Greenhouse Frog (*Eleutherodactylus planirostris*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, August 2011
Revised, November 2016
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1 Native Range and Status in the United States

Native Range

From Somma (2016):

"*Eleutherodactylus planirostris* is indigenous to Cuba, the Cayman Islands, and the northern Bahamas (Barbour and Ramsden, 1919; Schwartz, 1974; Schwartz and Thomas, 1975; Frost, 1985; Schwartz and Henderson, 1985, 1991; Powell et al., 1996; Estrada and Ruibal, 1999; Hedges, 1999; Kraus, 2008; Elliott et al., 2009; Echternacht et al., 2011; Heinicke et al., 2011)."

Status in the United States

From Somma (2016):

"**Status:** *E. planirostris* is well established wherever it has been collected (Duellman and Schwartz, 1958; King and Krakauer, 1966; Stevenson, 1976; Smith and Kohler, 1978; Ashton and Ashton, 1988; Moler, 1988; Bartlett, 1994; Dalrymple, 1994; McCoid and Kleberg, 1995; McCann et al., 1996; Butterfield et al., 1997; Bartlett and Bartlett, 1999; Duellman and Sweet, 1999; Meshaka et al., 2004; Elliot et al., 2009; Kraus, 2009; Anonymous, 2010; Krysko et al., 2011; Meshaka, 2011). Undoubtedly greenhouse frogs eventually will be discovered in the rest of the counties in North **Florida** and the panhandle where it has not yet been recorded, but erroneously mapped in Meshaka (2011). They are invasive and gradually spreading further westward through the panhandle and north of **Florida**."

"The *E. planirostris* in coastal Chatham County, **Georgia**, were clearly established and breeding when discovered (Winn et al., 1999). Jensen (2008) verifies that this species is established in Chatham County. Additional established coastal Georgia populations exist in Glynn and Camden Counties (Jensen, 2008). Greenhouse frogs are established in Lowndes and Thomas Counties, in noncoastal southern **Georgia** (Jensen, 2008). This species in [*sic*] spreading invasively and probably more widespread in **Georgia** than currently recorded (Jensen, 2008)."

"In **Louisiana**, *E. planirostris* is established and invasive (Dundee and Rossman, 1989; Dundee, 1994; Boundy, 1998, 2004; Conant and Collins, 1998; Elliott et al., 2009; Meshaka et al., 2009). They are spreading from their point of introduction in New Orleans."

"In **Mississippi**, the colony in Harrison County is established, but the status of greenhouse frogs in Oktibbeha County is unknown (Dinsmore, 2004)."

"*Eleutherodactylus planirostris* is established in southern **Alabama** (Carey, 1982; Kraus, 2008, 2009; Elliott et al., 2009). They probably will continue to spread throughout the Gulf States."

"The populations of greenhouse frogs found in Cole County, **Missouri**, and Tulsa County, **Oklahoma**, are confined to indoors environments and do not represent true introductions to the ecosystem (A. Hutton, personal communication 2001; B. Olsen, personal communication 2002). The **Missouri** *E. planirostris* might not survive cold winter weather in the greenhouse if it is unheated; however, survival of the single **Michigan** individual in freezing conditions could indicate otherwise (Zippel et al., 2005). The Tulsa Zoo population in **Oklahoma** is a large, very dense population of frogs; they are so numerous they often wander into nearby offices located within the Tropical Rainforest Building (B. Olsen, personal communication 2002). Obviously some frogs might some day find their way outside the confines of this building and invade the surrounding park grounds, but cold winters may eradicate them. The Oakland County, **Michigan**, record represents an single individual, and not an established population (Zippel et al., 2005)."

"*Eleutherodactylus planirostris* is a well-established, invasive species on the Hawaiian islands of Kauai, Maui, Oahu, and **Hawaii** (Big Island) (Kraus et al., 1999; Kraus and Campbell, 2002; Elliott et al., 2009; Kraus, 2009; Kraus and Thomas, 2009). They may be more widespread

within the Hawaiian Islands than currently realized, but have gone unnoticed due to their secretive habits and barely audible calls (Kraus and Campbell, 2002). A variety of methods are being used to monitor and eradicate these rapidly spreading frogs (Kraus et al., 1999; Beltz, 2002; Kraus and Campbell, 2002; Kraus and Thomas, 2009). Efforts to strictly legislate and eradicate nonindigenous herpetofauna in **Hawaii** have been met with some strident, self-serving resistance from individuals associated with the pet trade and amateur herpetoculture (Vivarium Staff, 1998; Walls, 1998). Measures to eradicate them or control their spread were not implemented in a timely fashion (Kraus and Campbell, 2002)."

"**Nonindigenous Occurrences:** Nonindigenous *E. planirostris* were first recorded by Cope (1863, 1875) from an undisclosed locality in southern **Florida**. Historically, it is the earliest nonindigenous introduction to the **Florida** herpetofauna (Krysko et al., 2011), and Heinicke et al. (2011) have demonstrated that they originated from Western Cuba. Later, Cope (1889) mentions a single specimen from Key West, Monroe County, Florida. Barbour (1910) collected a single *E. planirostris* from Eau Gallie, Brevard County, Florida. At this time Stejneger (in Barbour, 1910) mentioned four additional greenhouse frogs found in Lemon City (Miami), Miami-Dade County, Florida. Ever since their initial discovery in Florida more than 148 years ago, *E. planirostris* has spread northward to include all of the counties in peninsular and northeastern Florida from the northern counties of Nassau, Clay, Columbia, Union, Gilchrist, and Levy, southward to include most of the Florida Keys (Deckert, 1921; Neill, 1951; Duellman and Schwartz, 1958; Schwartz, 1974; Wilson and Porras, 1983; Ashton and Ashton, 1988; Dalrymple, 1988; Dodd and Charest, 1988; Moler, 1988; Lazell, 1989; Carmichael and Williams, 1991; Witz and Wilson, 1991; Bartlett, 1994; Franz, 1995; Conant and Collins, 1998; Bartlett and Bartlett, 1999; Meshaka, 1999a, b, 2011; Wray and Owen, 1999; Christman et al., 2000; Krysko and King, 2000; Meshaka et al., 2000, 2004; Seigel et al., 2002; Lillywhite and Sheehy, 2004; Florida Museum of Natural History records). In disjunct localities of the **Florida** panhandle *E. planirostris* has been found in Bay, Escambia, Franklin, Okaloosa, Leon, Gadsden, and Wakulla Counties (Jensen and Palis, 1995; Conant and Collins, 1998; Bartlett and Bartlett, 1999; Irwin, 1999; Krysko and Reppas, 1999; Irwin and Irwin, 2001; Johnson et al., 2003; Butler and Atkinson, 2008; Florida Museum of Natural History records)."

"In July 1998, greenhouse frogs (adults, juveniles, and eggs) were found in flowerpots kept outdoors at a residence in Savannah, Chatham County, Georgia (Winn et al., 1999). Seabrook (1998) indicates a second discovery of *E. planirostris* found in Georgia by a Brunswick resident in Glynn County. Additionally, Jensen (2008) records *E. planirostris* from Camden, Lowndes (Valdosta), and Thomas (Thomasville) Counties (also Graham et al., 2007; Dorcas and Gibbons, 2008), Georgia."

"In **Louisiana**, *E. planirostris* were collected in New Orleans, Orleans Parish, after observations dating back to 1975 (Plotkin and Atkinson, 1979; Dundee and Rossman, 1989; Dundee, 1994). Other nonindigenous records documenting the spread of greenhouse frogs in **Louisiana** include Jefferson Parish (Dundee, 1994), Plaquemines Parish (Dundee, 1994; Boundy, 2004), Baton Rouge, East Baton Rouge Parish (Platt and Fontenot, 1995), St. Bernard Parish (Boundy, 1998), St. John the Baptist Parish (Boundy, 1998), Lafayette Parish (Boundy, 2004), St. Tammany Parish (Elbers, 2007), Calcasieu Parish (Meshaka et al., 2009), and Terrebonne Parish (Liner,

2007)."

"Specimens have been collected from an isolated colony of *E. planirostris* in Gulfport, Harrison County, and another specimen from Starkville, Oktibbeha County, **Mississippi** (Dinsmore, 2004)."

"*Eleutherodactylus planirostris* has been introduced to Fairhope, Baldwin County, **Alabama** (Carey, 1982; also see Schwartz and Henderson 1991)."

"In Jefferson City, Cole County, **Missouri**, A. Hutton (personal communication 2001) discovered at least 40 juvenile *Eleutherodactylus* (apparently *E. planirostris*) living on the dirt floor beneath planting tables in a greenhouse of a commercial florist shop in 2001."

"A large, dense population of *E. planirostris* has been unintentionally introduced to the Tropical Rainforest Building of Tulsa Zoo, Tulsa, Tulsa County, **Oklahoma** (B. Olsen, personal communication 2002)."

"In **Hawaii**, greenhouse frogs have been introduced to the islands of Oahu, Hawaii Island (Big Island) (Kraus et al., 1999), Maui, and Kauai (Kraus and Campbell, 2002; Kraus and Thomas, 2009). Kraus and Campbell (2002) speculate that the original introductions probably took place in the early 1990s."

Means of Introduction into the United States

From Somma (2016):

"The greenhouse frog is aptly named since it is usually introduced as a stowaway on imported tropical plants and landscaping materials (Neill, 1951; Bartlett and Bartlett, 1999; Kraus and Campbell, 2002; Kraus in Hurley, 2003; Zippel et al., 2005), including plants shipped from **Florida** nurseries and **Hawaii** landscape shipments. This seems to be how it was introduced to **Georgia** (Winn et al., 1999), **Louisiana** (Dundee and Rossman, 1989; Meshaka et al., 2009), **Mississippi** (Dinsmore, 2004), **Missouri** (A. Hutton, personal communication 2001), **Oklahoma** (B. Olsen, personal communication 2002), **Michigan** (Zippel et al., 2005), **Hawaii** (Kraus et al., 1999; Kraus and Campbell, 2002), Guam (Kraus in Hurly, 2003), and in other nonindigenous localities."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2016):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata

Superclass Tetrapoda
Class Amphibia
Order Anura
Family Eleutherodactylidae Lutz, 1954
Subfamily Eleutherodactylinae Lutz, 1954
Genus *Eleutherodactylus* Duméril and Bibron, 1841
Species *Eleutherodactylus planirostris* (Cope, 1862)"

"Current Standing: valid"

Size, Weight, and Age Range

From Somma (2016):

"Size: SVL (snout-vent length) of 16-32 mm."

From CABI (2016):

"The mean survivorship in Florida is estimated to be 1.9 ± 2.3 months (range: 0.03-6.6) (Meshaka and Layne, 2002)."

Environment

From GISD (2016):

"A terrestrial, nocturnal amphibian, the greenhouse frog typically inhabits forests, riparian zones, and other areas that offer shelter and moisture. They are commonly found among husk piles and thrive in human altered areas such as junk yards, greenhouses, nurseries, lawns, and gardens. They are also resilient to hot and dry conditions making them a formidable colonist species."

From CABI (2016):

"*E. planirostris* seems to be restricted to low elevation areas. They are found from sea level up to 720 m in Cuba, 600 m in Jamaica and 500 m in the southeastern USA and Hawaii (Stewart and Mar[t]in, 1980; Díaz and Cádiz, 2008; Olson et al., 2012b)."

"*E. planirostris* is a terrestrial or sub-fossorial species, and can occassionally be found up to 2 m off the ground (Duellman and Schwartz, 1958)."

Climate/Range

From CABI (2016):

"*E. planirostris* has a high tolerance for warm and dry conditions compared to other Jamaican *Eleutherodactylus* species, with a preferred temperature of 27.3 ± 0.66°C (Pough et al., 1977). The maximum temperature range for *E. planirostris* was found to be from 36.4 to 41.8°C and critical water loss at 34.9% ± 0.004 of initial body weight in 40-50% relative humidity (Pough et al., 1977). Most areas of introductions have similar mean annual and maximum warmest-month

temperatures to Cuba (Rödder and Lötters, 2010). Temperature and rainfall will likely limit its spread in temperate climates; for example, populations found in Oklahoma City and Missouri are limited to indoor greenhouses and buildings (US Geological Survey, 2016). However, there is a record of one individual that survived one month in a frozen mulch bag in Michigan (Zippel et al., 2005) and given their long term residence in peninsular Florida, *E. planirostris* may have evolved adaptations to survive colder climates (Bomford et al., 2009; Heinicke et al., 2011). Species distribution models indicate that *E. planirostris* exhibits niche conservatism in its invaded habitats but this may be due to the environmental gradients available (Rödder and Lötters, 2010). It is believed that the distribution of *E. planirostris* is increasing northward as a result global warming."

Distribution Outside the United States

Native

From Somma (2016):

"*Eleutherodactylus planirostris* is indigenous to Cuba, the Cayman Islands, and the northern Bahamas (Barbour and Ramsden, 1919; Schwartz, 1974; Schwartz and Thomas, 1975; Frost, 1985; Schwartz and Henderson, 1985, 1991; Powell et al., 1996; Estrada and Ruibal, 1999; Hedges, 1999; Kraus, 2008; Elliott et al., 2009; Echternacht et al., 2011; Heinicke et al., 2011)."

Introduced

From CABI (2016):

"In the Caribbean, *E. planirostris* has been introduced into Great Inagua Bank in the south of the Bahamas (Schwartz, 1974, Schwartz and Henderson, 1991, Powell and Henderson, 2012). Schwartz (1974) speculated that populations found on Caicos (North Caicos) are native, but *E. planirostris* are now considered non-native in all of the Turks and Caicos (Lever, 2003; Reynolds and Niemiller, 2010; Reynolds, 2011; Reynolds, 2012; Powell and Henderson, 2012). Established populations are recorded on the islands of Providenciales, Grand Turk, North Caicos, Middle Caicos and Big Ambergris Key. *E. planirostris* is widespread throughout Jamaica, more commonly in open and disturbed habitats (Crombie, 1999; Hedges, 1999; Powell et al., 2011; Wilson, 2011). There are records for *E. planirostris* in Grenada (Kaiser, 1992; Hedges, 1999; Kraus et al., 1999) but some think that this is a mistake (Powell et al., 2011; Powell and Henderson, 2012). In Guadeloupe, there is a record of *Eleutherodactylus* cf *planirostris* but additional records are lacking and it is possible that it may have been a misidentification (Breuil, 2002; Lorvelec et al., 2007; Powell and Henderson, 2012). This species has also been recorded in Honduras, in San Pedro Sula in 2007, Isla de la Guanaja in 2012, La Ceiba in 2012 and Tegucigalpa in 2014 (McCranie et al., 2008; McCranie and Orellana, 2014; Solís et al., 2014a; Solís et al., 2014b) and in the neighbourhood of Cerro Ancón in Panama City, Panama in 2007. They have also been found in the neighbourhoods of Costa del Este, Dorado Lakes and Balboa, Altos del Chase and Fuentes del Fresno, Panama (Crawford et al., 2011). An abundant greenhouse population was recorded in the mangroves of Cayo Mayor, Cayos Miskitos in Nicaragua in 1992 (Villa, 2015). There is one record for an individual *E. planirostris* in a residential area of Paramaribo, Suriname (Ouboter and Jairam, 2012) but there is no further information. Records for *E. planirostris* in Mexico include the port of Veracruz and, more

recently, from Yucatán peninsula, in Playa del Carmen, 2010 and Cancun, 2015 (Schwartz, 1974; Cedeño-Vázquez et al., 2014; García-Balderas et al., 2016)."

"On Guam, an established population was found at St. John's School, Tumon in 2003 and later populations were found in Tamuning, Mangilao and Manengon and at the US Naval Computer and Telecommunications Station (Christy et al., [2007], Mathies et al., 2012). This species is now found throughout the island (Olson et al., 2012b). In Asia, calling males were first detected in 2013 in a landscaped residential area of Davao City on the island of Mindanao, Philippines (Olson et al., 2014). Established populations have also been found on the islands of Cebu, Luzon and Negros (Sy et al., 2015a; Sy et al., 2015b; Sy and Salgo, 2015). In Hong Kong, sightings of *E. planirostris* have been reported since 2011 at the Lung Fu Shan Country Park and Campus University of Hong (HKBWS, 2013; iNaturalist, 2016; Po et al., 2016). A record from Singapore reports a single individual frog in the residential area of Sembawang in 2015 ([Groenewoud] and Law, 2016). A photograph was taken, but no specimens were collected and there have been no additional individuals observed at the site."

"A biodiversity study in southeastern Nigeria reported that several *E. planirostris* were found at a site in 2008 (Ukpong et al., 2012), but there is no indication whether they established, or if verification photographs or specimens were collected."

Means of Introduction Outside the United States

From CABI (2016):

"Colonisation of neighbouring Caribbean islands, including Great Inagua Bank in southern Bahamas and the Turks and Caicos, is thought to be more recent and via unintentional transport, either through the nursery or shipping trade (Schwartz and Henderson, 1991; Kraus 2009[a], Powell et al., 2011; Reynolds, 2011). A recent introduction to Big Ambergris Cay, Turks and Caicos, possibly in or before 2011, is thought to have arrived with construction materials from Providenciales (Reynolds, 2012)."

"*E. planirostris* was introduced to Jamaica in major port cities prior to the 1930s and thought to have been transported via the shipping industry (Stewart, 1977). This species was first recorded in Montego Bay in 1937, Kingston in 1940 and by 1943, was considered to be widespread (Lynn, 1937; Lynn, 1940; Lynn and Dent, 1943). The shipping industry may have also introduced *E. planirostris* to Veracruz, Mexico, but more recent introductions to the Yucatán peninsula have occurred into residential areas (Cedeño-Vazquez et al., 2014) and probably transported via the nursery trade. Recent introductions to Panama and Honduras were to residential areas and believed to have occurred [*sic*] via the nursery trade (Crawford et al. 2011, McCranie and Orellana, 2014). Molecular analysis of specimens from Panama indicates that the *E. planirostris* populations originated from Florida (Crawford et al., 2011)."

Short Description

From GISD (2016):

"It may have light longitudinal stripes or a mottled coloration with light and dark patches. It is brown with orange or reddish tones and has reddish eyes. Its toes are not webbed and are long and thin with well-developed tubercles."

Biology

From CABI (2016):

"**Reproductive Biology**
E. planirostris is a direct-development frog, which means there is no tadpole phase and complete metamorphosis takes place inside of the egg. Eggs are laid on the ground, or under fallen leaves, rocks, or other debris (Goin, 1947; Díaz and Cádiz, 2008). Clutch size ranges from 3-26 eggs, and eggs hatch 13-20 days after deposition (Goin, 1947). Hatchlings resemble adult frogs, with similar colour patterns and an egg-tooth and reduced tail that is absorbed (Goin, 1947). Snout-vent-length (SVL) ranges from 4.3-5.7 mm (Goin, 1947; Lazell, 1989)."

"In Cuba, vitellogenesis is bimodal with first occurrence from April to June and then again from September to October. Temperature is a vital environmental cue for onset. Spermatogenesis occurs from March to November peaking in June and July (Iturriaga et al., 2014)."

"*E. planirostris* breeds seasonally in Cuba from April through January (Meshaka and Layne, 2002) and April to September in Florida (Goin, 1947; Meshaka and Layne, 2002). In Louisiana, breeding is limited to June and July (Dundee and Rossman, 1989). Breeding is seasonal in Hawaii and mirror the breeding season of Florida (Ferreira et al., 2015). Breeding usually occurs at night in warm and humid conditions (Meshaka and Layne, 2002). Males will call on the ground or vegetation, under debris or rocks and from subterranean lava tubes (Díaz and Cádiz 2008; Olson et al., 2012b)."

"Frogs become reproductively active 6-8 months after hatching in south-central Florida (Meshaka and Layne, 2002) and after one year in north Florida (Goin, 1947)."

"**Activity Patterns**
E. planirostris is active all year round in Cuba but in Florida, it may limit its activity during cooler temperatures (Goin, 1947). In the Everglades of southern Florida, *E. planirostris* was found hibernating under the bark of a wild tamarind tree (Harper, 1935). In native and introduced habitats, they are predominantly nocturnal, actively foraging at night and seeking daytime retreat sites in leaf litter or under debris (Goin, 1947; Stewart 1977; Díaz and Cádiz, 2008; Meshaka, 2011; Olson and Beard, 2012). Advertisement calls are heard at night with peak chorus just after sunset and before sunrise (Goin, 1947)."

"**Population Size and Structure**
Population density estimates are only available from introduced habitats. Densities estimated from mark-recapture studies of adults at three sites on the island of Hawaii were 4,564, 2,400 and 5,300 adults ha^{-1} (Olson et al., 2012a; Olson et al., 2012b). Preadult to adult ratio was also

determined at the first site as 1.7, thus the total population density was estimated to be 12,522 frogs ha-1. In Jamaica, the density of *E. planirostris* and th0000ree other *Eleutherodactylus* species was estimated at 4,635 frogs ha^{-1}. The abundance of *E. planirostris* was found to be higher in the dry season, at coastal regions and sites without native species (Stewart and Martin, 1980). For the latter survey, it was the most abundant species found. In southeastern Florida, it was one of the most abundant species during a study using coverboards (Engeman et al., 2016)."

"**Nutrition**
Dietary studies indicate that *E. planirostris* is primarily an insectivore and predominantly consumes leaf litter invertebrates. They will eat a variety of available species, but may specialise on ants (Olson and Beard, 2012; Ferreira et al., 2015). In Cuba, the native range, ants comprised 100% of their diet (Goin, 1947). In its introduced habitats of Florida, Jamaica and Hawaii, ants were also the dominant prey (Goin, 1947; Stewart, 1977; Olson and Beard, 2012; Ferreira et al., 2012). Other invertebrates found in their diet include springtails, arachnids (spiders and mites), termites, beetles, collembola, amphipods, isopods, cockroaches, dermaptera, millipedes, centipedes, worms, flies (adults and larvae), hemiptera (true bugs), Lepidoptera larvae and snails."

"**Associations**
In southeastern USA, *E. planirostris* is one of many species that are found commensal with the gopher tortoise (*Gopherus polyphemus*) using its burrows in mesic and xeric forests (Lips, 1991; Witz et al., 1991). One study in a long-leaf pine savannah habitat indicated that there is a slight correlation between *E. planirostris* abundance and number of gopher tortoise burrows (Catano and Stout, 2015)."

Human Uses

From GISD (2016):

"Some people intentionally introduce *Eleutherodactylus planirostris* to their gardens because they find them and/or their call appealing (Bomford et al., 2005)."

Diseases

From Rizkalla (2010):

"Several species were *Bd*-positive [i.e., positive for *Batrachochytrium dendrobatidis*] within the WMCA [Walt Disney World's Wildlife Management and Conservation Area], including […] three Greenhouse Frogs (*Eleutherodactylus planirostris*)"

Infection with *B. dendrobatidis* (chytrid fungus) is an OIE-reportable disease.

Threat to Humans

From CABI (2016):

"In Hawaii, where high densities of *E. planirostris* have been reported around resorts and hotels, costs have been incurred to treat infestations of irrigation boxes and around swimming pools however, these are minimal (Olson et al., 2012b)."

3 Impacts of Introductions

From Somma (2016):

"The impact of greenhouse frogs on indigenous ecosystems in **Florida** remains unclear, and may be further obfuscated by their long establishment in this state. Some of the concerns (see below) addressed by Kraus et al. (1999), and Kraus and Campbell (2002) for **Hawaiian** populations may have some validity in **Florida**, with the caveat that unlike **Hawaii**, **Florida** ecosystems have numerous species of native frogs and more diverse terrestrial fauna. Witz and Wilson (1991) found *E. planirostris* were burrow symbionts of *Gopherus polyphemus*, the gopher tortoise. On at least three occasions I have observed *E. planirostris* in **Florida**, sharing ground cover with indigenous *Gastrophryne carolinensis*, eastern narrow-mouthed toads (Somma, personal observation). The significance of these interactions is unknown."

"The impact of *E. planirostris* in **Alabama**, **Georgia**, **Louisiana**, and **Mississippi** is unknown but the same concerns addressing populations in **Florida** may apply to these four states."

"**Hawaiian** populations of these insectivores are invasive and spreading rapidly in a state that has no native frogs (Kraus et al. 1999; Kraus and Campbell 2002). Greenhouse frogs could potentially eat indigenous, endemic arthropods, including species of insects and spiders close to extinction (Kraus et al. 1999). This also could have a negative impact on indigenous insectivorous birds that may be forced to compete with *E. planirostris* for food (Kraus et al. 1999; Kraus and Thomas 2009). Nutrient flow through the native food web may be disrupted, and *E. planirostris* may serve as a source of food for nonindigenous, invasive predators (Kraus 1999; Kraus 2009[b])."

"Similar problems may be caused by established greenhouse frogs in Guam where they may additionally provide a source of food for nonindigenous invasive populations of rats, mongooses, and brown tree snakes (*Boiga irregularis*) (Campbell and Kraus in Hurley 2003)."

"The impact of *E. planirostris* in Veracruz, Mexico, Panama, and the Caribbean localities of Jamaica, Caicos Islands, and southern Bahamas, remains entirely unexplored. Due to the similarity in fauna and habitat, so relatively close to their native range and ecology, they may present fewer problems on some of the Caribbean islands (Kraus et al. 1999)."

From CABI (2016):

"*E. planirostris* consumes a variety of leaf-litter invertebrates which could threaten native species of ants, mites, spiders and beetles (Goin, 1947; Duellman and Schwartz, 1958; Olson and

Beard, 2012). It is possible that this species may compete with native insectivores, such as the Reef Gecko (*Sphaerodactylus notatus*) in southern Florida (Meshaka, 2011). Additionally, changes in native leaf litter invertebrate communities can impact ecosystem processes such as nutrient cycling or leaf litter decomposition rates, however as yet, there is no data to prove this (Olson and Beard, 2012). In Guam, *E. planirostris* may also provide an unnatural prey source for the invasive brown tree snake, *Boiga irregularis* and facilitate its spread (Mathies et al., 2012)."

"Nevertheless, in Hawaii, where all ant species are non-native and many negatively impact native invertebrates, plants and vertebrates, it is possible that *E. planirostris* may have a positive impact as it may help reduce non-native ant populations, specifically big-headed ants, *Pheidole megacephala*, Argentine ants, *Linepithema humile* and yellow crazy ants, *Anoplolepis gracilipes* (Olson and Beard, 2012)."

From Ferreira et al. (2015):

"We analyzed stomach contents of 397 frogs from 10 study sites in Maui. Results suggest Greenhouse Frogs are active, ant-specialist predators in the leaf litter. Ants (Formicidae) were the dominant prey found in stomachs in both number and volume. Furthermore, only ants were consumed in a higher proportion than they were sampled in the environment. Because ants dominated their diets, and because all ants are nonnative to Hawaii, this means Greenhouse Frogs consumed primarily nonnative invertebrates (>80%) in the areas sampled. Although results suggest that most native taxa are not at risk from Greenhouse Frog predation, the only locations where we could currently find Greenhouse Frogs were in human-dominated lowlands, which have a lower proportion of native species. Greenhouse Frogs may consume more native species if they invade more native-dominated habitat. Alternatively, nonnative ants are known to impact negatively many native invertebrates in Hawaii, and their possible reduction through Greenhouse Frog predation could affect other species positively."

4 Global Distribution

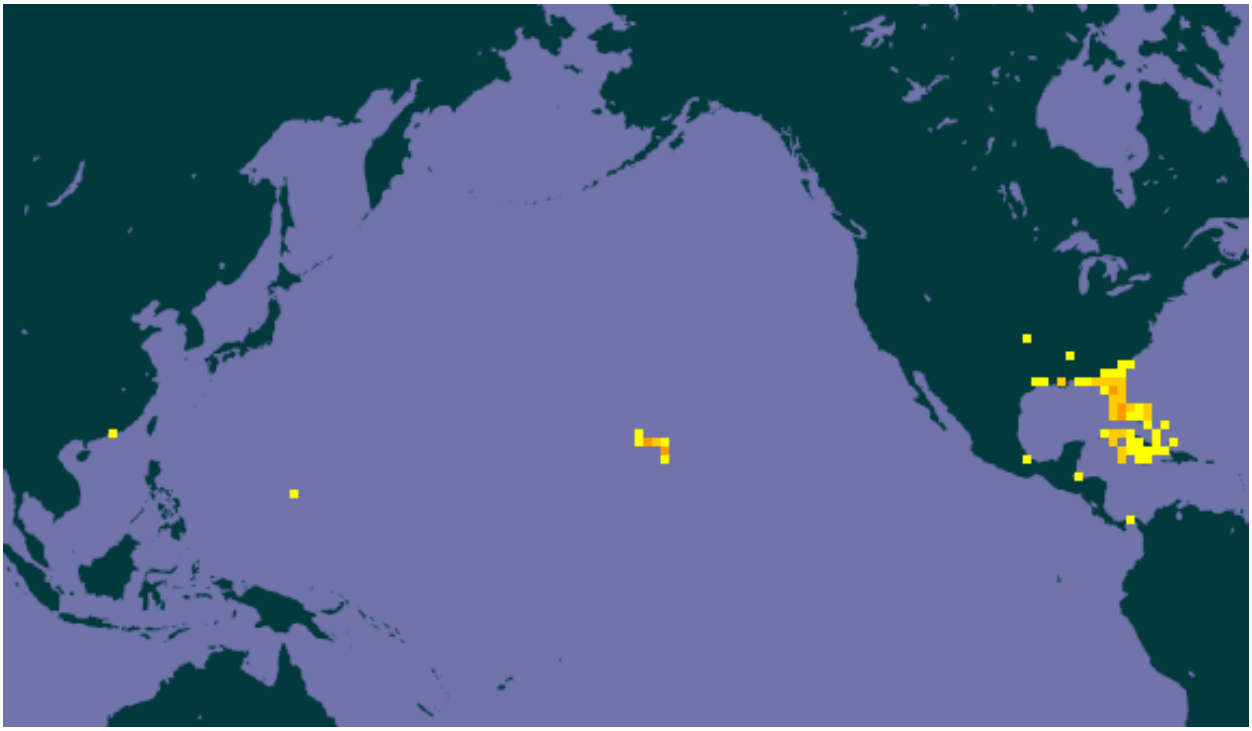

Figure 1. Known global established locations of *E. planirostris*. Map from GBIF (2016).

5 Distribution Within the United States

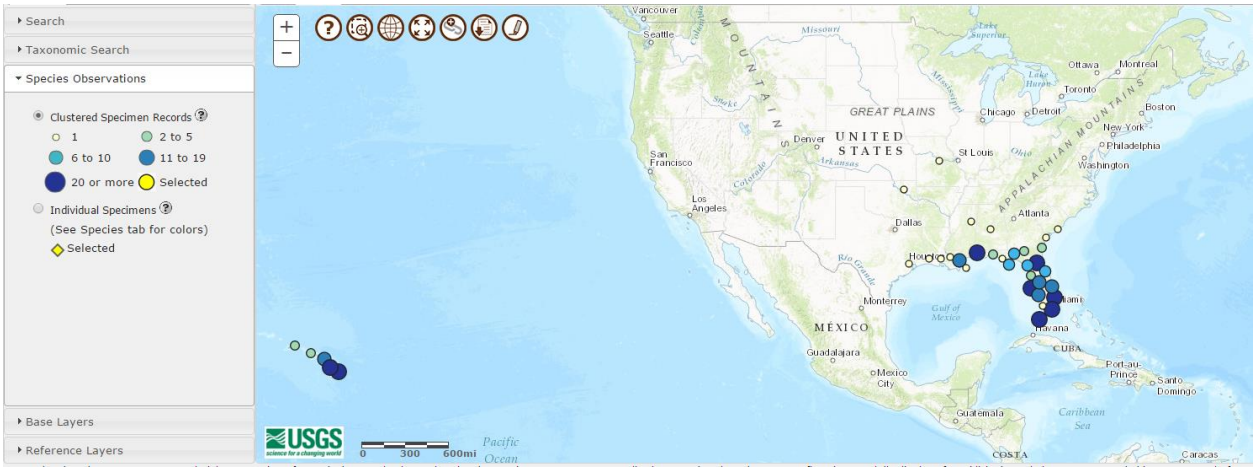

Figure 2. U.S. distribution of *E. planirostris* (Somma 2016). Locations in Oklahoma and Missouri do not represent established populations (see Section 1) and were excluded from climate matching.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) for the contiguous United States is high for the southeastern region. Medium match extended along coast from the Mid-Atlantic States to New Hampshire, and along the Pacific coast from the Mexican border to San Francisco and also inland in Washington north of Seattle. Low match covered the remainder of the contiguous U.S. Climate 6 score indicated that the contiguous U.S. is a high climate match overall. The range of scores indicating a high climate match is 0.103 and greater; Climate 6 score of *E. planirostris* is 0.179.

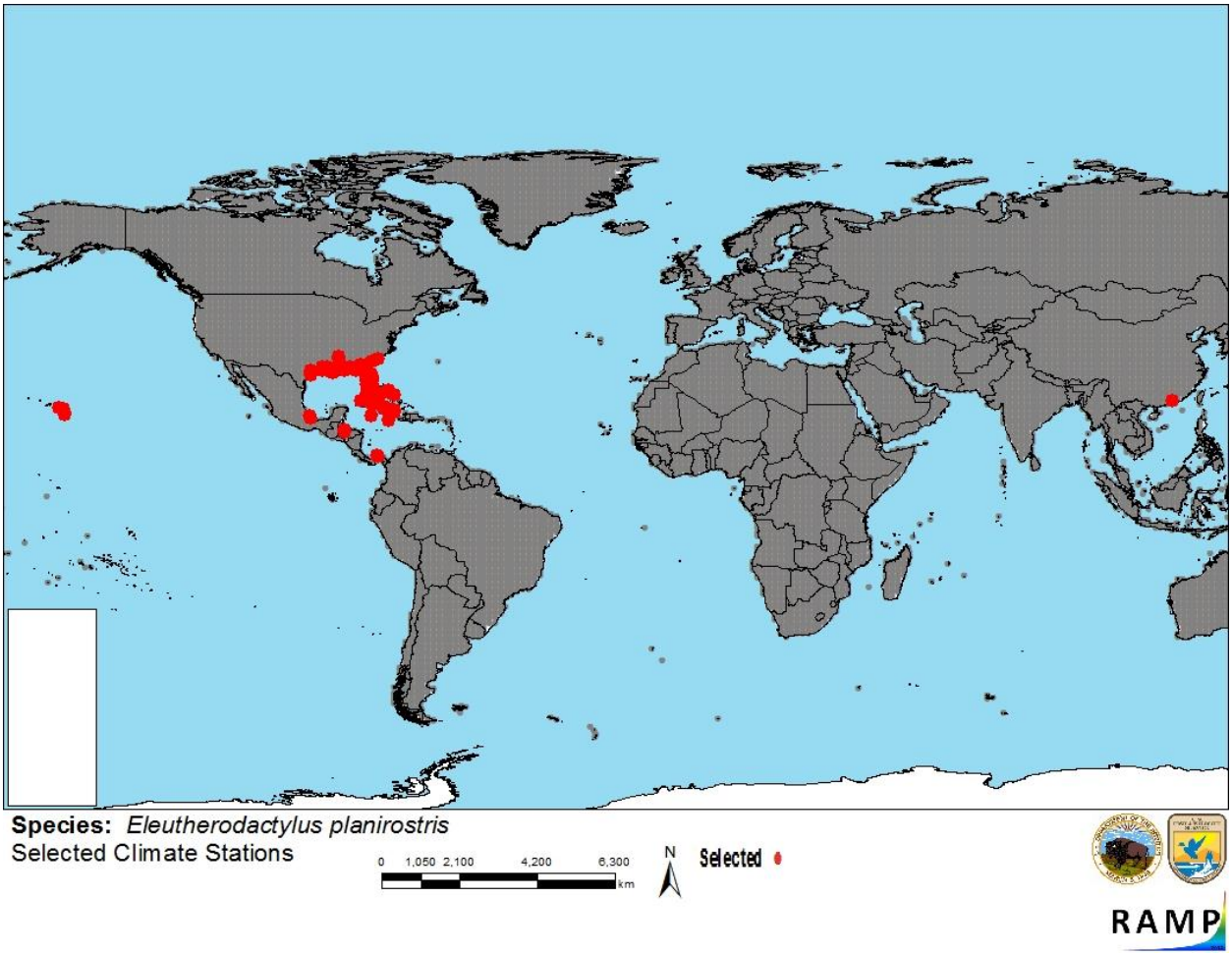

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *E. planirostris* climate matching. Source locations from GBIF (2016). Collections of *E. planirostris* in Oklahoma and Missouri do not represent established populations (see Section 1) and were excluded from climate matching. No georeferenced occurrences were reported for the Philippines, so established *E. planirostris* population in the Philippines was not included in the climate matching analysis. No source location in RAMP was available near Guam, so the established *E. planirostris* population in Guam was not included in the climate matching analysis.

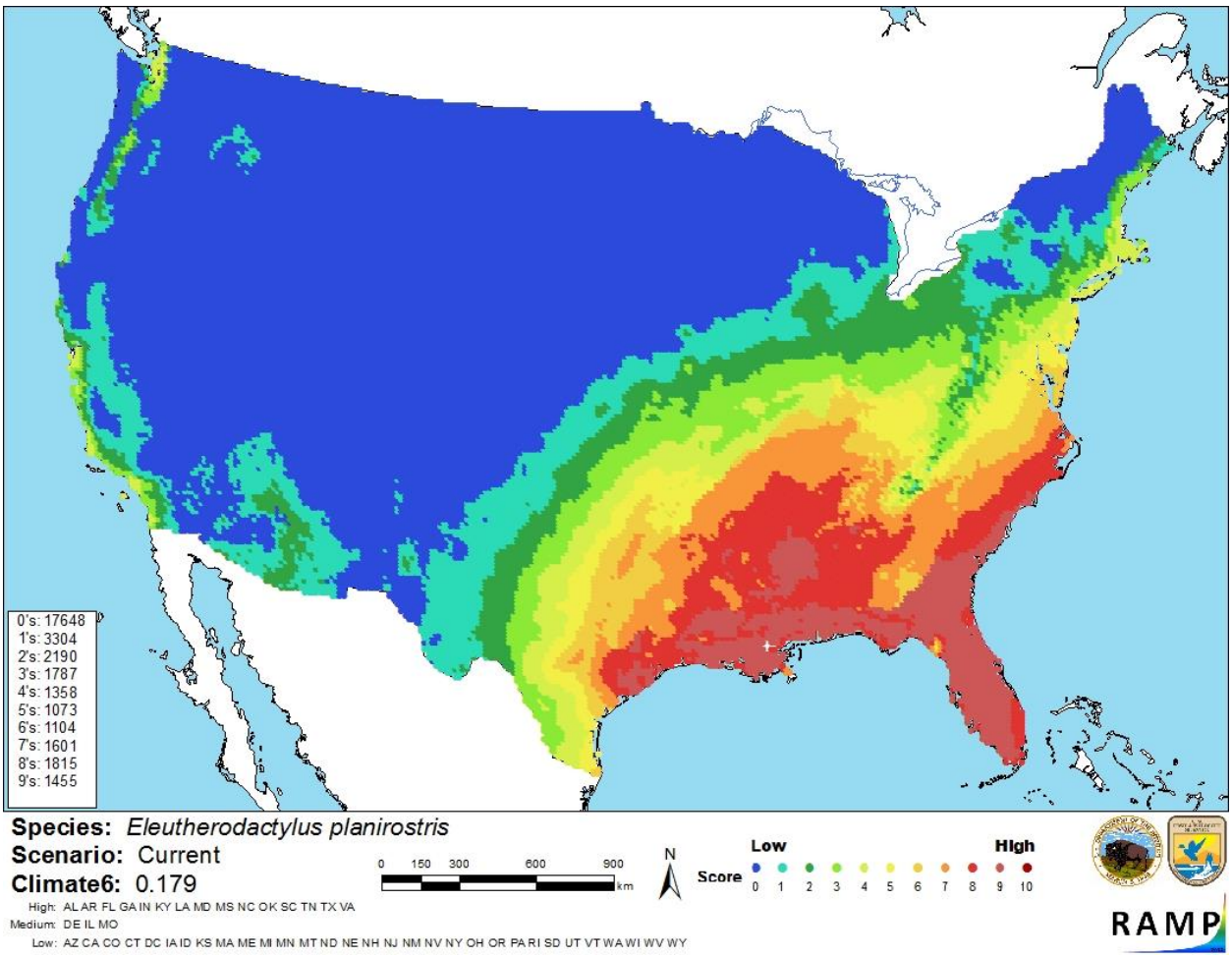

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *E. planirostris* in the contiguous United States. Source locations from GBIF (2016). 0= Lowest match, 10=Highest match. Counts of climate match scores are tabulated on the left.

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
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

7 Certainty of Assessment

Information on the biology, ecology, and distribution of *E. planirostris* is readily available. Information on realized impacts is scarce, despite many projected impacts of *E. planirostris* introduction. However, the ability of *E. planirostris* to carry the OIE-reportable chytrid fungus has been documented clearly. Certainty of this assessment is medium.

8 Risk Assessment

Summary of Risk to the Contiguous United States

E. planirostris is a frog that has successfully established populations in five states within the contiguous U.S. as well as in Hawaii, Guam, several Caribbean islands, Mexico, Honduras, Panama, Hong Kong, and the Philippines. The typical pathway of introduction is through the nursery trade. Introduction of *E. planirostris* is projected to affect native insectivores, nutrient cycling, and leaf-litter decomposition rates. The species may also serve as a prey item for other problematic, non-native species. Also, three *E. planirostris* in Florida tested positive for the fungus Bd, which is OIE-reportable. However, clear scientific evidence of negative impact to native species or ecosystems has yet to be documented. Climate match to the contiguous U.S. is high overall, with highest match occurring in the southeastern U.S. Overall risk posed by *E. planirostris* is high.

Assessment Elements

- **History of Invasiveness: None Documented**
- **Climate Match: High**
- **Certainty of Assessment: Medium**
- **Important additional information: Susceptible to carrying chytrid fungus caused by *Batrachochytrium dendrobatidis*.**
- **Overall Risk Assessment Category: Uncertain**

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