Coqui (*Eleutherodactylus coqui*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, August 2011
Revised, November 2016
Web Version, 12/26/2017

Photo: U.S. Department of Agriculture.

1 Native Range, and Status in the United States

Native Range

From Hedges et al. (2008):

"Puerto Rico."

Status in the United States

From Somma and Neilson (2016):

"Nonindigenous, established populations occur on St. Croix, St. John and St. Thomas, U.S. Virgin Islands (Schwartz and Thomas, 1975; Schwartz and Henderson, 1985, 1991; Conant and Collins, 1998; F. Kraus, personal communication 2002)."

"Coqui are recorded from South Miami and Homestead, Miami-Dade County, Florida (Austin and Schwartz, 1975; Smith and Kohler, 1978; Wilson and Porras, 1983; Loftus and Herndon, 1984; Ashton and Ashton, 1988; Bartlett, 1994; Da[lr]ymple, 1994; McCoid and Kleberg, 1995; McCann et al., 1996; Conant and Collins, 1998; Bartlett and Bartlett, 1999; King, 2006). In Hawaii coqui are found on Maui, Hawaii Island (Big Island), Kauai, and Oahu (McKeown, 1998; Kraus et al., 1999; Kraus and Campbell, 2002; Thomas, 2006; Woolbright et al., 2006). (Note: some specimens identified by Kraus et al. [1999] as *E. martinicensis* are actually *E. coqui* [Kraus and Campbell, 2002].) The record for New Orleans, Louisiana, (first mapped in Conant and Collins, 1991) is erroneous (Dundee, 1991; Dundee in Frost, 2000)."

"Populations in Miami-Dade County, Florida, persist and are limited to areas in and around a few greenhouses (Loftus and Herndon, 1984; Ashton and Ashton, 1988; Bartlett, 1994; Bartlett and Bartlett, 1999; Meshaka et al., 2004). Those coqui outside the greenhouses tend to die off during winter freezes and those once found at the Fairchild Tropical Gardens are now suspected extirpated (Wilson and Porras, 1983; Ashton and Ashton, 1988; Bartlett and Bartlett, 1999). It is not known if the Florida populations are self-sustaining or replenished through new horticultural plantings (Bartlett and Bartlett, 1999); thus, Butterfield et al. (1997) question listing *E. coqui* as an established, nonindigenous species. (Also see Meshaka et al. 2004)."

"Numerous populations of coqui in Hawaii are established, and highly invasive; a variety of methods are being used to monitor and eradicate these rapidly spreading frogs (Kraus et al., 1999; Kraus and Campbell, 2002; Thomas, 2006; Woolbright et al., 2006)."

Means of Introduction into the United States

From Somma and Neilson (2016):

"Most introductions are probably the result of horticultural and landscaping imports; many plants provide shelter for both the adult frogs and their eggs (Austin and Schwartz, 1975; Bartlett and Bartlett, 1999; Kraus et al., 1999; Kraus and Campbell, 2002; Thomas, 2006; Woolbright et al., 2006), although some releases in Hawaii are intentional (Kraus et al., 1999; Kraus and Campbell, 2002; Woolbright et al., 2006; F. Kraus, personal communication 2002)."

Remarks

From Somma and Neilson (2016):

"There is current concern that *E. coqui* may be transported to Guam and become established in the same fashion as the closely related greenhouse frog, *E. planirostris* (Hurley, 2003)."

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
Subfamily Eleutherodactylinae
Genus *Eleutherodactylus* Duméril and Bibron, 1841
Species *Eleutherodactylus coqui* Thomas, 1966"

"Current Standing: valid"

Size, Weight, and Age Range

From Somma and Neilson (2016):

"snout-vent length of 33-57 mm"

From CABI (2016):

"In Puerto Rico, mature calling males and "parental males" (males guarding a clutch) average about 34mm in length from snout to vent (snout-vent length, or SVL), while mature egg-laying females average about 41mm SVL."

From Maiorana (2006):

"Maximum lifespan of *E. coqui* is not known but individuals have been found in the wild up to 6 years old. An estimated 94% of adult individuals do not live past their first year. (Stewart and Woolbright, 1996)"

Environment

From CABI (2016):

"*E. coqui* has been described as a habitat generalist. Quantitative studies on habitat preferences of *E. coqui* in its native range have shown that different individuals preferred different heights from the forest floor."

From Hedges et al. (2008):

"It is found in mesic forests. Males call from elevated exposed surfaces such as leaves and tree trunks. It has also been recorded from agricultural land including plantations and arable land, and other disturbed habitats such as towns."

Climate/Range

From CABI (2016):

"In its native Puerto Rico, *E. coqui* occurs up to elevations of 1200m."

Distribution Outside the United States

Native

From Hedges et al. (2008):

"Puerto Rico."

Introduced

From CABI (2016):

"Bahamas"
"Dominican Republic"
"Ecuador –Galapagos Islands"
"New Zealand"

Means of Introduction Outside the United States

From NIES (2016):

"Accidental: Hitchhiking on building materials and/or garden trees, in the cases of other countries."

Short Description

From CABI (2016):

"Like the true tree frogs (family Hylidae), *E. coqui* have well developed pads at the end of each toe that are used for sticking to surfaces. *E. coqui* individuals are extremely variable in colouration. The dorsum (upper surface) is generally grey or grey-brown and may be uniform in colour. Alternatively, they may have either a dark "M" shape between the shoulders, two broad, light dorso-lateral bars (from the snout, through to the eye, to the axilla of the rear legs) bordered with black spots and/or a light bar on top of the head between the eyes and a light underside stippled with brown (Campbell, 2000)."

Biology

From Somma and Neilson (2016):

"These arboreal frogs are highly fecund and can exist in fairly large densities (Stewart, 1995; Joglar, 1998; Kraus et al., 1999; Kraus and Campbell, 2002). Near the Hilo area of eastern Hawaii Island (Big Island), population densities of *E. coqui* are three times higher than those in their native Puerto Rico (Woolbright et al., 2006). Coqui may reach the ground from their arboreal perches by parachuting (Stewart, 1985). To attract a mate, males call to females with the greater mating advantage going to the males with the highest call rates (Townsend and Stewart, 1986a; Lopez, 1996). Calls also are used in aggressive encounters (Stewart and Rand, 1991, 1992). Fertilization is internal; development is direct with well-developed neonate frogs hatching from eggs in vegetation without any aquatic tadpole stage (Townsend et al., 1981; Townsend and Stewart, 1985, 1986b; Townsend, 1996). Males brood eggs in an elevated, sheltered spot such as a cavity or a bromeliad (Taigen et al., 1984; Townsend et al., 1984; Townsend, 1986, 1996). In Hawaii, *E. coqui* supplement their shelter sites and nesting sites by making extensive use of subterranean passages and galleries within the porous lava substrate (Woolbright et al., 2006)."

From CABI (2016):

"*E. coqui* reproduce year-round in their native range, but breeding activity is concentrated in the wet season. Female *E. coqui* lay 4-6 clutches of about 28 eggs each (range 16-41) per year. The time period between clutches is around eight weeks. *E. coqui* utilize internal fertilization and, like other eleutherodactylids, the fertilized eggs undergo direct development, rather than passing through a free-living larval (tadpole) stage, so standing water is not required for egg laying. *E. coqui* are known to utilize the nesting cavities of several bird species in Puerto Rico, including the bananaquit (*Coereba flaveola portoricensis*), the Puerto Rican bullfinch (*Loxigilla portoricensis*) and the Puerto Rican tody (*Todus mexicanus*). Male frogs nest in protected cavities near the ground, such as dead, curled leaves or rolled palm frond petioles. Males, which guard the eggs (to keep them from drying out), are known to leave the nest in severely dry conditions to gather moisture to rehydrate the eggs (Campbell, 2000). […] The time period between clutches is around eight weeks (Campbell, 2000)."

"Quantitative studies on habitat preferences of *E. coqui* in its native range have shown that different individuals preferred different heights from the forest floor. Adults were seen to have a wider preference for a range of heights compared with juveniles. Adults have demonstrated a strong positive association with dead, fallen leaves and early successional species, such as *Cecropia*, *Heliconia* and *Prestoea*. *E. coqui* generally have positive associations with shrubs and negative associations with grasses, vines and ferns. Exceptions include *Philodendron angustatum* and *Danea nodosa*, which both have a broad leaf structure and are thus able to provide better structural support than other species in those habitat categories (Beard et al. 2003[a])."

"*E. coqui* is a generalist nocturnal predator and consumes an estimated 114, 000 invertebrates per hectare per night (Stewart & Woolbright, 1996) and even more at its highest densities in Hawai'i. It consumes invertebrates mostly on vegetation at night and in the litter during the day (Beard, 2007)."

"*E. coqui* forms part of the diets of birds and nocturnal mammals. They are known to be eaten by the giant crab spiders, *Olios* spp. and the Puerto Rican racer (a snake), *Alsophis portoricensis*."

Human Uses

From Maiorana (2006):

“Because *E. coqui* are commonly found living in human dominated landscapes, such as in homes and parks, they may function as a live-in pest control agent, removing unwanted insects from human homes. ("Gulf States Marine Fishery Commission", 1999)”

From CABI (2016):

“In its native Puerto Rico, *E. coqui* is considered a national symbol, and appears extensively on tourist items (Beard et al., 2009).”

Diseases

From Rollins-Smith et al. (2015):

“In spite of an average *Bd* [*Batrachochytrium dendrobatidis*] prevalence of 43% among highland populations, *E. coqui* survive with low to moderate infection intensities averaging 1003 *Bd* zoospore genomic equivalents, a pattern indicative of enzootic conditions (Longo & Burrowes 2010). However, the fact that these frogs die from chytridiomycosis when environmental conditions are harsh both in the lab and in the wild suggests that they are susceptible to *Bd* (Longo et al. 2010, 2013), and that a mechanism to resist high infections is effective during favorable times.”

Marr et al. (2008) report the following parasites of *Eleutherodactylus coqui* from 80 frogs in Puerto Rico and 80 frogs in Hawaii, with site of infection in parentheses: *Rhabdias* spp. (lung), *Porrocaecum* sp. (mesentery), *Parapharyngodon* sp. (colon), unknown larval nematode-likely *Aplectana* sp. (small intestine, colon), *Cosmocerca* spp. (small intestine, colon), Acanthocephalan 1 and Acanthocephalan 2 (GI tract), cestode (body cavity), mite (external surface), and *Allodero* sp. (ureter).

Threat to Humans

From CABI (2016):

“In Hawai‘i there are concerns over economic impacts as well as ecological impacts (Beard et al., 2009). The cost of current *E. coqui* detection and control on Hawai‘i alone is $2.8 million annually. An important pathway for spread has been through the nursery trade. Quarantine restrictions and de-infestation measures are costing the nursery and floriculture industries, and customers may be more reluctant to buy due to concerns of infestation (Beard, 2006). *E. coqui* have spread from horticultural sites where they were first restricted, to public land, residential areas and resorts. There are concerns that property value may be affected due to the high biomass of frogs on infested sites (Kraus and Campbell, 2002). The high pitched call of the frog is a disturbance and there are fears this may affect the tourism industry (HEAR, 2004). Real estate prices have been negatively affected in heavily infested areas.”

3 Impacts of Introductions

From GISD (2016):

“Experiments were conducted at two spatial scales to investigate the effects of terrestrial frogs (*Eleutherodactylus coqui*) on aerial and litter invertebrates, plant growth and herbivory, and litter decomposition. Results showed that at both scales, frogs reduced aerial invertebrates and leaf herbivory, but had no effect on litter invertebrates. At the smaller scale, frogs increased foliage production rates, measured as the number of new leaves and new leaf area produced, by 80% and decomposition rates by 20%. These results demonstrate that *E. coqui* may affect ecosystem functions by decreasing prey items and increasing nutrient cycling rates (Beard *et al.* 2003[b]).”

From Somma and Neilson (2016):

“Impact of *E. coqui* in the U.S. Virgin Islands remains unknown, but due to the similarity in fauna and habitat, so relatively close to their native range and ecology, Kraus et al. (1999) expect few problems. The few Florida populations are clearly noninvasive, and lead a tenuous existence. Hawaii has no native frogs. Hawaiian populations of these insectivores are invasive and spreading rapidly (Kraus et al., 1999; Woolbright et al., 2006). Coqui 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. coqui* for food (Kraus et al., 1999; Thomas, 2006). Nutrient flow through the native food web may be disrupted, and coqui may serve as a source of food for nonindigenous, invasive predators (Kraus, 1999; Woolbright et al., 2006). Woolbright et al. (2006) found no effective predators of coqui in Hawaii and only recorded a single instance of predation by the rodent, *Rattus rattus*. Anthropocentric concerns include the disruption caused by their loud calls. In Hawaii residents have lost sleep, tourists have lodged complaints with hotels, and residents may have difficulty selling infested property or experience weaker property values (Kraus et al., 1999; Kraus and Campbell, 2002; Thomas, 2006). Woolbright et al. (2006), recorded sound pressure levels of calling male coqui in eastern Hawaii Island (Big Island) up to 73 dB.”

From Choi and Beard (2012):

“Across sites, coquis reduced the total number of leaf-litter invertebrates by 27%, specifically by reducing Acari by 36%. Across sites, coquis increased flying Diptera by 19%. Changes were greater where coqui densities were higher. We suggest that coquis changed leaf-litter communities primarily through direct predation, but that they increased Diptera through the addition of frog carcasses and excrement.”

“Similar to other invasive amphibians, coquis have the potential to induce measurable changes in invertebrate communities at the landscape scale (Catling et al. 1999).”

4 Global Distribution

Figure 1. Known global established locations of *E. coqui* (GBIF 2016). Although CABI (2016) reports introduction of *E. coqui* to the Bahamas, the Dominican Republic, Ecuador, and New Zealand, no further information (including georeferenced occurrences) is available about these locations.

5 Distribution Within the United States

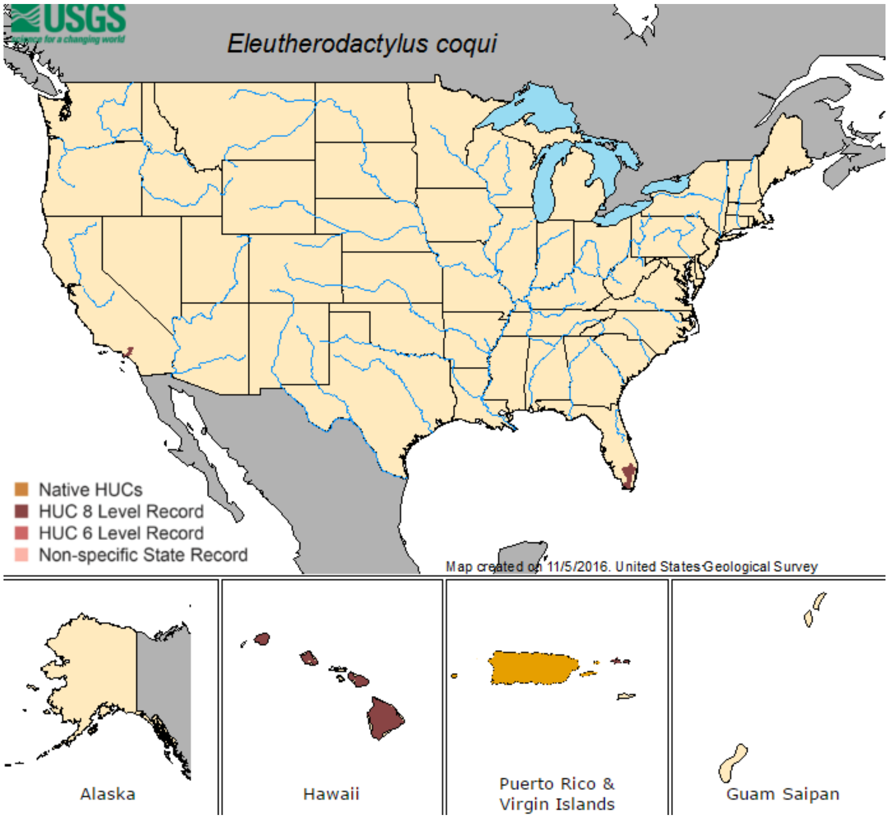

Figure 2. Known established locations of *E. coqui* in the contiguous United States (Somma and Neilson 2016).

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 in the southern half of peninsular Florida. Climate match is medium in northern Florida, along the Gulf Coast, coastal California, and coastal Washington north of Seattle. Climate match is low elsewhere. Climate 6 score indicates that the contiguous U.S. has a medium climate match. The range of scores indicating a medium climate match is greater than 0.005 and less than 0.103; Climate 6 score of *E. coqui* is 0.014.

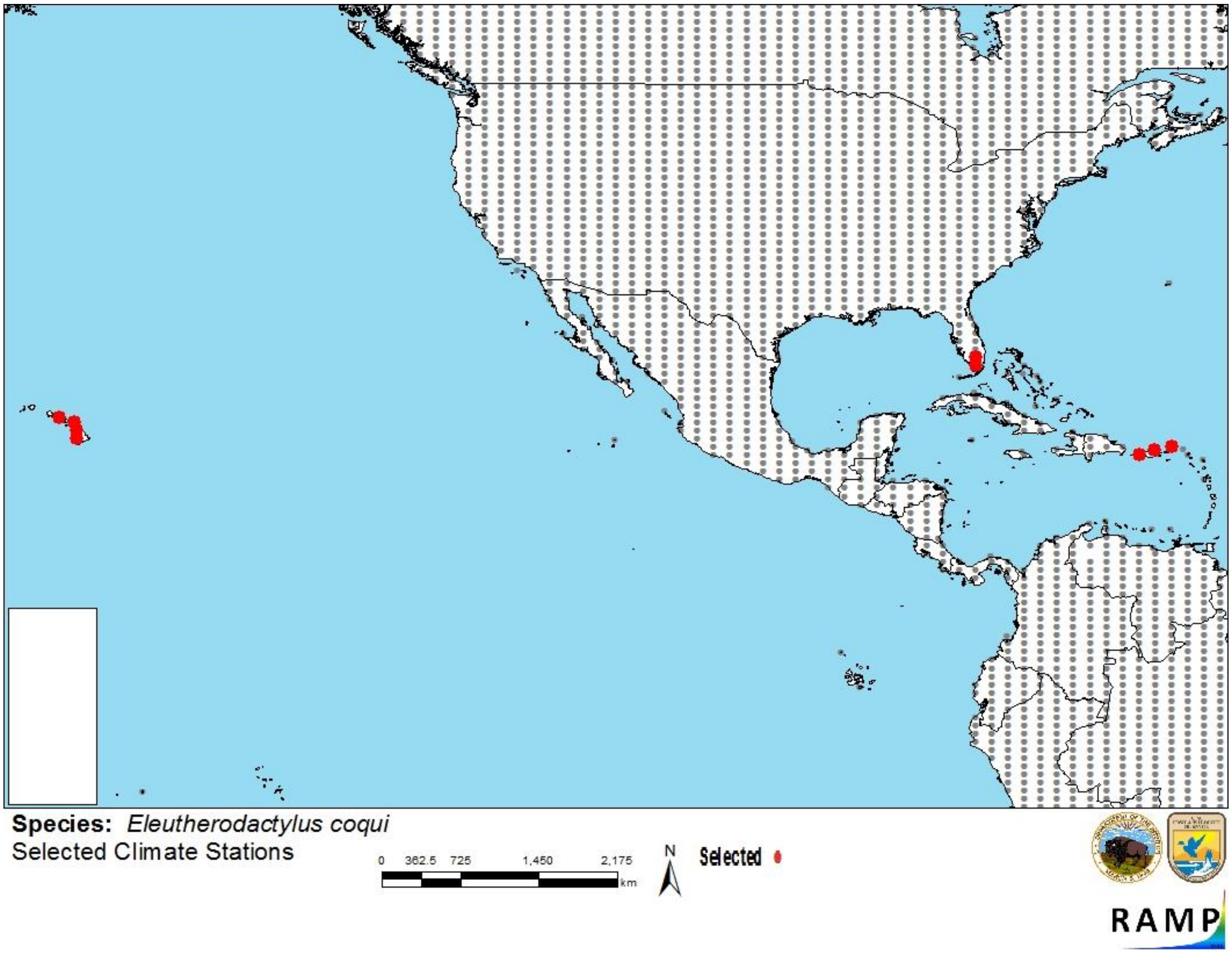

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *E. coqui* climate matching. Source locations from GBIF (2016).

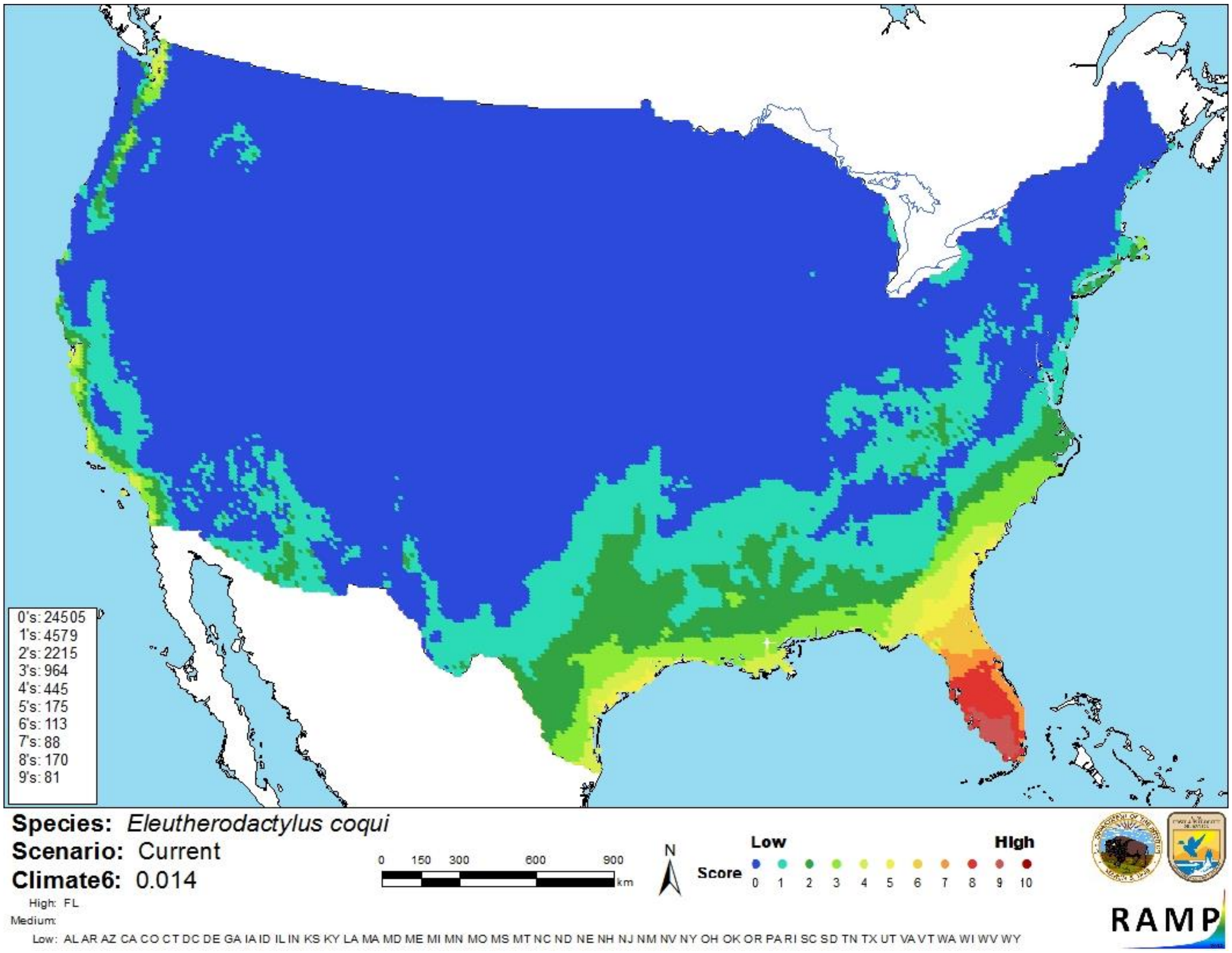

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *E. coqui* in the contiguous United States based on source locations reported by GBIF (2016). 0=Lowest match, 10=Highest match.

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

There is abundant information on the ecology of *E. coqui* and the impacts it has had on native species and humans in Hawaii. Information on its distribution outside of the United States (including territories) is difficult to locate. Nevertheless, certainty of this assessment is high because further distributional information would not decrease the climate match.

8 Risk Assessment

Summary of Risk to the Contiguous United States

E. coqui, a frog native to Puerto Rico, has successfully established populations in the Hawaiian Islands, Florida, and Puerto Rico's neighboring islands in the Caribbean. The frogs have been accidentally shipped in horticultural and landscaping imports. Impacts on native fauna and flora are significant, as this species alters leaf-litter and aerial invertebrate communities and reduces herbivory, potentially altering patterns of nutrient cycling. Economic impacts of this species in Hawaii include loss of property value and tourism due to the frog's loud calls, and reduced profits for plant nurseries with products that could be contaminated with *E. coqui* adults or eggs. Climate match for the contiguous U.S. is medium, with highest match in southern Florida. Overall risk assessment of *E. coqui* is high.

Assessment Elements

- **History of Invasiveness: High**
- **Climate Match: Medium**
- **Certainty of Assessment: High**
- **Overall Risk Assessment Category: High**

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