Cuban Treefrog (*Osteopilus septentrionalis*)

Ecological Risk Screening Summary

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1 Native Range and Status in the United States

Native Range

From Somma et al. (2018):

"*Osteopilus septentrionalis* is indigenous to Cuba, Isla de la Juventud (=Isle of Youth or Isle of Pines), the Bahamas, including San Salvador and Acklins Island, and the Cayman Islands (Echternacht et al., 2011; Heinicke et al., 2011; Krysko et al., 2011a)."

From GISD (2018) lists *Osteopilus septentrionalis* as native in the Bahamas, Cayman Islands, Cuba, and Seychelles.

From AmphibiaWeb (2009):

"This species is native to Cuba, the Isla de Pinos, the Bahamas Islands including Little Bahama Bank, Grand Bahama Bank, San Salvador, Rum, Crooked, and Acklins Islands, and the Cayman Islands including Grand Cayman, Little Cayman and Cayman Brac (Duellman and Crombie 1970)."

Status in the United States

From Somma et al. (2018):

"The Cuban treefrog was first introduced to Florida at Key West (Barbour 1931), and has been established in mainland Florida since at least 1951 (Schwartz 1952)."

"In Louisiana, individual Cuban Treefrogs have been observed occasionally in the nursery department of a home improvement store in New Orleans as early as the 1990s (Bob Thomas, pers. comm.)."

"Other nonindigenous populations of Cuban Treefrogs are reported from the Caribbean: St. Croix and St. Thomas (U.S. Virgin Islands), […]"

"In southern, central, and northern peninsular **Florida**, including the Florida Keys and Dry Tortugas, *O. septentrionalis* is well-established, invasive, and dispersing northward along the both coasts (Granatosky and Krysko, 2011; Heinicke et al., 2011; Krysko et al., 2011a, 2011b)."

"The status of Cuban Treefrogs further north in colder, temperate Holmes, Leon and Washington counties, the **Florida** panhandle (Meshaka, 2001; Meshaka et al., 2004), were determined to be erroneous by Johnson (2004; Krysko et al., 2011a). The status of the single verified specimens from Bay, Franklin, and Gadsden counties in the **Florida** panhandle is unclear (Johnson, 2004; Krysko et al., 2005; Enge et al. 2008). However, other recent northern county records (Alachua, Bradford, Columbia, Duval, Flagler, Levy, Marion, Nassau, Putnam, St. Johns) represent established populations (Johnson et al., 2003; Krysko et al., 2005, 2011a, 2011b; Stevenson and Somma, 2011) The two earlier specimens from Alachua County, northern peninsular **Florida**, are isolated individuals that originally did not represent an established population (Meshaka, 2001:173; J. Matter, personal communication 2002), until the discovery of more frogs and breeding populations by Krysko et al. (2005; Krysko et al., 2011a). The single Cuban Treefrog collected at a nursery in Orange Springs, Marion County, **Florida** (UF 142699; Krysko et al., 2011a), does not represent an established population in that particular city."

"The Cuban Treefrogs collected in New Orleans, Slidell, Baton Rouge and Lafayette, **Louisiana** were isolated occurrences have not led to any known established populations (Chatfield and Vance 2014; Glorioso et al. 2016, 2018), except the population in the Audubon Zoo in New Orleans. Multiple year classes have been found at the Audubon Zoo and the population has been described as dispersing (Glorioso et al. 2018)"

"The Cuban Treefrogs collected from **Alabama, Colorado, Georgia, Indiana, Kansas, Maryland, North Carolina, Texas, Virginia**, or **Ontario**, **Canada** do not yet seem to represent

established populations (Benson et al., 2004; Taggart, 2006; Jensen et al., 2008; Knapp, 2008; Kraus, 2009)."

"McKeown (1996) claimed *Osteopilus septentrionalis* was an established, invasive species in Oahu, **Hawaii**; however, there is no vouchered evidence to verify this (Kraus, 2008, 2009). In **Puerto Rico**, Cuban Treefrogs have been established since the 1950s and are invasive (Kraus, 2009; Heinicke at al., 2011)."

From Masterson (2007):

"The first reports of the Cuban treefrog occurring in the United States date to 1931 from Key West, although the species likely existed there well before it was reported. Introduction was likely accidental, e.g., as undetected stowaways in import vegetables from Cuba ([Behler and King 1979]). By the early 1950s, *Osteopilus septentrionalis* was present in most of the Keys, and by 1952 specimens were turning up in mainland Florida (Miami) as well (Schwartz 1952). Northward range expansion continued such that the species was confirmed present in Broward County by 1960, and in St. Lucie and Indian River counties less than 20 years later (King 1960, Myers 1977). Range expansion continued on the Gulf coast of Florida such that the species was confirmed in Naples by 1970 and in Fort Meyers and Sanibel Island by the early 1980s (Duellman and Crombie 1970, Wilson and Porras 1983). The species is now established on the east coast of Florida as far north as Jacksonville."

Means of introductions in the United States

From Somma et al. (2018):

"*Osteopilus septentrionalis* is usually introduced through horticultural shipments and plantings (especially palm trees) (Enge et al. 2008; Krysko et al., 2011b; Powell et al., 2011), building materials (Owen et al., 2005, 2006; Krysko et al., 2011b), and motorized vehicles (Meshaka, 1996[a]; Enge et al. 2008). In addition to anthropogenic dispersal, it also is possible that they can disperse throughout much of the Caribbean by rafting on floating vegetation (Meshaka, 2001). Several authors have suggested that indigenous Cuban Treefrogs may have existed on Key West and the lower Florida Keys since pre-Colombian times (Lazell, 1989; Meshaka, 2001; Heinicke et al., 2011)."

"The unverified population on Oahu, **Hawaii**, is the only example of *O. septentrionalis* being allegedly introduced (illegally) through pet releases during the 1980s (McKeown, 1996; Meshaka, 2001)."

"James R. Wiley (personal communication 2005, 2006) has repeatedly observed Cuban Treefrogs hidden between the doors and door jams of his car when leaving Melbourne (Brevard County, Florida) on his way home to Gainesville (Alachua County, Florida) where they escape into his residential neighborhood."

From GISD (2018):

"Recent increases in shipping and trade, as well as increasing human populations and demands for non-regional produce and landscaping and building materials have enabled the dispersal and invasion of the Cuban treefrog (Platenberg, 2007)."

From Johnson (2017):

"The expansion of their range is augmented by the activities of people. Cuban treefrogs are transported to new areas as stowaways on cars, trucks, and boat trailers as well as in ornamental plants and trees that are shipped north from southern Florida."

Remarks

From Somma et al. (2018):

"The most thorough, overall literature reviews on Cuban Treefrogs are by Duellman and Crombie (1970), and Meshaka (2001, 2011). The most current taxonomic reviews are by Duellman and Crombie (1970), Frost (1985, 2000), Maxson (1992), Anderson (1996), Collins and Taggart (2002, 2009), Faivovich et al. (2005), and Frost et al. (2006). Lazell (1989) continued to place *O. septentrionalis* in the genus *Hyla*; a taxonomic arrangement that is no longer accepted. Schwartz and Henderson (1991), Rivalta González and Díaz Beltrán (2003), Vargas-Salinas (2006[a], [b], [c]), Elliott et al. (2009), and Granatosky and Krysko (2011) have reviewed the natural history of *O. septentrionalis*, but by far the most thorough review of its natural history, distribution, and dispersal is by Meshaka (2001, 2011, and his other studies listed therein)."

"Cuban Treefrogs are a storm-adapted species that can immediately increase its fecundity and rapidly disperse during and after hurricanes (Meshaka, 1993, 1996[b], 2001, 2011). Meshaka (2001, 2011) predicts that *O. septentrionalis* will eventually disperse to Jamaica, much of the Caribbean and, more speculatively, throughout the Hawaiian Islands. Additionally, Florida populations probably will spread along the Gulf Coast, throughout the coastal United States, then southward into Mexico (Meshaka, 2001, 2011; Rödder and Weinsheimer, 2009). Their northward dispersal in the United States may be limited by climate (Meshaka, 2001; Granatosky and Krysko, 2011) and a decrease in female body size with northward latitude (McGarrity and Johnson, 2009), unless aided by anthropogenic Global Warming (Rödder and Weinsheimer, 2009). However, this fails to take into consideration the future potential for a certain degree of adaptation to a more temperate climate. *Osteopilus septentrionalis* may eventually spread north of Nassau County, Florida, along the eastern Atlantic coast, as far north as the Georgia coastline. Non-coastal Florida populations might also spread slightly northward, perhaps limited to disjunct populations in highly sheltered, especially anthropogenic, habitat."

From GISD (2018):

"High fecundity, a short larval period, broad diet, open habitat, and dietary niches make this species a successful widespread anuran population in situations that seem less than ideal for supporting it (Townsend, Eaton, Powell et al, 2000)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2018):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Tetrapoda
Class Amphibia
Order Anura
Family Hylidae
Subfamily Hylinae
Genus *Osteopilus*
Species *Osteopilus septentrionalis* (Dumeril and Bibron, 1841)"

"Taxonomic Status:
Current Standing: valid"

Size, Weight, and Age Range

From Somma et al. (2018):

"**Size:** 28-165 mm SVL (snout-vent length)"

From Johnson (2017):

"Cuban treefrogs are the largest species of treefrog in Florida, and adult females may exceed 6 inches in length. Most Cuban treefrogs, however, range from 1–4 inches long."

From Masterson (2007):

"[…] males typically growing to 90 mm in body length and females usually reaching 125 mm and possibly as much as 140 mm (Behler 1979, Ashton and Ashton 1988, Carmichael and Williams 1991, Conant and Collins 1991)."

From Dameron (2016):

"The Cuban treefrog can live up to 12.9 years in captivity. This species has an approximate lifespan of 5 to 10 years in the wild. ([UF/IFAS Extension], 2013; AnAge, 2014; Mattison, 2011; Salinas, 2006)"

"*Osteopilus septentrionalis* weighs 57 g, on average. ([UF/IFAS Extension], 2013; Crump, 1986; Dorcas and Gibbons, 2008; Lannoo, 2005; McGarrity and Johnson, 2009)."

Environment

From Hedges et al. (2010):

"Terrestrial; Freshwater"

"It generally inhabits mesic habitats but may be found in xeric habitat in the Bahamas, […]. It can also tolerate brackish water."

From Dameron (2016):

"The Cuban treefrog is successful in the dry habitat of Florida."

Climate/Range

From Hedges et al. (2010):

"The native range of *Osteopilus septentrionalisi* is tropical but has invaded into warmer temperate climates, such as Florida."

From Dameron (2016):

"The Cuban treefrog typically inhabits xeric habitats. The maximum elevation the Cuban treefrog inhabits is 1110 m."

From Masterson (2007):

"Cuban treefrogs are reportedly limited to geographical areas where daytime [air] temperatures typically range between 23-29°C and where temperatures usually remain above 10°C. Hiwever [sic], the persistence of breeding populations in north Florida where seasonal freeze events occur indicate that these temperature limits are not absolute (Johnson 2007). Similar to other treefrogs, *Osteopilus septentrionalis* prefers areas of high humidity."

Distribution Outside the United States

Native

From Somma et al. (2018):

"*Osteopilus septentrionalis* is indigenous to Cuba, Isla de la Juventud (=Isle of Youth or Isle of Pines), the Bahamas, including San Salvador and Acklins Island, and the Cayman Islands (Echternacht et al., 2011; Heinicke et al., 2011; Krysko et al., 2011a)."

GISD (2018) lists *Osteopilus septentrionalis* as native in the Bahamas, Cayman Islands, Cuba, and Seychelles.

From AmphibiaWeb (2009):

"This species is native to Cuba, the Isla de Pinos, the Bahamas Islands including Little Bahama Bank, Grand Bahama Bank, San Salvador, Rum, Crooked, and Acklins Islands, and the Cayman Islands including Grand Cayman, Little Cayman and Cayman Brac (Duellman and Crombie 1970)."

Introduced

GISD (2018): lists *Osteopilus septentrionalis* as introduced to Anguilla, Antigua and Barbuda, Canada, Colombia, Costa Rica, Guadeloupe, Jamaica, Mexico, Netherlands Antilles, Panama, Peru, Saint Barthelemy, Saint Martin (French Part), Turks And Caicos Islands, and the British Virgin Islands.

From Somma et al. (2018):

"Other nonindigenous populations of Cuban Treefrogs are reported from the Caribbean: […] Antigua, Dominica, Nevis, Bonaire, St. Barts, Curaçao, St. Maarten/ St.-Martín, Anguilla (U.K.), Turks & Caicos, and Beef Island, Necker Island, Peter Island, Tortola and Virgin Gorda (British Virgin Islands) (Kraus, 2009; Heinicke et al., 2011; Powell et al., 2011)."

"Almost all other nonindigenous populations of Cuban Treefrogs in the **Caribbean** and **Costa Rica** are established except those in **Dominica** and **Curaçao** (Owen et al., 2005; Kraus, 2009; Heinicke et al., 2011), and potentially invasive. The population from **St. Maarten**/**St Martín**, was thought to be misidentified *Scinax rubra* (Common Scinax) population (Powell and Henderson, 2003; […]), but in fact *O. septentrionalis* are established (Kraus, 2009; Powell et al., 2011). Meshaka (2001, 2011), and Rödder and Weinsheimer (2009) predict that Cuban Treefrogs will eventually reach Jamaica and other circum-Caribbean localities."

From NIES (2018):

"Import, transport and keeping are prohibited in Japan by the Invasive Alien Species Act."

Means of Introduction Outside the United States

From GISD (2018):

"Recent increases in shipping, along with increasing human populations and demands for non-regional produce and landscaping building materials have enabled the dispersal of opportunistic invaders such as the Cuban treefrog (Platenberg, 2007). Pet/aquarium trade: This species has been used as pets and display animals (Hedges et al., 2008)."

From Johnson (2017):

"The expansion of their range is augmented by the activities of people. Cuban treefrogs are transported to new areas as stowaways on cars, trucks, and boat trailers as well as in ornamental plants and trees that are shipped north from southern Florida."

Short Description

From AmphibiaWeb (2009):

"There is no webbing between the toes on the front legs; however, the rear toes are slightly webbed. […] While these frogs have irises that are parallel to the ground when sitting, they do not have a stripe running through or below their eyes, as some tree frogs do. They have a distinct tarsal fold extending the full length of the tarsus."

From Somma et al. (2018):

"*Osteopilus septentrionalis* is a very large, warty, treefrog (*hylid*) with an adult SVL (snout-vent length) of 28-165 mm (1.1-6.5 in); making it the largest treefrog in the U.S. (Bartlett and Bartlett, 1999; Meshaka, 2001; Elliott et al., 2009). The toepads (disks) are noticeably large, similar in size to its tympanum (eardrum) (Dorcas and Gibbons, 2008; Elliott et al., 2009). The dorsal color of Cuban treefrogs, a species which has the ability to change colors, may vary from unpatterned to heavily-patterned gray, tan, brown, bronze, olive-green to blue-green (Elliott et al., 2009; also illustrated in Dorcas and Gibbons, 2008; Knapp, 2008; Krysko et al., 2011a). Unlike indigenous U.S. treefrogss, the dorsal skin on adult *O. septentrionalis* is fused to the skull (Powell et al., 1998; Meshaka, 2011). Younger individuals are difficult to distinguish from indigenous U.S. treefrogs because they lack "warts" and exhibit very little pattern (Conant and Collins, 1998); however, they sometimes lack the light or dark lateral stripe found on many treefrog species (Conant and Collins, 1998). Tadpoles are black or darkly pigmented dorsally, with a visible intestinal coil ventrally, and a moderately pigmented tail with light areas on the anterior musculature (Gregoire, 2005 […]; Dorcas and Gibbons, 2008)."

"Unlike other U.S. treefrogs, the single vocal sac of calling males inflates bilaterally, giving the appearance of two sacs (Conant and Collins, 1998; Bartlett and Bartlett, 1999). The call is a rasping snarl or rubbery snore which may superficially resemble the call of *Lithobates* [=Rana] *sphenocephalus*, the southern leopard frog (Bartlett, 2000; Knapp, 2008; also CD recordings available from Library of Natural Sounds, 1996); however, a higher-pitched, scream-like escape call is used to deter predators (Dorcas and Gibbons, 2008)."

From Dameron (2016):

"On average, *Osteopilus septentrionalis* is 2.5 to 12 cm long. Its size is a distinguishing feature as one of the largest of the treefrog species found in Florida. The female can be almost twice as large as the male. The Cuban treefrog has bulging eyes. This frog can be identified by its expanded pads on the end of its toes, giving it the ability to climb. […] These frogs develop into froglets when the tadpoles reach a length of 1.25 to 1.91 cm. *Osteopilus septentrionalis* weighs 57 g, on average. ([UF/IFAS Extension], 2013; Crump, 1986; Dorcas and Gibbons, 2008; Lannoo, 2005; McGarrity and Johnson, 2009)."

According to Johnson and McGarrity (2017), young Cuban treefrogs often have reddish eyes, often have light lines down their sides, and have blue bones.

Biology

From Hedges et al (2010):

"Breeding events have been found to last only one night and male mating behavior changes from acoustic competition to scramble searching over the breeding event. Most males have similar opportunities to mate with a female, and there doesn't appear to be a direct adaptive benefit for high mating selectivity by females, which can increase the invasive capacity of *O. septentrionalis* (Vargas-Salinas, 2006[c])."

From Johnson (2017):

"Cuban treefrogs breed predominately in the spring and summer, but in southern Florida they can breed year round. Reproduction is largely stimulated by rainfall, especially warm summer rains such as those associated with tropical weather systems and intense thunderstorms. […] Cuban treefrogs are not picky about their breeding sites, as long as the sites lack predatory fish, such as bass and bream. Acceptable breeding sites include isolated wetlands, ditches, decorative ponds, and even swimming pools that are neglected. Cuban treefrogs can breed in surprisingly small amounts of water. An old ice chest or child's wading pool half full of water are suitable nurseries for Cuban treefrog tadpoles to develop into frogs."

"Like our native treefrogs, Cuban treefrogs are excellent climbers and will climb high into trees where they sleep during the day. They may also be found closer to the ground in small trees and shrubs. They have even been found buried several inches deep in dry soil. Also like our native treefrogs, Cuban treefrogs are most active at night when they come out from daytime hiding places to feed and reproduce."

"Invasive Cuban treefrogs eat a wide variety of food items, including snails, millipedes, spiders, and a vast array of insects. They are predators of several of Florida's native frogs and are cannibalistic. They are also known to eat lizards and even small snakes."

From Dameron (2016):

"This frog species is an ambush predator. As a tadpole, it primarily feeds on algae, but is known to engage in cannibalism. (Dorcas and Gibbons, 2008; Glorioso, et al., 2010)"

"Adult treefrogs have skin with defensive compounds that are extremely toxic to humans and other mammalian predators. When this treefrog is taken by a predator, a loud distress call is emitted and the body inflates. This may attract other animals to distract the predator."

"When [air] temperatures are below 9.5° Celsius, the Cuban treefrog goes into a state of torpor. The Cuban treefrog is generally a terrestrial species, but migrates en masse to breeding sites following heavy rainstorms."

"The male Cuban treefrog reaches sexual maturity at 120 days, on average. The female treefrog reaches sexual maturity at 255 days, on average."

"This frog is oviparous with external fertilization by the male. The female Cuban treefrog lays over 3,000 eggs, laying them 75 to 1,000 at a time. […] The eggs float on the surface of the water and will only survive in the presence of adequate ambient temperatures above 27° Celsius. The eggs hatch quickly, within 24 to 32 hours. In water temperatures above 35° Celsius, tadpoles will undergo metamorphosis relatively quickly, in 3 weeks. However with temperatures below 29° Celsius, metamorphosis typically takes a month. There is no parental care and this treefrog is immediately independent. (AnAge, 2014; Dorcas and Gibbons, 2008; Lannoo, 2005; McGarrity and Johnson, 2009; [Vargas-]Salinas, 2006[c])"

From Somma et al. (2018):

"They are in turn preyed upon by native snakes and owls (Meshaka and Ferster, 1995; Meshaka, 2001, 2011; Dorcas and Gibbons, 2008), and parasitized by the nematode, *Skrjabinoptera scelopori* (Meshaka, 1996[c]). […] Females are continuously fertile, laying very large clutches of 1,200 to over 16,000 eggs (Meshaka, 2001, 2011[…] Tadpoles are omnivorous, even cannibalistic, and could potentially eat the eggs of indigenous frogs (Babbitt and Meshaka, 2000; Meshaka, 2001, 2011). However, eggs of the nonindigenous toad, *Rhinella marina*, are toxic to *O. septentrionalis* tadpoles (Punzo and Lindstrom, 2001)."

From McGarrity and Johnson (2009):

"In *O. septentrionalis*, female fecundity increases with increasing body size, but breeding is random (Vargas-Salinas 2006[c], [b]) and sexual selection is not implicated as a cause of SSD [sexual size dimorphism] (Vargas-Salinas 2006[c], [b]). The explosive breeding behavior of *O. septentrionalis* likely favors small, agile males (Woolbright 1983), and males do not engage in territorial or competitive behaviors (Vargas-Salinas 2006[c], [b]) that would favor large male size (Shine 1989). Growth estimates from capture data suggest that female *O. septentrionalis* may grow faster and mature later than males (Meshaka 2001), and that there are differences in age–sex structure among *O. septentrionalis* populations (Meshaka 2001). However, data from mark-recapture studies are needed in order to evaluate the role of growth, maturation, and age–sex structure in SSD of *O. septentrionalis.*"

Human Uses

From GISD (2018):

"The Cuban treefrog has been used in the form of a pet as well as a display animal and in international horticulture. In fact, it has been reported that a large percentage of this species has been a part of captive breeding/farming at some point (Hedges et al., 2008)."

Diseases

There are no known OIE-reportable diseases for this species.

From Dameron (2016):

"The Cuban treefrog negatively impacts ecosystems and native species in Florida because it is a known predator of native treefrogs in Florida, colonizing and taking over natural areas populated by native species. The Cuban treefrog, specifically in Tampa, Florida, is susceptible to various parasites whether introduced or acquired, including nematodes (*Oswaldocruzie lenteixeirai*, *Aplectana* species, *Physaloptera* species, and *Rhabdias* species), trematodes (*Digenean metacercaria*) and cestodes (*Cylindrotaenia americana*). *Aplectana* species are most prevalent in the Cuban treefrog species found in Tampa, Florida. In its native range in Cuba, reported parasites include nematodes (*Parapharyngodon osteopilli*) and trematodes (*Mesocoelium crossophorum*), which infect the small intestines and stomach of the treefrog. ([UF/IFAS Extension], 2013; Ortega, et al., 2015)"

From Ortega et al. (2015):

"Only one parasite species, *O. lenteixeiria*, appears to be a confirmed intro-duced species because it is found commonly in the native range of CTFs [Cuban treefrogs] […], but there are no records of this species from frogs native to Florida."

From Somma et al. (2018):

"[…] parasitized by the nematode, *Skrjabinoptera scelopori* (Meshaka, 1996[c])."

Threat to Humans

From Johnson (2017):

"The secretions cause a burning and itching sensation that can last for more than an hour. This can be especially problematic for people who suffer from asthma or allergies, in which case full recovery from the ill effects of the frog's skin secretions may take several hours."

3 Impacts of Introductions

From Wyatt and Forys (2004):

"The impact of Cuban Treefrogs on native treefrogs is mainly thought to be due to direct predation (Meshaka 2001). Currently, Cuban Treefrogs significantly overlap with the distribution of the following four native hylids in Florida: *Hyla cinerea* (Schneider), *H. femoralis* (Bosc and Daudin), *H. gratiosa* (Le Cont), and *H. squirella* (Bosc) (Ashton and Ashton 1988). Although predation is most likely to be significant in human-modified environments where Cuban Treefrogs are most abundant, researchers may be unknowingly increasing the incidence of predation through use of PVC pipe refuges (O'Neill 1995) in more pristine areas where Cuban Treefrogs are present. PVC pipes are an increasingly popular method used to census treefrogs due to their efficiency and cost effectiveness (Boughton et al. 2000). These artificial refuges

attract treefrogs because the pipes provide a moist environment, shelter from the wind, and refuge from extreme temperatures. Although these artificial refuges mimic natural refuges by protecting treefrogs from many native predators (e.g., birds, snakes), in Florida they may expose treefrogs to increased predation by Cuban Treefrogs because the PVC pipes are particularly attractive to this exotic species."

"Although not indicating a selection or preference for predation on other treefrogs, our trials demonstrated that Cuban Treefrogs will eat both Green Treefrogs and conspecifics. More importantly, knowing the range of prey sizes that the Cuban Treefrog can consume will aid our understanding of their potential impacts on native treefrog species. […] The fact that Cuban Treefrogs are capable of consuming both subadult and adult Green Treefrogs highlights their potential to negatively affect native treefrog populations. By removing reproductive individuals from the population, Cuban Treefrogs may limit future reproductive output in native treefrog species. Indeed, almost 7% of the Cuban Treefrogs were large enough to consume small-medium sized treefrogs and 63% of the Green Treefrogs found in the palm hammock were classified as being in this size range."

From Somma et al. (2018):

"The impact of the highly invasive Cuban Treefrog throughout its nonindigenous range is not yet clear; however, its ability to prey on indigenous frogs is a cause for concern in Puerto Rico (Meshaka, 2001), Costa Rica, and Florida (Lever, 2003; Rice et al., 2011). Butterfield et al. (1997) believe that the notion of competition with indigenous species in Florida is somewhat overplayed, but provide no data to validate their assertion. […] Populations of native treefrogs recover and subsequently increase when *O. septentrionalis* were removed from selected localities in Florida (Rice et al., 2011). Cuban Treefrog tadpoles compete with indigenous amphibian larvae in Florida and have a negative impact on their growth and development (Smith, 2005[b]). Smith (2004) found a male *O. septentrionalis* showing mating behavior (amplexing) with an indigenous female Southern leopard frog (*Lithobates. sphenocephalus*) in Hillsborough County, Florida, in May 2002. While these two species cannot hybridize, the result of these pairings may cause reproductive interference with indigenous frogs (Smith, 2004). In Hawaii, where there are no indigenous frogs (McKeown, 1996), their potential impact is negative if they are ever verified as established."

From Johnson (2017):

"Cuban treefrogs are having negative impacts on Florida's native species and ecosystems. Although they predominately occur around human development, such as urban neighborhoods, Cuban treefrogs are also able to invade natural areas. In both natural and urbanized settings, Cuban treefrogs are known predators of Florida's native treefrogs […] and appear to be responsible for declines of some native treefrog species. They also are known to eat several additional species of native frogs, lizards, and many types of invertebrates. Many homeowners in Florida report that Cuban treefrogs appear to have replaced native treefrogs as the dominant frog found around their homes. These same people say that they no longer see native species, such as squirrel treefrogs or green treefrogs, but only Cuban treefrogs."

"Cuban treefrogs may also be a nuisance to wildlife enthusiasts that set up nesting boxes to attract and benefit birds. Because Cuban treefrogs prefer enclosed hiding spaces, they readily enter nest boxes erected for birds. Birds may be dissuaded from using nest boxes when they are invaded by Cuban treefrogs […], but research is needed to study how the presence of the invasive frogs affects bird use of nest boxes."

"There do not appear to be any documented deaths or serious injuries of pets from ingesting or attempting to eat a Cuban treefrog. However, there are reports of excessive salivation and even seizures by pets that have tangled with these noxious frogs, so dogs and cats should be kept away from them."

"Unlike many invasive insect pests and invasive plants, Cuban treefrogs do not currently appear to be having any large-scale negative effects on Florida's economy. Nonetheless, they are known to get into transformer boxes and electrical switches […] and occasionally cause short-circuits. This increases maintenance costs for electrical utility companies, and power to some customers in central Florida has been interrupted as a result of short-circuits in disconnect switches caused by Cuban treefrogs. They may also invade electric water pump housings and AC compressor units around residential homes, potentially causing damage. As Cuban treefrog populations continue to expand, this may eventually become a large-scale issue."

From GISD (2018):

"The standard of living may be lowered in areas where the Cuban treefrog prospers. For example, this species has been found in toilet bowls and has clogged drains. The mating calls of male Cuban treefrogs can be an annoyance as well (Johnson, 2007)."

From Goetz et al. (2018):

"This study demonstrates how Cuban Treefrogs likely function as an evolutionary trap for a native predator. Common Gartersnakes exhibited equal preference toward the cues from native Green Treefrogs and nonindigenous Cuban Treefrogs. Snakes ate all offered prey items during the feeding trial, including Cuban Treefrogs; however, consumption of Cuban Treefrogs resulted in a 50% reduction in growth rate, a variable correlated with fitness (Stewart 1968; Seigel and Ford 1987). Interestingly, we did not detect a difference in growth or preference between snakes from invaded and non-invaded Cuban Treefrog regions indicating that snakes co-occurring with Cuban Treefrogs lack evolutionary or learned responses that would allow escape from the trap."

From McGarrity and Johnson (2009):

"Mounting evidence suggests that this frog negatively impacts native anurans (Meshaka 2001; Owen et al. 2005; Townsend 2000). Although once believed restricted to urban areas and unlikely to colonize natural areas (Butterfield et al. 1997), populations of *O. septentrionalis* have now been documented in a variety of natural habitats (both mesic and xeric) in Southern and Central Florida (Bartareau 2004; Johnson unpubl. data; Meshaka 2001; Meshaka et al. 2004; Wyatt and Forys 2004). In areas of Florida where *O. septentrionalis* is present in large numbers, native treefrog abundance and survival can be greatly reduced (Meshaka 2001; Rice et al. 2003).

These large treefrogs prey on native anurans in urban and natural areas (Heflick 2001; Johnson unpubl. data; Meshaka 1996[b]; Meshaka 2001; Wyatt and Forys 2004), and their tadpoles have been experimentally shown to be superior competitors to tadpoles of some native anuran species (Smith 2005[a], [b]). Reproductive interference by *O. septentrionalis* on other anurans has also been documented, although effects of such behavior may be minimal (Meshaka 1996[d]; Smith 2004)."

"This geographical trend of decreasing SSD [sexual size dimorphism] driven by a pronounced decrease in female size toward the northernmost extent of the introduced range of *O. septentrionalis* undoubtedly has important implications for impacts of invasion of the southeastern United States. Most importantly, a decrease in mean female size toward the northernmost extent of the introduced range may be accompanied by a reduction in predation on native vertebrate fauna. Across its introduced range, *O. septentrionalis* is known to prey upon at least six families of native anurans and some small squamates (Campbell 2007; Heflick 2001; Johnson unpubl. data; Maskell et al. 2003; Meshaka 2001; Vargas-Salinas personal communication). Predation on native anurans by *O. septentrionalis* is predominantly attributed to the largest females; analyses of gut contents have found that anurans were consumed by up to 12.4% of females but only up to 3.5% of males (Heflick 2001; Meshaka 2001; Johnson unpubl. data). These studies suggest that native anurans feature prominently in the diet of large female *O. septentrionalis*. Thus, a decrease in female size in northern populations provides encouraging evidence for a possible reduction of the potentially deleterious impacts on native anurans toward the northern extent of the introduced range."

From Knight et al. (2009):

"The results of this study strongly suggest that the impacts of *O. septentrionalis* on native anurans extend beyond the adult life history stage to include the larval stage, thus providing further evidence that *O. septentrionalis* is a significant driver of amphibian community dynamics in Florida. The presence of *O. septentrionalis* in mixed-species pond environments impacts the development and survival of native anurans suggesting interspecific competition. By comparison, high density assemblages of only *H. squirella* also show decreased mass and prolonged larval periods, but effects are not as substantial as when paired with *O. septentrionalis*. This indicates that *H. squirella* responds to any increase in larval density, but the influence of interspecific competition is much stronger than the effects of intraspecific competition. Similar responses are observed among *B. terrestris* larvae but the effects of *O. septentrionalis* are not as significant. The weaker effects of interspecific competition might be explained by the extremely short larval stage for *B. terrestris*. With many individuals reaching metamorphosis within 3 weeks or less, compared to a larval period averaging weeks longer for *O. septentrionalis*, the brief larval stage may help release *B. terrestris* from competition. Native anuran larvae transforming at a small body size due to the competitive impacts of *O. septentrionalis* are less likely to attain a large adult body size, thereby decreasing their potential mating success and reproductive output (Berven and Gill 1983). Furthermore, the prolonged larval stage experienced by native anurans competing with *O. septentrionalis* puts them at increased risk of mortality from factors such as pond desiccation and predation (Heyer et al. 1975; Wilbur 1980)."

"Striking in our study, the proportion of native anuran larvae surviving to metamorphosis is severely impacted by the presence of a nonindigenous species. For *H. squirella* the reduction in survival is significant, dropping from approximately 60% survival when reared alone to 10% or less when *O. septentrionalis* was present. Although not as pronounced, survivorship of *B. terrestris* larvae also declines when *O. septentrionalis* is present in the pond. These findings are quite different from the results of a similar study conducted under tightly controlled laboratory settings, where the proportion of native anurans surviving to metamorphosis was not significantly impacted by the presence of an exotic species (Smith 2005[a])."

From Ortega et al. (2015):

"Only one parasite species, *O. lenteixeiria*, appears to be a confirmed introduced species because it is found commonly in the native range of CTFs [Cuban treefrogs] […], but there are no records of this species from frogs native to Florida."

4 Global Distribution

Figure 1. Known global distribution of *O. septentrionalis*. Map from GBIF Secretariat (2018).

Points from Canada, Grenada, New York, North Carolina, South Carolina, Illinois, Kansas, and Texas were not used in the climate match as they do not represent established populations (Somma et al. 2018). The points in Hawaii were also not used as source points since it is not thought that the species is established in Hawaii (Somma et al. 2018).

The location off the north coast of Venezuela is on the island of Grenada, it was not used as a source point for the climate match as the climate matching program does not have a source location with 100km of that observation (Sanders et al. 2014).

5 Distribution Within the United States

Figure 2. Known distribution of *Osteopilus septentrionalis* in the United States. Map from Somma et al. (2018).

Points in the contiguous United States that are outside of Florida, and coastal Louisiana were not used in the climate match because they are not representative of wild established populations (Somma et al. 2018). The points in Hawaii were also not used as source points since it is not thought that the species is established in Hawaii (Somma et al. 2018).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Osteopilus septentrionalis* was highest in the Gulf Coast and southern Atlantic Coast, covering Florida and ranging from Louisiana to North Carolina. The climate match was medium in areas surrounding the area of high match and low everywhere else. The climate match (Sanders et al 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.139, high. The following states had high individual climate scores: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Texas.

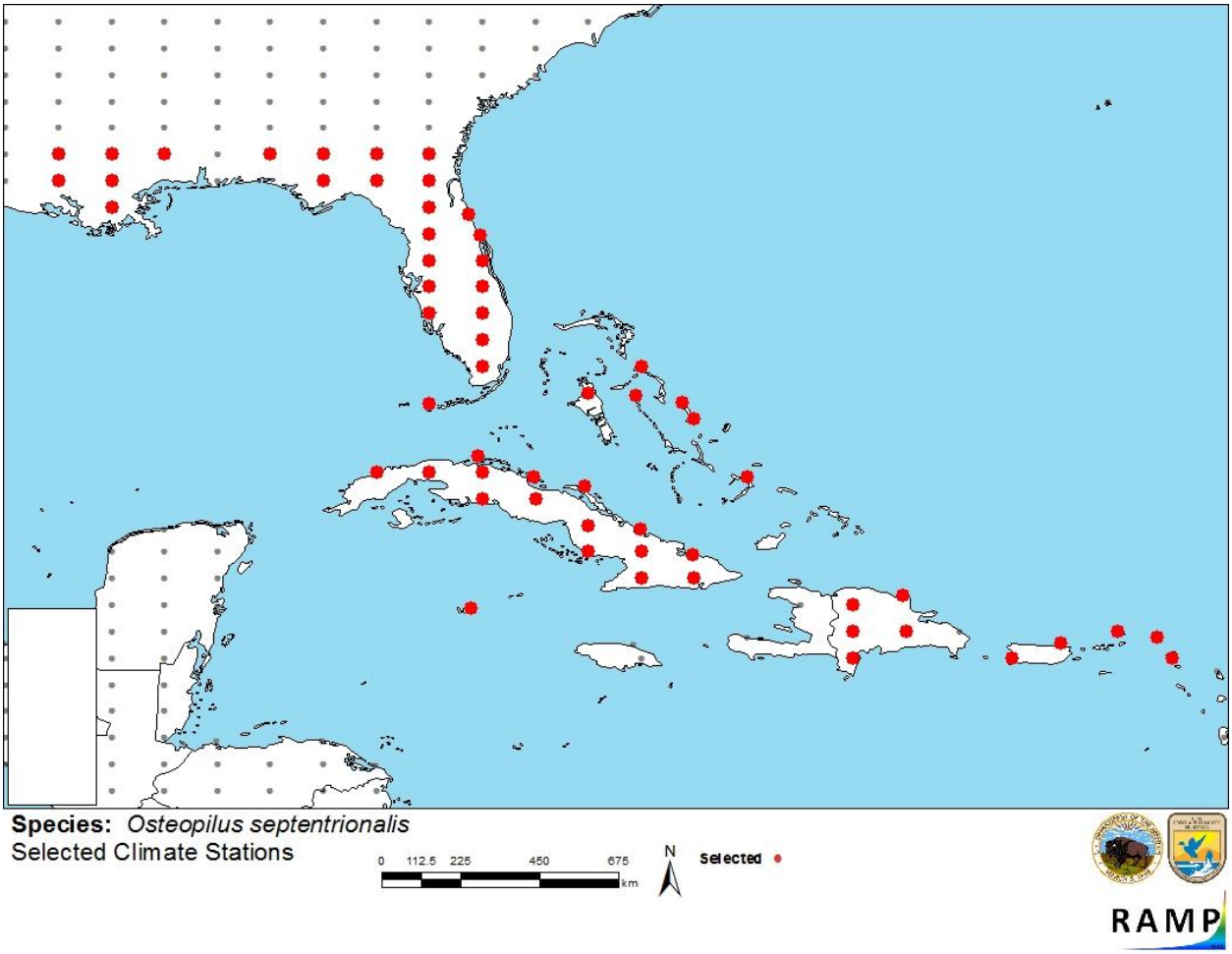

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations in the southeastern United States and Caribbean selected as source locations (red) and non-source locations (gray) for *Osteopilus septentrionalis* climate matching. Source locations from GBIF Secretariat (2018) and Somma et al. (2018).

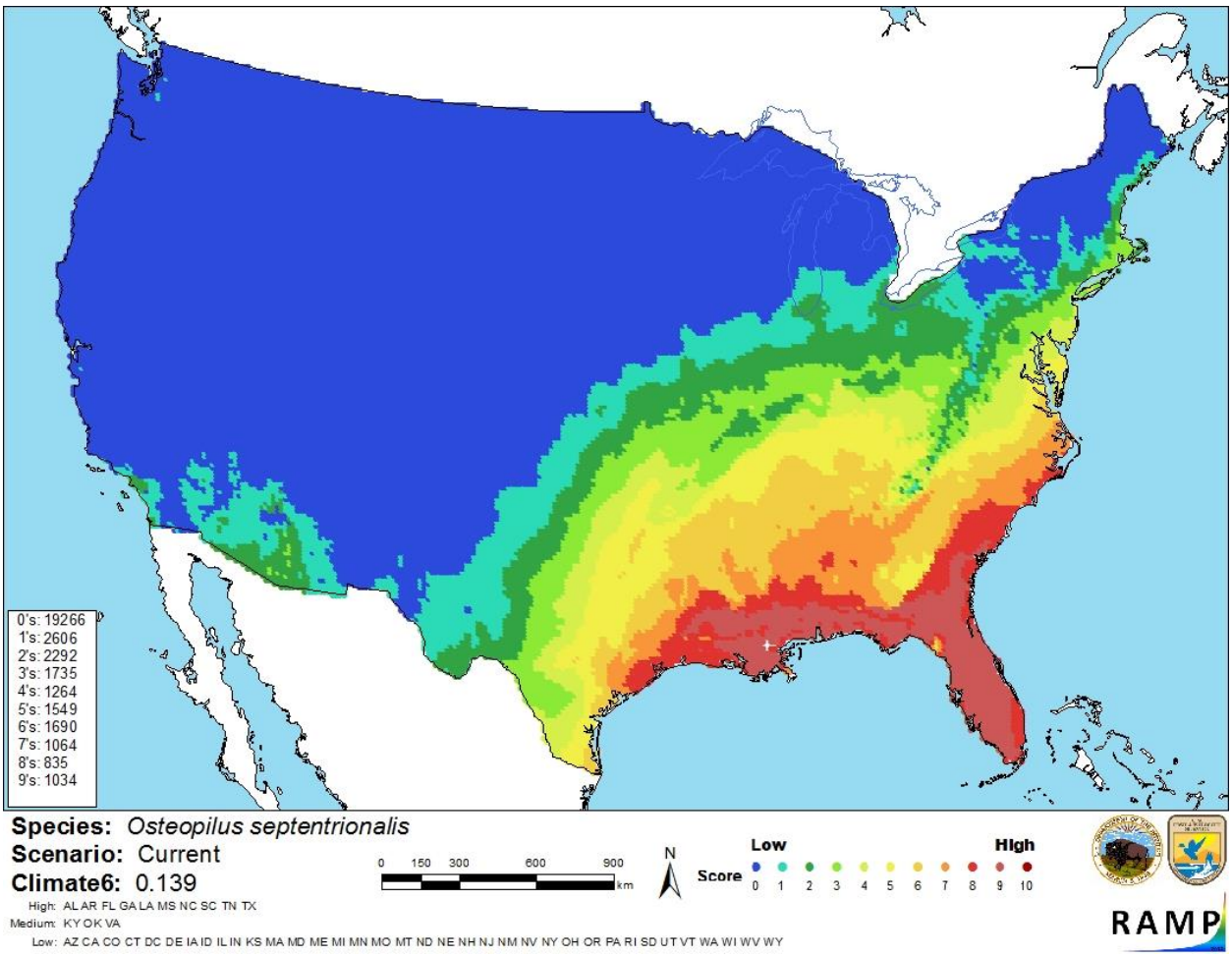

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Osteopilus septentrionalis* in the contiguous United States based on source locations reported by GBIF Secretariat (2018) and Somma et al. (2018). Counts of climate match scores are tabulated on the left. 0 = Lowest match, 10 = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

7 Certainty of Assessment

Certainty of this assessment is medium. Information on the biology, invasion history and impacts of this species is available, including some peer-reviewed literature. There is information available to describe the risks posed by this species.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Osteopilus septentrionalis is a tree frog native to Cuba and a few neighboring islands in the Caribbean. They consume invertebrates and small vertebrates, including other frogs, lizards, and small snakes. Breeding can occur in very small water bodies and individuals reach sexual maturity in less than one year. The history of invasiveness is high. *O. septentrionalis* has become established in areas of the southern United States and multiple Caribbean islands. There is a potential established population in Hawaii but it has not been confirmed. Direct predation on native fauna is the primary concern associated with this species in novel environments and it has been shown to have a negative impact of survivorship and growth of native species. Climate matching indicated the contiguous United States has a high climate match with already established *O. septentrionalis* populations in Florida and Louisiana. Certainty of this assessment is medium. The overall risk assessment category is high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Medium**
- **Remarks/Important additional information:** This species is present in pet trade and often transported in horticulture, and therefore can be easily spread to areas of concern.
- **Overall Risk Assessment Category: High**

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Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

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