cave systems, Prior and Gibson (1997), Vareschi and Janetzky (1998), Koenig and Schwartz (2003), and Dávalos and Eriksson (2004) observed *C. subflavus* roosting (i.e., waiting) and/or hanging from branches and vines to strike at bats as they emerged in the evening. This foraging strategy also has been reported for *C. inornatus* and *C. angulifer* (Hardy 1957; Silva-Taboada 1979; Rodríguez-Duran 1996; Puente-Rolón and Bird-Picó 2004). Research on the feeding habits of wild *C. subflavus* also indicates avian prey are an important food resource as ontogenetic shift in diet occurs. For example, Prior and Gibson (1997), Koenig (2001), and Koenig et al. (2007) identified *C. subflavus* as a significant predator of both Black-billed Parrots (*Amazona agilis*) and Yellow-billed Parrots (*A. collaria*). In addition, *C. subflavus* is also recognized as one of the leading causes of nest failure for these two endemic bird species, especially at breeding/nesting sites located at forest edges as compared to interior forest habitats (Koenig et al. 2007). Wilson et al. (2011) provide evidence that invasive Cane Toads (*Rhinella marina*) are preyed on by *C. subflavus*. If consumed, however, this toad will secrete toxins capable of causing mortality of *C. subflavus* (Wilson et al. 2011). Though rare, *C. subflavus* also will opportunistically enter human dwellings and agricultural areas in search of prey (e.g., rats, *Rattus* spp., and chickens, *Gallus gallus domesticus*). In captivity, juvenile and adult *C. subflavus* are often fed a diet of rats every two to three weeks. Captive neonate *C. subflavus* are usually fed chicks (*G. gallus domesticus*) and/or pre-killed, frozen House Mice (*Mus musculus*) often treated with chick, lizard, or frog scent to stimulate consumption (Snider 2016).

Predation.—Currently, no published data exist on natural predators of *C. subflavus*, but birds such as American Kestrel (*Falco sparverius*; Cruz 1976), Red-tailed Hawk (*Buteo jamaicensis*), Broad-winged Hawk (*Buteo playpterus*), Jamaican Owl (*Pseudoscops grammicus*), Northern Harrier (*Circus cyaneus*), herons and egrets (Family Ardeidea), and other avian species are documented as predators of West Indian reptiles and amphibians (Powell and Henderson 2008) and may depredate *C. subflavus* in the wild, especially neonate snakes. Jamaican Crows (*Corvus jamaicensis*) also are known to mob *C. subflavus* that get near crow nests or fledglings, which is presumably done (1) as a defense tactic of nests and fledglings, (2) to teach offspring predator recognition and how to react, and (3) to improve social status (Schaefer et al. 2018). Non-native, invasive predators include the *H. auropunctatus*, Feral Domestic Cats (*Felis catus*), Feral Domestic Dogs (*Canis lupus familiaris*), and though rare, Goats (*Capra aegagrus hircus*) and Pigs (*Sus scrofa domesticus*).

While little is known about the defensive behavior of wild *C. subflavus*, its cryptic coloration allows it to escape detection in its natural habitat as well as retreat from predators in dense vegetation. When threatened, the defensive display of *C. subflavus* includes hissing, biting, throat inflation, and cloacal secretions that often produce an extremely foul odor and become rancid when exposed to oxygen, thus decreasing palatability (Tolson 1987). These secretions also are hypothesized to play a role in slowing evaporative water loss as well as species and sex recognition (Tolson 1987; Tolson and Henderson 1993).

Home range and activity patterns.—Research by Newman et al. (2019) supports Gibson's (1996) assessment of the secretive behavior of this species such that probability of visually detecting radio-tracked *C. subflavus* during a 2-y study was only 22.0% for resident snakes (n = 7) and 10.0% for short-distance translocated (SDT) snakes (n = 7) at all radio tracked location sites. Wunderle et al. (2004) recorded visual detection rate of 15.5% of all radio tracked locations for the ecologically similar *C. inornatus* in Luquillo Experimental Forest, Puerto Rico, with visibility increasing after Hurricane George due to strong winds that reduced cover (e.g., epiphytes and leaves) and access (e.g., branches and vines) to arboreal sites. Newman et al. (2019) also showed that areas used by SDT female *C. subflavus* ranged in elevation from 46–328 m with mean home range areas = 0.305 ± (standard error) 0.10 ha and 3.21 ± 0.71 ha for 50% and 95% Minimum Convex Polygons (MCP), respectively, and 1.38 ± 0.4 ha and 11.01 ± 3.1 ha 50% and 95% Adaptive Kernels (AK), respectively. Although conclusions were made from a temporally restricted data set, Miersma (2010) showed that resident (i.e., non-translocated) male *C. subflavus* had larger 95% MCP mean activity areas of 10.53–14.03 ha as compared to females at 2.24–3.66 ha. Resident males also had larger 50% MCP mean core areas of use at 1.42–1.95 ha as compared to females at 0.29–0.81 ha (Miersma 2010).

Habitat use.—*Chilabothrus subflavus* has been observed in a variety of ecotypes, such as humid tropical and montane forests, limestone scrub-forest, swamplands, mangrove, and cave systems (Gosse 1851; Grant 1940; Tolson and Henderson 1993; Henderson and Powell 2009). Based on two radio-telemetry studies conducted by Miersma (2010) and Newman et al. (2019), *C. subflavus* prefer areas of primary and secondary forests and open savannas that border broadleaved forests. In addition, *C. subflavus* use arboreal microhabitats in greater proportion than terrestrial locations, and are found in areas characterized by tall, canopy layer trees with canopy-crown connectivity to neighboring trees and with high densities of vines and epiphytes (Newman et al. 2019).

Niche.—*Chilabothrus subflavus* are considered a top predator and are known to engage in both active and ambush predation using vines and tank bromeliads (*Aechmea paniculigera*) for mobility and camouflage (Koenig et al. 2007; Henderson and Powell 2009). Observations made by Grant (1940) suggest that *C. subflavus* actively raid flycatcher (*Tyrannidae* spp.) nests. Cruz and Gruber (1981), Koenig (2001), and Koenig et al. (2007) have identified *C. subflavus* as a predator of Black-Billed Parrots (*A. agilis*) and Yellow-Billed Parrots (*A. collaria*) in Cockpit Country, Jamaica. While no published data exist on the relative abundance of *C. subflavus* in Jamaica, research suggests *A. agilis* experience a higher rate of nestling predation by boas in ecotones as compared to forest habitat; therefore, a correlation may exist between the foraging ecology of *C. subflavus* and edge habitat in Cockpit Country (Koenig et al. 2007), which is similar to findings on other snake species (Weatherhead 1985; Dodd and Smith 2003; Baldwin and Machand 2004).

Although little is known about the foraging behavior of *C. subflavus* at cave systems, extensive research conducted by Puente-Rolón and Bird-Picó (2004) on cave populations of Puerto Rican Boas at Cueva de los Culebrones showed *C. inornatus* tend to depredate smaller bat species of which successful capture depended on perch position occupied by boas. The most used perch categories by *C. inornatus* were wall limestone outcroppings, looped roots, and vines across the center of the cave openings with looped perches providing the highest rate of prey-capture success (Puente-Rolón and Bird-Picó 2004). Competition for the looped roots as a hunting spot by *C. inornatus* was observed with only one snake occupying this site at a time whereas two or more snakes occupied other perch categories simultaneously while foraging (Puente-Rolón and Bird-Picó 2004). Individuals occupying looped roots during the day also occupied these sites during feeding time with interference between *C. inornatus* resulting in confrontation (abandonment of hunting posture to snout to snout position) with three observed confrontations resulting in loss of prey (Puente-Rolón and Bird-Picó 2004). Combat between male *C. subflavus* has only been observed in captivity and increased female aggression toward conspecifics has been observed under certain conditions (Huff 1976, 1979).

Diseases and parasites.—No studies have confirmed the presence of disease or infectious agents (e.g., viruses, bacteria, fungi, protozoa, and helminths) from wild *C. subflavus* populations (Wilson 2011). Although *Ophidiomyces ophidiicola* (Snake Fungal Disease) is recognized as an emerging threat to wild snakes in the USA (Burbrink et al. 2017), to date there is no evidence of this fungal disease occurring in wild *C. subflavus* populations. Inclusion body disease (IBD) has been identified in captive *C. subflavus* populations and could pose a threat to native wild populations if captive snakes are being bred for reintroduction to Jamaica (Jacobson 2007; Chang and Jacobson 2010). Ectoparasites collected from wild *C. subflavus* populations include two species of hard tick (Acari: Ixodidae): *Amblyomma quadricavum* Schulze, 1941 (previously known as *Aponomma quadricavum*; Burridge 2011) and the Iguana Tick (*Amblyomma dissimile*). *Amblyomma quadricavum* poses little to no threat to *C. subflavus* health nor is this tick species associated with pathogen transmission to humans or other species. *Amblyomma dissimile* is primarily a parasite of reptiles and amphibians and may pose a minor threat to *C. subflavus* health as it has been documented to cause ulcers, pustular dermatitis, and vector the hemogregarine parasite *Hepatozoon fusifex* in other snake species (Dunn 1918; Ball et al. 1969; Foster et al. 2000; Burridge 2011). Grant (1940) reported the Relapsing Fever Tick, *Ornithodoros turicata* (referred to in his report as *Ornithodoros americanus*), as infesting *C. subflavus* from Goat Island. *Ornithodoros turicata*, is a soft tick (Acari: Argasidae) that parasitizes amphibians, reptiles, and mammals (Olúsolá and Phillips 1996). Although *O. turicata* poses little to no threat to *C. subflavus* health, this tick species is a vector of the bacterium *Borrelia turicatae*, commonly referred to as New World Tick-borne Relapsing Fever, and viruses in the genus *Asfivirus,* and therefore is a significant health concern to humans and domestic swine, respectively (de la Fuenta et al. 2008). Although parasite loads can strongly affect host fitness, behavior, and spatial ecology (Natusch et al. 2018), at present no research has been conducted to determine the impacts of ectoparasites on the ecology or transmission of disease in wild *C. subflavus* populations.

Conservation Threats

The total area of the West Indian Islands (excluding Trinidad and Tobago) only comprises 0.15% of land area of the Earth but supports approximately 6.5% of the known reptiles of the world with new species currently under study and soon to be identified (Hedges 2006). At approximately 11,000 km^2, Jamaica is the third largest island in the West Indies with wide ranging elevational gradients (sea level to 2,256 m) and mountainous terrain highly susceptible to soil erosion (Bates et al. 1986; Headley and Evelyn 2000). Jamaica is broadly divided into three major physical regions: the Limestone Region, Blue Mountains Region, and Coastal Plain Region (Hennemann and Mantel 1995) of which *C. subflavus* populations can be found in all three physical regions (Fig. 3). Due to various geological events and tectonic activities, each region contains different soil compositions, varying climates and topographically unique landscapes that once sustained high densities of reptiles and amphibians. Currently Jamaica supports a native herpetofauna of 64 species; however, six species have not been sighted in over 20 y and the conservation status of many others is unknown (Wilson 2011). Although no comprehensive assessment of the conservation status of West Indian reptiles exists, two main factors have been recognized as the leading threats to snake conservation in the Caribbean: habitat loss coupled with fragmentation and introduced invasive species. In this section, we consider the vulnerability of *C. subflavus* populations within the context of these two documented conservation threats in Jamaica.

Habitat loss.—Jamaica was once heavily forested, but due to centuries of anthropogenic pressure, primarily unsustainable agriculture, suburban sprawl, tourism, and bauxite mining, much of the primary forest and natural vegetation of the island has become severely degraded. Today, < 10% of primary forest habitat remains and except for a few remote areas, Jamaica has retained little pristine habitat (Headley and Evelyn 2000; Evelyn and Camirand 2003; Berglund and Johansson 2004; Wilson 2011). Based on the most recent assessment of forest cover and land use in Jamaica conducted by the Jamaica Forestry Department, 30% of Jamaica, approximately 3,359 km^2, is classified as forest, of which 2,150 km^2 (64%) is unprotected and 880 km^2 (8%) is classified as closed broadleaved forest (primary forest) with minimal human disturbance (Headley and Evelyn 2000). Newman et al. (2016) estimated that < 10% of the total land area of Jamaica constituted useable habitat for *C. subflavus*. The protection and conservation of Cockpit Country is particularly critical as it is the largest tract of contiguous primary forest left in Jamaica and contains the highest concentration of endemic amphibian and reptile species (Wilson 2011). Further, research by Newman et al. (2016) showed that it consists of 64% of habitats used by *C. subflavus* in greater proportion than available as well as 39% and 15% of the habitats *C. subflavus* used in greater occurrence than available throughout its distribution as well as within all of Jamaica, respectively (Newman et al. 2016).

***Fragmentation.*—**Due to their arboreal nature, *C. subflavus* have limited mobility and specific habitat requirements (e.g., primary and secondary forests) that may increase their vulnerability to anthropogenic landscape change. In addition to habitat loss, commercial mining for bauxite also plays a significant role in fragmentation of *C. subflavus* habitat in Jamaica as it creates barriers to dispersal, increased opportunities for mortality, and greater human access to previously inaccessible areas of forest via construction of roads and trails (Durán et al. 2013). Selective logging activities for construction materials, charcoal production and firewood, and yam sticks (saplings harvested to provide support for growing/climbing yam vines) for small scale agriculture occur throughout Jamaica, which also progressively alters forest composition, structure, and function (Beckford and Barker 2003; Lewis 2009). As forest structure and function change, so too does micro-environment, species composition, and ultimately trophic interactions, which could have profound effects on *C. subflavus* populations as it is a top predator in the terrestrial ecosystems of Jamaica (Schneider-Maunoury et al. 2016).

***Introduced invasive species.*—**Introduced species are the second greatest threat to global biodiversity (Wilson 2013). In particular, predation by introduced mammals coupled with habitat degradation has played a significant role in altering prey-base, distribution, and abundance of *C. subflavus* throughout Jamaica (Tolson and Henderson 2006; Wilson 2011). While some reptiles may be unaffected by introduced mammalian predators, other larger species such as *Chilabothrus* snakes are generally the first to suffer (Tolson and Henderson 2006). *Herpetes auropunctatus*, introduced into Jamaica in 1872 (Espeut 1882; Bennett et al. 2011) as well as the offshore cay of Great Goat Island shortly thereafter (Grant 1940), has been implicated in the extinction of at least four reptile and two bird species in Jamaica (Wilson 2011). Although *C. subflavus* are nocturnal and primarily arboreal, these snakes will bask on rocks after heavy rains in the morning (Grant 1940; Henderson and Powell 2009); therefore, *H. auropunctatus* poses a threat to boa populations in Jamaica as it is a known predator of *Chilabothrus* snakes in the insular Caribbean (Tolson and Henderson 1993). *Felis domesticus* and *C. lupus familiaris* prey on a wide variety of amphibians and reptiles of the West Indian Islands (Tolson and Henderson 2006; Henderson and Powell 2009). Grant (1940) observed several *C. subflavus* carcasses in the bush at Portland Point, Clarendon Parish, which were supposed to have been killed by cats. Introduced rodents, especially the Norway Rat (*Rattus norvegicus*) and the Black Rat (*R. rattus*) may depredate neonate *C. subflavus* as well as modify boa habitat via consumption of seeds and seedlings; however, their impact on boa populations in Jamaica is currently unknown (Powell and Henderson 2008; Wilson 2011). Ungulates, such as Cattle (*Bos taurus*), Donkeys (*Equus asinus*), *C. aegagrus hircus*, and *S. scrofa domesticus* indirectly pose a threat to *C. subflavus* by degrading habitat or in some instances consuming snakes (Tolson and Henderson 2006; Jolley 2007; Powell and Henderson 2008; Wilson 2011).

As with mammals, introduced amphibians and reptiles also may pose a threat to the conservation of *C. subflavus*. Introduced to Jamaica in 1855 (Lewis 1949), the Cane Toad (*Rhinella marina*) is now widespread throughout the island at low to mid-elevations (Wilson 2011). *Rhinella marina* not only alter prey base of Jamaican reptiles and amphibians by consuming small amphibians, reptiles, and rats, but also can induce mortality if ingested by *C. subflavus* via naturally produced toxic steroid lactones known as bufotoxins (Wilson et al. 2011). Research by Reynolds et al. (2013b) has documented the breeding success of and seizure of over 150 Common Boa Constrictors (*Boa constrictor*) from Mayagüez, Puerto Rico, since 2011. Although *B. constrictor* has not been found in Jamaica, this invasive snake may pose a threat to *C. subflavus* populations because it shares a common prey base, has similar habitat requirements, and based on conditions in its native range (Central and South America) could potentially acclimate and propagate in Jamaica. Research and eradication programs designed for Puerto Rico will undoubtedly provide useful mitigation strategies as well as basis for comparison (Reynolds et al. 2013b) if future invasion of this snake occurs in Jamaica.

Research Needs and Recommendations

Currently, Jamaica is undergoing rapid environmental changes. The absence of information concerning population sizes of *C. subflavus* across Jamaica makes it difficult to implement proper management strategies to conserve this species in the wild; however, data based on incidental sightings and limited field research suggests a historical decline in numbers. While funds for research are limited, research is needed to ensure the conservation and protection of remaining *C. subflavus* populations on Jamaica. We list suggested research in priority order (Table 3); however, we encourage modification based on changing circumstances, adequate funding, and stakeholder objectives, which is inevitable in planning recovery strategies and research (Restani and Marzluff 2002).

Table 3. Priority listing of research needs and recommendations for gaining knowledge and proper management of the Jamaican Boa (*Chilabothrus subflavus*).

Priority	Research Recommendation
1	Develop an amendment for the government of Jamaica within the Wild Life Protection Act that changes the scientific name from *Epicrates subflavus* to *Chilabothrus subflavus* so that protection of *C. subflavus* can occur in Jamaica.
2	Develop educational programs to change the current cultural bias against snakes on Jamaica and highlight the ecological benefits of *C. subflavus*.
3	Initiate a caller-safe program to report mortality of *C. subflavus* by any means and location of killed snake to add to snake abundance and distribution database.
4	Initiate science-based survey program throughout Jamaica to acquire annual trends of abundance and distribution for *C. subflavus*.
5	Determine effect of major mortality factors (i.e., predators, disease, parasites, anthropogenic hazards, etc.) on *C. subflavus* populations and develop management strategies to offset mortality.
6	Develop a GIS-layered map of Jamaica concerning the distribution of *C. subflavus* based on the map of Newman et al. (2016), and with geographic landforms, climate, habitat, anthropomorphic features, etc. to determine priority areas for conservation.
7	Determine feasibility of reestablishing *C. subflavus* populations, via captive breeding programs, in areas with suitable habitat where this snake has been extirpated.
8	Determine minimal viable populations needed to maintain genetic vigor within each established population on Jamaica.
9	Initiate long-term ecological and behavioral studies in ecological regions of Jamaica that currently have populations of *C. subflavus* to elucidate behavior and ecology of this species across its range.
10	Determine the width and required habitat to develop corridors for *C. subflavus* to disperse to other regions of established populations throughout Jamaica.
11	Continue conservation genetic studies to expand on baseline research of Tzika et al. (2008, 2009).

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