Coquí Llanero (*Eleutherodactyus juanariveroi*)
5-Year Status Review: Summary and Evaluation

Photo by: C. Pacheco, USFWS

U.S. Fish and Wildlife Service
Southeast Region
Caribbean Ecological Services Field Office
Boquerón, Puerto Rico

5-YEAR REVIEW
Coquí llanero (*Eleutherodactyus juanariveroi*)

I. GENERAL INFORMATION

A. Methodology used to complete the review

The U.S. Fish and Wildlife Service (Service) accomplished this review using information obtained from the final rule listing this species as endangered under the Endangered Species Act (ESA) (77 FR 60778), the species draft recovery plan (USFWS 2018), literature review, and information obtained from experts on this species. The Service's lead recovery biologist for this species prepared this review. On March 12, 2018, the Service published a notice in the *Federal Register* (83 FR 10737) announcing the 5-year review of the coquí llanero. The notice requested new information concerning the biology and status of this species. We opened a 60-day public comment period with this notice but no comments or information were received. We also sought peer review from four individuals familiar with this species and its habitat (see Appendix A). Comments were incorporated into this final document as appropriate.

B. Reviewers

Lead Region: Kelly Bibb, Southeast Region (404) 679-7132.

Lead Field Office: Jan P. Zegarra, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico, (787) 851-7297, extension 220.

C. Background

1. **Federal Register Notice citation announcing initiation of these reviews:** 83 FR 10737; March 12, 2018

2. **Species Status:** Stable. On October 4, 2012, coquí llanero, a small endemic Puerto Rican frog, was listed as endangered throughout its range, and critical habitat was designated (77 FR 60778). Only one population is known to occur within an area of approximately 615 ac (249 ha) which is part of a freshwater herbaceous wetland in the municipality of Toa Baja in northern Puerto Rico. The only available estimated mean annual population density for the coquí llanero (473.3 ± 186.8 individuals per ha or 192 per ac) is from 2005-2006 (Ríos-López *et al*. 2014). Although long-term population trends are lacking, the species expert has continued to visit the site, and the population and its habitat have persisted since the species was first collected in 2005, and persisted through the recent Hurricanes Irma and María in September 2017. Furthermore, there are no indications that the coquí llanero population is declining or that it has reduced its distribution within the wetland.

3. **Recovery Achieved:** 1 (0-25% of species recovery objectives achieved).

4. **Listing History:**
   Original Listing
   FR notice: 77 FR 60778
   Date listed: October 4, 2012
   Entity listed: Species
   Classification: Endangered

5. **Associated Rulemakings:** None.

6. **Review History:**
   Each year, the Service reviews and updates listed species information for inclusion in the required Recovery Report to Congress. Through 2013, we did a recovery data call that included status recommendations such as "Stable" for this frog. We continue to show that species status recommendation as part of our 5-year reviews. The most recent evaluation for this species was completed in 2018.

   This document represents our first 5-year review for this relatively recent listed frog. As part of the process of completing our draft recovery plan in 2018, we created a species' biological report for the coquí llanero. We used this report as a reference point document for this 5-year review. We do not have a final approved recovery plan for this species yet, but in some parts of this document, we will present what we envision will be the direction of our recovery efforts to come.

7. **Species' Recovery Priority Number at the start of review (48 FR 43098):** The coquí llanero is assigned a recovery priority number of 5c, which indicates the species faces a high degree of threat and a low recovery potential with conflict. Recovery potential is considered low for the coquí llanero because of its highly specialized biological requirements and the management challenges of the habitat currently occupied by the species.

8. **Recovery Plan:**
   Name of plan: Draft Recovery Plan for the coquí llanero (*Eleutherodactylus juanariveroi*)
   Date issued: July 9, 2018

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

1. **Is the species under review listed as a DPS?** No

2. **Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy?** No

Recovery Criteria

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** No. We are in the process of completing our final recovery plan for the coquí llanero.

   As we work to finalize this recovery plan, we have had some initial critical progress towards recovering this animal. For example, the former Mayor of Toa Baja signed Municipal Ordinance Number 31 (Series 2006-2007) on September 13, 2006, to prohibit harm or destruction of the habitat of the coquí llanero within the only site known where it occurs in the Municipality of Toa Baja. In addition, the Navy set aside land of the former U.S. Naval Security Group Activity Sabana Seca (USNSGASS), which they designated as essential habitat for the conservation of the coquí llanero. They included a quitclaim deed advising the potential buyers about the presence of threatened and endangered species in the area as well as other essential natural resources (e.g., wetland).

B. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features, or demographic trends:

Ríos-López *et al*. (2014) suggest that the species' population dynamics are regulated by the availability of suitable *Sagittaria lancifolia* (bulltongue arrowhead) for breeding, seasonality in rainfall, and egg morphology adaptations that lead to high hatching success without parental care.

From July 2005 to July 2006, Ríos-López *et al*. (2014) conducted population surveys that resulted in the only available estimated mean annual population density for the coquí llanero (473.3 ± 186.8 individuals per ha or 192 per ac). Although there is no information on long-term population trends, density usually decreases during months with lower temperature and less rainfall (i.e., January to April) and increases during months with higher temperatures and greater rainfall (i.e., May to December; Ríos-López *et al*. 2014). This is the general patter of population fluctuations for other Puerto Rican *Eleutherodactylus* frogs (Joglar 1998).

Although no updated quantitative estimates or surveys have been completed, the species seems stable. The species' expert has continued to visit the critical habitat area, and there are no indications the coquí llanero has reduced its distribution within the wetland (N. Ríos, UPR Humacao, pers. comm. 2019). In addition, there is a permanent audio recording station within the wetland, which has continually recorded the species activity according to its natural fluctuations. The coquí llanero was even recorded calling before and

right after Hurricane María (Sept. 2017) (M. Aide, ARBIMON, pers. comm. 2018), suggesting a high species and habitat resiliency to such events.

b. Genetics, genetic variation, or trends in genetic variation:

No information is available on genetics, genetic variation or trends in genetic variation for the species.

c. Taxonomic classification or changes in nomenclature:

The coquí llanero was described as a new species of the genus *Eleutherodactylus* in 2007 (Ríos-López and Thomas 2007). It was named *Eleutherodactylus juanariveroi* honoring Dr. Juan A. Rivero, a distinguished Puerto Rican herpetologist. Researchers Neftalí Ríos-López and Richard Thomas first collected the coquí llanero in 2005 from a freshwater herbaceous wetland within the former USNSGASS property and the Caribbean Primate Research Center (CPRC) property, both properties in the municipality of Toa Baja in northern Puerto Rico.

d. Species' spatial distribution, trends in spatial distribution, or historic range (e.g. corrections to the historical range, change in distribution of the species within its historic range, etc.):

The coquí llanero is only found within a palustrine herbaceous wetland at Sabana Seca Ward, Toa Baja (Figure 1). The coquí llanero has the most reduced geographic distribution among all *Eleutherodactylus* in Puerto Rico (Ríos-López and Thomas 2007). When the species was first discovered and described, it was estimated that the species occurred on approximately 445 acres (ac) (180 hectares [ha]) (Ríos-López and Thomas 2007). Joglar (2007) conducted additional surveys and estimated that the distribution of the species occupied approximately 504.5 ac (204 ha) in that same area. The Service designated about 615 ac (249 ha) as critical habitat for this species (Figure 1).

There have been efforts to locate the coquí llanero in other wetlands outside the Sabana Seca area, but no other populations have been found. The historical range of the species is unknown, however land-use history for Puerto Rico suggests past habitat modifications may have reduced the species range to the present remnant population (Ríos-López and Thomas 2007). The wetland occupied by the species is surrounded by development (i.e., housing, roads, landfill), thus the possibility that the coquí llanero expands its range is expected to be very low, mainly because of the low dispersal capabilities typical of small frogs, and the lack of suitable habitat in the adjacent wetland areas.

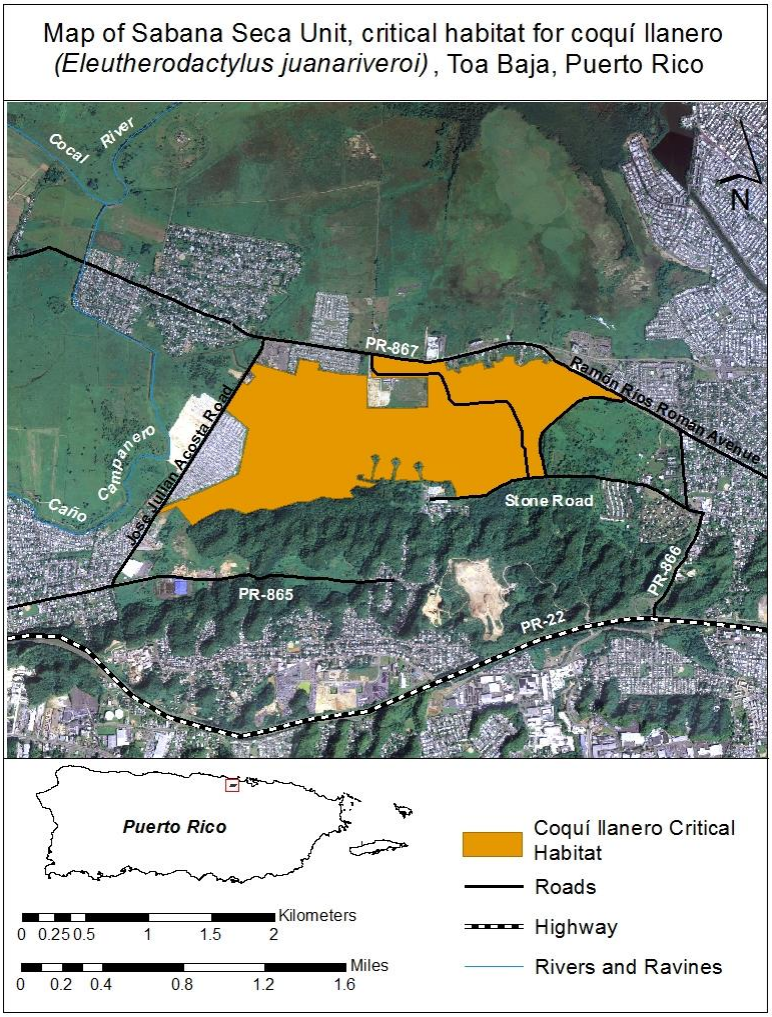

Figure 1. Map of Sabana Seca Unit, critical habitat for the coquí llanero (77 FR 60802).

e. Habitat:

The wetland where the coquí llanero occurs is classified as a Palustrine Emergent seasonally flooded and persistent wetland (National Wetland Inventory 2018). According to Ríos-López *et al*. (2014), this wetland is seasonally flooded between May and January, and reaches the lowest water depth from late February to early April, coinciding with the lowest population density of the coquí llanero. Ríos-López *et al*. (2014) also reported an average water depth of 1ft (0.28 ± 0.22 m) within their study plots. The soils of this wetland consist of swamp and marsh organic deposits from Pleistocene or recent origin or both (Ríos-López and Thomas 2007). The species' habitat "could represent a relic palustrine herbaceaous wetland now rare in Puerto Rico." (Ríos-López and Thomas 2007).

This wetland is within the subtropical moist forest life zone (Ewel and Whitmore 1973). Ríos-López *et al*. (2014) recorded temperature, relative humidity, and precipitation during their research. The average annual ambient temperatures was 77°F (25°C) and the warmest months were between May and November (i.e., period of coquí llanero highest population density); relative humidity varied little, reaching 100% during the night and 60% during daylight; annual average rainfall was 67 inches (1700 mm), with most of the rain occurring from May to November.

The microhabitat conditions provided within the wetland may be essential for the conservation of coqui llanero (Ríos-López *et al*. 2014). For example, researchers found more individuals of the coquí llanero perching and calling on ferns, while only using leaf axils of *S. lancifolia* for laying its eggs and as a retreat. The *S. lancifolia* plant may be considered a limiting resource, as it only occupies 7.4% of the vegetation cover in the wetland (Ríos-López *et al*. 2014). Moreover, differences in egg clutch deposition site further suggest the importance of *S. lancifolia* as a retreat and breeding site (Ríos-López *et al*. 2014).

We identified the primary constituent elements of the critical habitat for the coquí llanero (77 FR 60778):

- Palustrine herbaceous wetland: Palustrine emergent persistent wetlands that are seasonally to permanently flooded. Ocean-derived salts need to be less than 0.5 parts per thousand (ppt).
- Vegetation and vegetation composition of the palustrine herbaceous wetland: Emergent vegetation characterized by erect, rooted herbaceous hydrophytes usually dominated by perennial plants like ferns, *S. lancifolia*, flatsedges, spike rushes, vines, and grasses. At least 25% of the plant composition should be ferns and *S. lancifolia* must be present.
- Hydrology: A hydrologic flow regime (i.e., the pathways of precipitation, surface runoff, groundwater, tides, drainage channels and flooding of rivers) that maintains the palustrine herbaceous wetland.

The hydrology of the wetland is influenced by precipitation, karst topography, river floodplains, and stormwater drainage patterns (GLME 2007). In general, the topography of the landscape in Sabana Seca has an east to west inclination, which causes the surface and ground water from the limestone hills to the south of Road PR 867 and adjacent areas to discharge into the critical habitat wetland. The natural flow of water then heads towards the north and northwest connecting to Caño Campanero, and with waters from the Cocal River, then draining into the Atlantic Ocean (PRDNER 2007). Given that wetlands are dynamic habitats formed and maintained by water quantity, channel slope, and sediment input to the system through periodic flooding (Mitsch and Gosselink 2007), an increase in

land use intensity may be expected to significantly affect water quality and flooding hydroperiod in the coquí llanero's habitat (GLME 2007).

The wetland area is part of a more extensive swamp system in the municipality of Toa Baja (i.e., San Pedro swamp). The Puerto Rico Department of Natural and Environmental Resources (PRDNER) recognizes the San Pedro swamp as an important wildlife area principally due to its unique characteristics and because of the presence of rare and endangered species in this wetland (PRDNER 2005). The palustrine herbaceous wetland where the coquí llanero currently exists consists of Federal lands previously managed by the USNSGASS and areas owned by the Commonwealth of Puerto Rico (i.e., University of Puerto Rico and Puerto Rico Land Authority).

2. Five Factor Analysis

(a) Present or threatened destruction, modification, or curtailment of its habitat or range;

The final listing rule for the coquí llanero (77 FR 60778) discussed the following habitat threats: urban development; operation and possible expansion of a go-kart and motorbike racetrack in the coquí llanero wetland habitat; contamination from the Toa Baja Municipal Landfill (TBML); habitat degradation for flood control projects; and competition of invasive wetland plant species with native plants.

Some of those threats have lowered in intensity but have not been eliminated. For example, the threat from urban development and expansion of the racetrack within the wetland should be eliminated because the former Mayor of Toa Baja signed Municipal Ordinance Number 31 (Series 2006-2007) on September 13, 2006, to prohibit harm or destruction of the habitat of the coquí llanero. In addition, the federally owned area contained within the critical habitat has been designated for conservation (D. James, NAVFAC Atlantic, pers. comm. 2014).

However, land outside of the existing known coquí llanero habitat may still be developed further encroaching upon the limited species habitat. For example, according to timeline images using Google Earth imagery, the owners of the houses bordering the critical habitat have been expanding their backyards towards the wetland, possibly filling coquí llanero habitat. Other habitat modifications that could affect this wetland is the potential repaving of Redman Road and clearing of the vegetation bordering the road. This road was constructed before the species' discovery, and filled part of the wetland where the coquí llanero occurs. Thus, any future maintenance or expansion of this road would need to follow conservation measures to avoid and minimize potential detrimental effects to the coquí llanero and its habitat. In addition, maintenance clearing of the vegetation that borders Redman Road

should be monitored to avoid significant impacts (see further discussion below under Factor E).

Regarding the operation of the TBML, the final listing rule for the coquí llanero (77 FR 60778) indicates that leachates reaching the wetland could change the quality of the water, the soils and the plant composition of the wetland. However, there is no additional information available regarding these potential effects and how they could be influencing the status of the species. The Service will continue to evaluate all potential effects from the TBML, including landfill closure measures that may affect the suitability of the habitat by altering the hydrology of the wetland, and by contaminating the wetland with more of the landfill runoff. This landfill is located inland on top of a limestone hill, at 0.5 mi (0.8 km) south of the known habitat for coquí llanero. To date we have not seen nor received a closure plan for this landfill, even though the EPA ordered one in 2012 (EPA 2012).

According to the information available, one of the TBML disposal areas was ordered to stop receiving waste by September 30, 2014. However, the TBML has a Puerto Rico Environmental Quality Board (EQB) permit up to June 28, 2021 (Title V Operating Permit PFE-TV-4953-70-0903-1526). Despite the EPA closure order, the TBML continues to be operational even after Hurricane María in September 2017, when it was receiving solid wastes and debris as a result of the this hurricane (https://bit.ly/2JbXdCN).

The Service does not have any updated information since the original listing regarding the potential effects (i.e., drying of the wetland and accelerate colonization of invasive plants) from channel-clearing activities for flood control along the main drainage channel within the wetland where the species occurs. We do not have any current specific information on the total area being cleared, how often these activities are occurring, how they are potentially affecting the overall quality of the habitat, or the status of the coquí llanero population. Since this species is considered a wetland specialist, any activity that influences the hydrology of the wetland, could affect the persistence of the species and the vegetation it depends on for reproduction and survival.

Also, we do not have updated information regarding the potential detrimental effects (i.e., habitat modification) from invasive wetland plant species. For example, the southern cattail (*Typha domingensis*) continues to occur within the coquí llanero wetland, but there is no current information on its area of cover, if it has invaded new areas within the wetland, or if this species is displacing *S. lancifolia* and ferns that the coquí llanero depends on for reproduction and other activities.

Based on the above information, habitat curtailment or modification continues to be a threat to the coquí llanero.

(b) Overutilization for commercial, recreational, scientific or educational purposes:

At the time of listing (2012, 77 FR 60778), there was no information indicating that the coquí llanero was being overutilized. Currently, only a few permitted researchers are conducting studies on the species and/or its habitat. Although collection could be a significant threat to the coquí llanero due to its rarity, any collection of this species will require a permit from the PRDNER and the Service. We do not have information indicating that the coquí llanero is being illegally collected. Therefore, we continue to conclude that overutilization for commercial, recreational, scientific, or educational purposes is not a threat to the coquí llanero.

(c) Disease or predation:

At the time of listing (2012, 77 FR 60778), the Service determined that predation was a threat to the coquí llanero, but not disease. There is no new information regarding disease about it being a threat to the species. On the contrary, the most recent information suggest the secretions from glands in the skin on the coqui llanero and the thick jelly-mass that wraps the eggs, protects adults and egg clutches from diseases, dehydration and microbial/fungi overgrow (Ríos-López *et al*. 2014). It is believed that microbiota in the wetland water may protect the coqui llanero from the pathogenic chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*) (N. Ríos, UPR-Humacao, pers. comm., 2019). Nevertheless, we should continue monitoring for *Bd* in case other unknown threats may lower the species immune response to *Bd* or other diseases.

Information gathered for the final listing rule (77 FR 60778) suggested that natural predation pressure may be intense and that interspecific competition for breeding sites may be significant. Egg predation by native and exotic invertebrates was observed, with some predators (e.g., ants and terrestrial invertebrates) consuming entire egg masses in 3 days (Ríos-López 2009, Ríos-López *et al*. 2014). Additional information found that embryos from examined egg clutches either all hatched or all died, presumably because of predation, referred to as common, and dehydration, referred to as rare (Ríos-López *et al*. 2014). The researchers also recorded natural egg clutch predation or destruction from another coquí species (*E. cochranae*), crickets, ants and possibly mollusks.

Ríos-López *et al*. (2014) also found that predation increased during the dry season (i.e., January to April), when the reproductive activity of the coquí llanero decreases naturally. The researchers suggest that future studies should examine the influence of seasonality on prey and predator abundance to determine the relative contribution of each factor (prey availability and

predation pressure) to the species' seasonality in egg production, and thus, population fluctuations.

A new predation threat has emerged from the introduced Striped keelback snake (*Xenochrophis vittatus*). Native to Indonesia, this snake has been observed in Puerto Rico since 2011, but there are anecdotal reports of similar looking snakes since 1994 (Herrera-Montes 2015a). By February 2017, and other more recent observations (March & October 2018), the species was detected within the coquí llanero habitat (N. Ríos, UPR-Humacao, pers. comm. 2018). The main concern with the Striped keelback snake is that besides fish, it feeds primarily on frogs, and it is considered to have a well-established population in Puerto Rico (Herrera-Montes 2015a, 2015b). Santiago-Suliveras *et al.* (in press) examined the content of stomach and intestines of four adult specimens of this snake – collected in the wetland of the coquí llanero – and found among them the remains of the white-lipped frog (*Leptodactylus albilabris*) and an unidentified *Eleutherodactylus* frog (presumably not the coquí llanero, N. Ríos, UPR-Humacao, pers. comm. 2019).

The Service needs to further evaluate these predation threats in order to determine its influence on the status of the coqui llanero (refer to section IV). Furthermore, habitat modifications (natural or human related) and/or environmental changes (e.g., drier wetland conditions) that favor coquí llanero's predators may exacerbate this threat.

Therefore, based on the above, predation continues to be a threat to the coquí llanero.

(d) Inadequacy of existing regulatory mechanisms:

At the time of listing (2012, 77 FR 60778), the Service determined that inadequacy of existing regulatory mechanisms is not a threat to the coquí llanero. In addition to the ESA protections, other Federal laws and regulations provide measures to protect the coquí llanero and its habitat, for example the Clean Water Act that provides adequate protection to the wetland occupied by the species. In addition, through a Section 6 agreement between the Service and the PRDNER, when a species is listed under the Endangered Species Act (ESA), the Commonwealth upholds the protections for that species and includes it in their list of threatened and endangered species. The Commonwealth Law No. 241-1999, "Nueva Ley de Vida Silvestre de Puerto Rico" (New Wildlife Law of Puerto Rico) and Regulation 6766 afford protection to the species by prohibiting hunting, capturing or causing damage to any wildlife species, or modifying its natural habitat without authorization of the Secretary of the PRDNER.

Section 7 of the ESA requires Federal agencies to carry out programs for the conservation of threatened and endangered species. Consultation is required in cases where a Federal action, such as Federal funding or permit, is associated with the potential project that may affect the coquí llanero or its critical habitat. For example, the Service has been informally consulting with the University of Puerto Rico Primate Research Center, the USNSGASS, and the TBML for actions related to potential effects on the coquí llanero or its habitat as a result of the actions carried out by these entities. None of these informal consultations have resulted in a may affect determination for the coquí or in adverse modification for its critical habitat.

The former Mayor of Toa Baja signed Municipal Ordinance Number 31 (Series 2006-2007) on September 13, 2006, to prohibit harm or destruction of the habitat of the coquí llanero in the Municipality of Toa Baja. Also, the Navy set aside land of the former U.S. Naval Security Group Activity Sabana Seca (USNSGASS) which was designated as essential habitat for conservation. They included a quitclaim deed advising the potential buyers about the presence of threatened and endangered species in the area as well as other unique natural resources (e.g., wetland).

In addition, the limestone hills just south of the designated critical habitat were included within the Restricted Special Planning Area of the Karst under Regulation No. 8486 (*Plan y Reglamento del área de Planificación Especial del Carso*) of the Puerto Rico Planning Board and the PRDNER (PRPB and PRDNER 2014). This delimitation requires taking appropriate conservation measures to prevent any project from generating changes in the composition, coverage and structure of ecosystems within the Restricted Karst Area.

Based on the presence of Federal and Commonwealth laws and regulations protecting the coquí llanero, and the absence of evidence supporting lack of enforcement of regulations to protect this species, Factor D is not considered a threat to the species at this time.

(e) Other natural or manmade factors affecting its continued existence:

At the time of listing (2012, 77 FR 60778), the Service identified the following threats under this factor: highly specialized ecological requirements, potential water and soil pollution, potential effects from herbicides, potential effects from brush fires, competition from the whistling coquí (*Eleutherodactylus cochranae*), climate change, and human access or use of the wetland area.

Climate Change:
The Service considers climate change, coupled with the species highly specialized ecological requirements, as the threat of most concern under this factor, which can have a variety of direct and indirect impacts on the coquí

llanero and can exacerbate the effects of other threats, especially those related to habitat (Factor A). It is one of the most challenging threats to address since climate change scenarios for Puerto Rico predict a gradual trend towards a dryer and hotter climate (Henareh *et al*. 2016, Bhardwaj *et al*. 2018). To a certain extent, evaluating the vulnerability of the coquí llanero to climate change would require linking the magnitude of changes (i.e. temperatures and humidity) with the physiological response of the species to those changes (Glick *et al*. 2011, Pacifici *et al*. 2015). This level of detailed information is not available for the coquí llanero.

Previous analysis of weather data from 1970 to 2000 by Burrowes *et al*. (2004) revealed a significant warming trend for Puerto Rico and an association between years with extended periods of droughts and the decline of some *Eleutherodactylus* frogs. Although the coquí llanero is considered a wetland specialist, juvenile *Eleutherodactylus* frogs within tropical forests in Puerto Rico are likely unable to survive extensive droughts and the potential risk of desiccation may affect adult foraging during extended dry periods (Stewart 1995). Additional information by Walls *et al*. (2013) specifies that variations in seasonal rainfall affect wetland hydrology and the timing of amphibian reproduction, which may modify the composition of communities and change the dynamics of competitive predatory interactions.

The effects of climate change on amphibians are likely complex, and may affect survival, growth, reproduction, and alter habitats including vegetation and hydrology (Blaustein *et al*. 2010). According to Walls *et al*. (2013) and citations within, insufficient rainfall, extreme drought and/or shortened hydroperiods have been linked with declines in anuran calling activity and local extinctions, among others. Ríos-López *et al*. (2014) found the coquí llanero's phenology was explained by rainfall only, a somewhat unexpected result because water variables are unlimited resources in the species' wetland habitat and because the species' reproductive mode (direct development of terrestrial eggs) are expected to be less dependent on rainfall for hatching success, when compared to temperature related variables.

Although Burrowes *et al*. (2004) research was conducted before the discovery of the coquí llanero, the species seems to have persisted such climatic changes (significantly drier than average) and population fluctuations (potential declines) during the 1970s and 1990s, which represent periods of amphibian extirpations and declines. Of course, assuming that during that period, the coquí llanero existed in the only known locality. However, Burrowes *et al*. (2004) suggested amphibians were being affected by a possible synergistic interaction between drought and the chytrid fungus, the fungus which does not seem to affect the coquí llanero (see Factor C).

Information presented by Ospina *et al*. (2013) specify that sites like the coquí llanero wetland habitat will probably become dryer during the dry season and

wetter in the rainy season (Ramírez-Beltrán *et al*. 2007; and Harmsen *et al*. 2009, as cited in Ospina *et al*. 2013). Ospina *et al*. (2013) found that the coquí llanero calling activity (from automatic recorders) responded negatively to temperature and precipitation, possibly related to its small body size and the exposed location of calling sites (i.e., ferns), thus increasing the individuals water loss and decreasing calling and reproductive activity.

This calling response somewhat contradicts results from Ríos-López *et al*. (2014), in which density increased (from visual and auditory detections) during warmer and rainy months. Methods used between the researchers were different and may help explain some of the differences. Still, research by Ospina *et al*. (2013) explains the logic that the smaller coquí llanero would be more prone to dehydration during hot days, than larger species such as the common coquí (*E. coqui*) or the whistling coquí (*E. cochranae*), and thus, needing to reduce its calling reproductive activity.

Ospina *et al*. (2013) further suggest that if climate predictions for Puerto Rico are correct, then one can expect populations of the smaller sized frogs to decline, such as the coquí llanero and the grass coquí (*E. brittoni*), and making them more vulnerable to climate change. The calling frequency decline of the coquí llanero detected by Ospina *et al*. (2013) does not necessarily reflect a decline in the population and the authors suggest further studies should try to determine if the calling rate from automatic recorders is correlated with the density of calling males. The Service needs to assess how resilient the coquí llanero would be to some of the predicted changes in climate.

Ríos-López *et al*. (2014) explain that developing conservation measures under scenarios of projected climate change is challenging, particularly because 1) predictions of population trends rely on a better understanding of the ecological mechanisms of interest, and 2) the type of climate data being collected may result in different interpretations. Ultimately, climate patterns and events that promote droughts and less rain would drive populations of all coquí species in Puerto Rico towards a declining trend by directly affecting the reproductive output of the population.

Moreover, it is expected that climate change influence the rate of rising sea levels (Blaustein *et al*. 2010). We consider sea level rise a likely threat based on results from a Sea Level Affecting Marshes Model prepared by Davila (2013). The model suggested the gradual but inevitable demise by 2100 of the only known occupied habitat for the coquí llanero. Since there is limited suitable habitat within the Commonwealth (seven potential sites in all Puerto Rico), this threat would risk the entire species existence. Sea level rise would impart more pressure towards the species and in its habitat since the possible sea (salt) water intrusion would consequently change the physical and ecological characteristics of the freshwater wetland, changing the vegetation

and affecting the reproduction since this species is dependent on a specific freshwater plant. Thus, the projected sea level rise and accompanied salt-water intrusion into the wetland, may have detrimental effects to the survival of the coquí llanero because the known area occupied by this species lies between 1 and 6 m above sea level (Ríos-López *et al.* 2014), while most of the wetland lies at 0 m asl (Google Earth Pro ©, version 7.1.7.2606). Moreover, the majority of the potential sites identified by D. Davila are near coastal areas that may suffer from the same detrimental effects. Based on this prediction, it is recommended to safeguard the genetic material of this species by establishing *ex-situ* populations in suitable areas away from the coast (refer to section IV).

Herbicides, brush fires, competition, and soil pollution:
Other potential threats such as herbicides, brush fires and competition will always be present to some degree. As specified in the listing rule (77 FR 60778), there is no direct use of herbicides within the species habitat. Although there is probably some herbicides and/or pesticides entering the wetland habitat system from the surrounding communities, or even from spraying for mosquito control, there is no specific indication that these components are negatively impacting the species.

Available information indicates no reported fires have occurred within the species designated critical habitat. Reported illegal fires have mostly occurred on the San Pedro Swamp north section, presumably from land crab hunting activity. The proximity of the critical habitat to this area and other commercial and urban development certainly increase the exposure and susceptibility of fires occurring within the critical habitat. If a brush fire were to occur within the designated critical habitat, it would destroy plants proven essential for the reproduction of the coqui llanero, will facilitate establishment of invasive weeds and cattail, can kill frogs and egg masses, and further encroach the frog's already limited habitat (77 FR 60778).

Competition threats from the whistling coquí (*E. cochranae*) will also be present, especially towards the drier and more disturbed edges of the wetland. As previously discussed, climate change and habitat modification may exacerbate this threat by facilitating the whistling coquí invasion further into the wetland. The whistling coquí rarely invades more permanently flooded areas of the wetland, suggesting a synergism between hydrology alteration and competition that may result in magnified negative biological interactions against the coquí llanero (Ríos-López 2009). The Service and its partners need to further evaluate this competition threat in order to determine its relative contribution to the species status (see section IV).

We also identified other threats such as the potential effects from water and soil pollution from the proximity of the TBML to the species habitat (e.g., landfill leachates entering the wetland). However, there is still no

information indicating any negative responses of the species to potential soil and water pollution from likely contaminant from this facility. The Service will continue to assess and consult on measures being implemented by the TBML to improve leachate management and runoff into the species wetland (see Factor A).

As explained above, specialized ecological requirements, climate change, and fires are still considered threats to the coquí llanero and its habitat. Furthermore, while these threats may act in isolation, it is very likely that two or more of these stressors act simultaneously or in combination, which may magnify the influence of threats to the coquí llanero and its habitat.

3. Synthesis

The coquí llanero is the smallest and only herbaceous wetland specialist within the frog genus *Eleutherodactylus* in Puerto Rico. Probably having a more extensive geographic distribution in the past, it is only known from a single site in the municipality of Toa Baja, Puerto Rico. Only one population is known to occur within an area of approximately 615 ac (249 ha), which is part of a freshwater herbaceous wetland in that municipality in northern Puerto Rico. Thus, the coquí llanero has a low redundancy and representation, making it more difficult for the species to withstand and recover from stochastic or catastrophic events. However, the coquí llanero is considered to have at least a moderate resilience since its population status seems stable despite past and current threats. Factors currently affecting the species and its habitat are: habitat curtailment and degradation (Factor A), predation (Factor C), and climate change, sea level rise, and natural and human induced catastrophic events like fires (Factor E). In addition, the species has highly specialized ecological requirements (Factor E) within its wetland habitat, which increases the species susceptibility to present threats because of its limited area of occurrence and specific breeding requirements (*S. lancifolia*).

III. RESULTS

A. Recommended Classification:

__X__ **No change is needed.**

B. New Recovery Priority Number: No change.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Develop and establish a long-term strategy for systematic surveys to document trends in abundance and population size.

- Continue to ensure the perpetual protection of the Sabana Seca wetland in Toa Baja (Figure 1) and assess the vulnerability of the species and its habitat to future scenarios of climate change and sea-level rise (or others).
- Assess other potentially suitable areas that may harbor the species or would be suitable for potential introductions.
- Assess strategies for the introduction of populations elsewhere, such as translocations and/or establishing an *ex-situ* captive population of the coquí llanero.
- Determine the population's genetic structure to guide strategies for introduction and captive breeding programs.
- Study the species thermal and hydric limitations to evaluate the species resilience to climate change or other factors.
- Study the interactions between native and exotic predators and responses to seasonal changes in the availability of prey.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the Coquí llanero (*Eleutherodactylus juanariveroi*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

_X_ No change is needed

Review Conducted By: Marelisa Rivera and Jan P. Zegarra, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico

FIELD OFFICE APPROVAL:

Edwin E. Muñiz, Lead Field Supervisor, U.S. Fish and Wildlife Service

Approved By: Edwin Muñiz Date 8/2/2019

APPENDIX A: Summary of peer review for the 5-year review of Coqui llanero (*Eleutherodactyus juanariveroi*)

A. Peer Review Method: The draft 5-year review document was sent to 4 independent peer reviewers:

- Neftalí Ríos, species expert and Herpetology professor at University of Puerto Rico (UPR), Humacao Campus
- Fernando Bird-Picó, Herpetology professor at UPR, Mayagüez Campus
- Sondra Vega, Herpetology professor at UPR, Arecibo Campus
- Ramón Rivera, Wildlife biologist for the Puerto Rico Department of Natural and Environmental Resources

B. Peer Review Charge: The following cover letter was sent along with the draft 5-year review (excluding signature page) to the peer reviewers:

Dear colleague,

On March 12, 2018, the U.S. Fish and Wildlife Service published a notice in the Federal Register (83 FR 10737) announcing a five-year review of 8 federally listed species, including the Coqui llanero. The purpose of five-year reviews is to ensure that the classification of species as threatened or endangered is accurate and reflects the best available information.

Following Service current policy and guidelines on the process to conduct independent peer review, we are assisting our Caribbean Ecological Services Field Office to complete peer review of the science in the 5-year review for this frog. You have provided data used to review the status of the Coqui llanero and are knowledgeable about it or amphibians like it. Therefore, in order to ensure that the best available information has been used to conduct this five-year review, we now request your peer review of the attached document. Specifically we ask for comments on:

• Have we assembled the best available scientific and commercial information?
• Is our analysis of this information correct and properly applied?, and
• Can you identify any additional new information on the Coqui llanero that has not been considered in this review?

Please note that we are not seeking your opinion of the legal status of this species, but rather that the best available data and analyses were considered in reassessing its status.

As part of the peer review process, we must evaluate the potential for conflicts of interest with the subject species or the action. We therefore ask that you fill out the attached Conflict of Interest form and return it with any notes, comments, or questions that you are willing to provide as your peer review.

We appreciate your interest in furthering the conservation of rare plants and animals by becoming directly involved in the review process of our Nation's threatened and endangered species. Your review and comments will become a part of the administrative record for this species, and you can be certain that your information, comments, and recommendations will receive serious consideration.

We hope that you view this peer review process as a worthwhile undertaking. We ask that you review the attached draft and submit comments to the Southeast Regional Office, to our Regional Recovery Coordinator, Kelly Bibb. Your comments can be provided to Kelly by email kelly_bibb@fws.gov or by letter (1875 Century Boulevard, 4th Floor, Atlanta, Georgia 30345) and should be received by July 8, 2019, to help us complete the final 5-year review for signature. If you have any questions, please call Kelly Bibb (404) 679-7132, or email her. Thank you in advance for your assistance.

C. **Summary of Peer Review Comments/Report:** Two peer reviewers provided comments.

a. R. Rivera added information about the Puerto Rico Planning Board and Puerto Rico Department of Natural and Enviromental Resources 2014 Regulation No. 8486, that further protects the limestone hills just south of the designated critical habitat. This area was included within the Restricted Special Planning Area of the Karst, and requires taking appropriate conservation measures to prevent any project from generating changes in the composition, coverage and structure of ecosystems within that restricted area.

b. N. Ríos mostly provided grammatical suggestions to the text, but also provided clarification with some of his investigation results and the words being used, and updated research results, for example, on predation by a non-native snake.

D. **Response to Peer Review:** We included R. Rivera's new information under our Factor D discussion (pg. 11) and most of N. Ríos suggestions throughout the entire document.