Guajón

(*Eleutherodactylus cooki*)

Status Review:

Summary and Evaluation

Guajón male guarding clutch of eggs. Photo by JP Zegarra, USFWS.

U.S. Fish and Wildlife Service
South Atlantic-Gulf Region
Caribbean Ecological Services Field Office
Boquerón, Puerto Rico

August 2022

STATUS REVIEW

Guajón **(*Eleutherodactylus cooki*)**

GENERAL INFORMATION

Current Classification: Threatened

Lead Field Office: Caribbean Ecological Services Field Office (CESFO), Boquerón, Puerto Rico, Jan Zegarra (jan_zegarra@fws.gov)

Reviewers:

Lead Regional Office: Carrie Straight, South Atlantic-Gulf & Mississippi Basin Regional Office, (404) 679-7226.

Date of original listing: June 11, 1997 (62 FR 31757)

Critical Habitat designation: October 23, 2007 (72 FR 60068)

Methodology used to complete the review: In accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (Act), the purpose of a status review is to assess each threatened species or endangered species to determine whether its status has changed and if it should be classified differently or removed from the Lists of Threatened and Endangered Wildlife and Plants. The U.S. Fish and Wildlife Service (Service) evaluated the biology, habitat, and threats of the guajón (*Eleutherodactylus cooki*) to inform this status review. In conducting this 5-year status review, we relied on the best available information pertaining to historical and contemporary distributions, life histories, genetics, habitats, and threats of this species. We announced initiation of this review and requested information in a published Federal Register notice with a 60-day comment period on July 14, 2021 (86 FR 37178). We received no public comments during the open comment period. We used a variety of information resources, including monitoring reports, surveys, and other scientific and management information. Specific sources included the final rule listing this species under the Act, peer reviewed scientific publications, unpublished field observations by Federal, State, and other experienced biologists, unpublished studies and survey reports, and notes and communications from other qualified individuals.

FR Notice citation announcing the species is under active review:
July 14, 2021 (86 FR 37178)

Species' Recovery Priority Number at start of 5-year review (48 FR 43098): 11. At the time of listing, the guajón was recognized as a species with a moderate degree of threat and a low recovery potential.

Review History: Two previous 5-year status reviews were published on April 20, 2011 and August 1, 2017 (Service 2011, 2017). Both reviews recommended the status of the species remain listed as Threatened.

REVIEW ANALYSIS

Listed Entity

Taxonomy and nomenclature:
We are not aware of any changes to the taxonomy of this entity; thus, this species is still considered valid by the Service.

Distinct Population Segment (DPS):
The Act defines species as including any subspecies of fish or wildlife or plants and any distinct population segment of any vertebrate wildlife species. The guajón was not listed as a DPS, and we have no new information that would indicate the species should be listed as a DPS under the Service's 1996 DPS Policy (61 FR 4722).

Recovery Criteria

Recovery Plan
Recovery Plan for the Guajón or Puerto Rican Demon (*Eleutherodactylus cooki*), September 24, 2004 (Service 2004).

Guajón or Puerto Rican Demon Recovery Plan Amendment, September 27, 2019 (Service 2019).

The Amended Recovery Plan establishes delisting (recovery) criteria that states the guajón could be considered for delisting when the following two criteria are met:

1. Within the five (5) known coqui guajón genetic clusters, populations are geographically distributed and connected in a manner that allows for the continued existence of populations that exhibit a stable or increasing trends, natural recruitment, and multiple age classes (addresses Factors A, C and E).

2. Suitable habitat of the five (5) known coqui guajón genetic clusters are protected and managed by a conservation mechanism to ensure the ecological integrity of those areas is not affected by adverse anthropogenic habitat modification, including indirect effects of upstream/downstream land uses (addresses Factors A, C and E).

None of the above delisting criteria have been met. The Service continues to promote research and gather the necessary information towards meeting the delisting criteria. The most recent conservation actions regarding this species have been implemented as part of cooperative agreement with a partner and particularly through Section 7 consultations (refer to new information in this review).

Biology and Habitat Summary
A detailed review of the species' biology and habitat information can be found in the previous guajón 5-year status reviews (Service 2011, 2017) and in the 2004 Recovery Plan (Service 2004). The guajón is a frog species with a limited geographic distribution and specific habitat requirements. The guajón is known to occur at elevations of 83 ft (26 m) up to 1,381 ft (421 m)

above sea level in southeastern Puerto Rico in the municipalities of Yabucoa, San Lorenzo, Patillas, Humacao, Las Piedras, Juncos, and Maunabo (Figure 1).

The guajón utilizes large to small caves and crevices formed by different sized granite boulders within rocky streams. This type of habitat is commonly known as *guajonal*. The species is limited to forested areas that contain rock formations and patches of rocks near streams and drainages (Vega-Castillo 2000, Service 2004). The streams can be perennial (a stream with a continuous surface flow) or ephemeral (a stream that forms after heavy rain events) and are usually surrounded by secondary forest vegetation. The species also has been detected using road culverts and adjacent to Puerto Rico's sewer and aqueduct water facilities.

From November 2012 to March 2014, rapid assessment population surveys were conducted within 16 critical habitat (CH) units and another 4 non-CH sites (20 total). Results categorized 13 out of 20 (65%) populations with a high relative abundance (100+ frogs), 5 out of 20 (25%) as medium (50-99 frogs), and 2 out of 20 (10%) as low (López-Torres and Longo 2015). One of these last two sites was within the Jacaboa critical habitat Unit 05 and no frogs were heard nor found, suggesting an extirpated population. Although we are unable to determine population trends from this data, the information at least suggested there are populations that seem stable and a few that may be declining and one extirpated (Service 2017). Genetic samples were also collected from the 19 extant populations and a connectivity assessment revealed that these 19 populations are divided into five genetic clusters (Figure 1) (López-Torres and Longo 2015). Additional genetics results were summarized in the previous review (Service 2017).

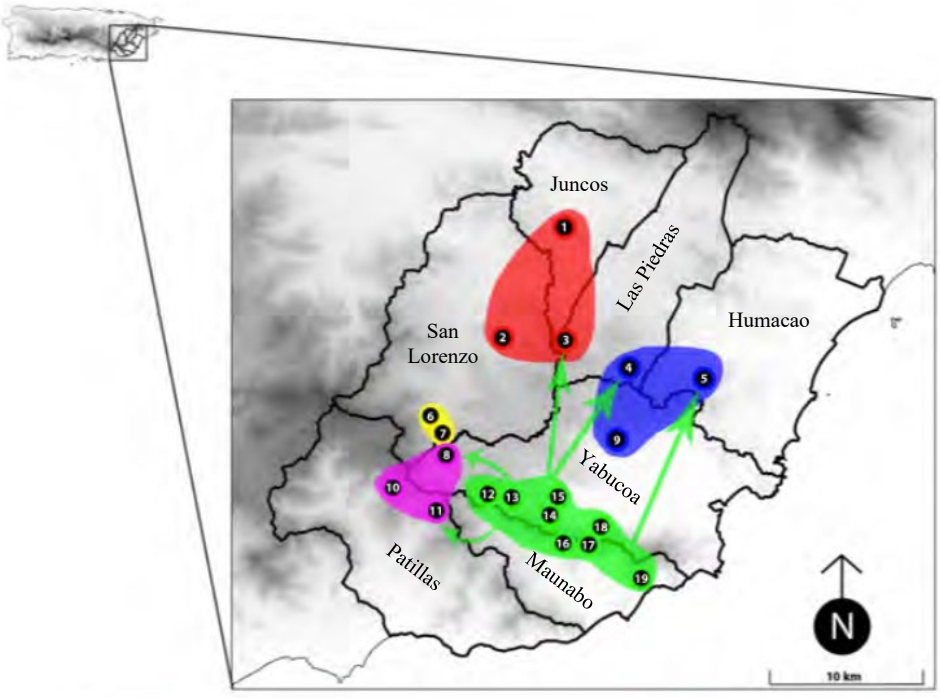

Figure 1. The five genetic clusters of the 19 sampled *E. cooki* populations within the seven municipalities range (Figure from López-Torres and Longo 2015).

On September 2017, the category 4 Hurricane María made landfall on the southeast coast of Puerto Rico over the species range (Figure 2). Although no formal post-hurricane assessments were conducted, a researcher familiar with the species visited a known guajón population in the municipality of Humacao and informed the Service of a potential decrease of calling male frogs (less than 5) compared to past observations from that site that showed higher abundance (Service 2017). Thus, there are some likely direct hurricane impacts on the guajón and direct and indirect impacts to its habitat through torrential rain, landslides, and impacts to microclimates through loss of forest cover within the habitat. However, there is no additional information currently available to precisely assess the hurricane's effect on the known guajón populations. Ongoing surveys (see below) should help determine the current status of the guajón populations four to six years after Hurricanes María.

Figure 2. Map of Puerto Rico showing the municipalities occupied by the guajón (green color) and the trajectory (red line) of Hurricane María's center moving from the southeast to the northwest across the island.

In May and June 2021, researchers conducted rapid assessment surveys in six of the guajón sites (Longo 2021), and were again able to visit five of those sites on October 2021 (Longo 2022). Results show that in general frogs were difficult to find because of drier conditions throughout the species range and especially during the wet season (~May to November) (Longo 2022). Thus, frog activity at all sites was relatively lower than during the 2012 to 2014 effort, suggesting that guajón populations may be experiencing a downward population trend.

As part of the project, the researchers are planning on visiting and collect samples through 2023. More information will become available once the project is completed. The Jacaboa CH Unit 05 has not yet been revisited to confirm potential extirpation of that population. Per the previous review (Service 2014), other new guajón areas continue to be found (at least two new ones since the last review). Most of the known populations continue to occur mostly within private land and there are no new populations within protected areas from those mentioned in the previous review (Service 2014): Las Casas de la Selva, and two properties managed by Para La Naturaleza (Puerto Rico Conservation Trust).

Threats (Five-Factor Analysis) Summary

A detailed review of the species' threats can be found in the 2017 guajón 5-year status review (Service 2017). The status of a species is determined from an assessment of factors specified in section 4 (a)(1) of the Act, including:

Factor A (the present or threatened destruction, modification, or curtailment of its habitat or range).
Factor B (overutilization for commercial, recreational, scientific, or educational purposes).
Factor C (disease or predation).
Factor D (the inadequacy of existing regulatory mechanisms).
Factor E (other natural or manmade factors affecting its continued existence).

A summary of this assessment is detailed below.

Deforestation, vegetation removal, earth movement for agricultural uses, and road construction activities are still considered primary threats to the guajón and their habitat (Factor A) as detailed in the last 5-year review (Service 2017). Roads and urban developments near or within guajón habitat result in habitat destruction, modification of vegetation and streams, increased noise levels, and habitat fragmentation that may interrupt the connection between subpopulations, potentially affecting the genetic variability and populations of the guajón (Burrowes 1999, Service 2004). The immediacy of this threat is high because the guajón's habitat is naturally fragmented, and the majority of the known populations are on private lands, where an increased level of land development threatens to reduce further and fragment the species' habitat and alter its distribution and affect the species likelihood of recovery.

Deforestation near streams increases flash flooding and can result in severe erosion. Sediment entering streams during these events fills the interstitial area between rocks and boulders, decreasing the availability of retreat sites. Flash flooding also results in the flushing and drowning of adults and destroying egg clutches or nests. Stream modifications such as channelization and development projects for urban, tourism or agricultural purposes within the watersheds where the guajón exists could result in erosion and alteration of the streams' habitat quality resulting in direct or indirect mortality of individuals through dehydration (Rogowitz et al. 1999) and threatening the genetic diversity of the species by fragmenting and isolating populations (Burrowes 1997).

Over the past decade, the Service has provided technical assistance and conducted consultations under section 7 of the Endangered Species Act with the Puerto Rico Highway Authority (PRHA), the U.S. Army Corps of Engineers (USACE), and the Federal Emergency Management Agency (FEMA), respectively, on several projects (e.g., hurricane response, the proposed building of a dam, tunnel construction, installation of culverts, and bridge construction) that would directly or indirectly affect guajón habitat by removing boulder habitat, modifying stream characteristics, and sedimentation of crevices. For example, in 2017, guajón habitat was impacted with fill material during the construction of an access road as part of the emergency response to restore the electric power grid system after Hurricane María (Service 2021). Mitigation and restoration measures were implemented after this impact. A proposed project (Cerro Gordo Water Treatment Plant Raw Water Intake project, FWS-R4-CESFO-WI-062), will potentially affect guajón individuals and its habitat along the project's footprint. At the time of this

review, the USACE is still in the process of reinitiating consultation with the Service for this proposed project.

We have no indication that overutilization for commercial, recreational, scientific, or educational purposes (Factor B) poses a significant threat to the species. Of note, as described in the 2017 5-year review, while collection has not been documented as contributing to the decline of the guajón specifically, large numbers of *Eleutherodactylus* species, including several identified species at risk, have been reported in scientific collections.

Disease and predation (Factor C) is currently considered a threat to the species. Burrowes et al. (2004) suggested that the chytrid fungus (*Batrachochytrium dendrobatidis*), which causes chytridiomycosis diseases among endemic Puerto Rican frog species, could be the cause of anuran population decline on the island when the climate was significantly drier than average, and offered a likely cause for the declines and disappearances of amphibians. Chytridiomycosis can result in thickening of the skin resulting in limitations in oxygen exchange, impaired temperature regulation, abnormal feeding behavior, skin infections, and has been identified as contributing to the decline or extinction of over 200 species of frogs and other amphibians across the globe (Cornell University 2018). Drought stressed *Eleutherodactylus* species that become infected by chytrids are more likely to die from the disease due to their inability to uptake water (Burrowes et al. 2004). The most recent surveys documented abnormally dry conditions and moderate drought within the species range, especially during the wet season (~May to November), which could increase the presence of chytrid infection on the guajón (Longo 2021, 2022).

In addition to this disease, parasitism by the tick *Ornithodoros talaje* has been documented on the guajón (López-Torres and Longo 2015), however, the effects of this parasite on the species are unknown. Preliminary results from the ongoing research reports that 73% of the frogs captured at one locality (Emajagua CH Unit 04) had tick infestations ranging from one to eleven per individual (Longo 2022). Another researcher documented 5 guajón individuals in the municipality of Humacao infected with ticks (Barrios-González 2022).

Several laws and regulations (Factor D) are in place that provide protection to the species and its habitat and thus, this factor is still not considered a threat to the species at this time. Details of this factor can be found in the 2011 5-year review (Service 2011).

Other natural or manmade factors (Factor E) continues to be an important factor negatively affecting the guajón. In September 2017, category 4 Hurricane María made landfall right over the species range in southeast Puerto Rico (https://coast.noaa.gov/hurricanes). Hurricanes and tropical storms affect habitat suitability by modifying the structure of the habitat and with intense rainfall by washing away frogs and nests, thus, reducing reproductive output. Models identify increases in temperature, intensity of extreme weather (tropical cyclones/hurricanes), droughts, among others (Intergovernmental Panel on Climate Change (IPCC) 2022). All of which could have a detrimental effect on the species or its habitat. Even though no formal post-hurricane assessments have been conducted, a researcher familiar with the species visited

a known guajón population in the municipality of Humacao and informed the Service of a potential decrease of calling male frogs (less than 5) compared to past observations from that site that showed higher abundance (Service 2017). Thus, there are some likely direct hurricane impacts on the guajón and direct and indirect impacts to its habitat through torrential rain, landslides, and impacts to microclimates through loss of forest cover within the habitat.

In addition, climate change can have a variety of direct and indirect impacts on the guajón. Climate change scenarios in Puerto Rico predict a gradual trend towards dryer and hotter climates (Khalyani et al. 2016, Bhardwaj et al. 2018). Although not currently available for guajón, evaluating the magnitude and vulnerability of the guajón 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).

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. 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 other *Eleutherodactylus* frogs in Puerto Rico. Thus, effects of climate change on the guajón is expected to be similar to other species in the genus and could be particularly detrimental to the guajón since they are associated to forested stream environments that provide the microclimate conditions for basic needs such as reproduction. 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.

Synthesis

The guajón is a threatened frog species limited to seven municipalities in southeastern Puerto Rico and has very specific habitat requirements (i.e., forested areas that contain large boulder granite rock formations and patches of rocks near streams and drainages). The species occurs primarily within private lands and only three protected areas are known to harbor guajón populations. Surveys in 2012 to 2014 suggested that some populations that seem stable and a few may be declining or even extirpated. Previous genetic analysis suggested certain populations are isolated and others well connected through streams and forest corridors. This genetic study grouped the 19 populations sampled into 5 genetic clusters, which may provide a framework for future recovery activities. In 2017, a category 4 hurricane made landfall on the southeast coast of Puerto Rico passing through the species range. Although exact causes are unknown, since 2017 one anecdotal report suggested a potential decrease in the number of calling frogs, and studies in 2021 suggested that the guajón may be experiencing a downward population trend.

The main threats to the species continue to be anthropogenic habitat modification and fragmentation, erosion, agricultural practices that degrade the species' habitat and climate change (Factors A and E). Evidence of potential declines since Hurricane Maria in 2017, suggests that there may be direct impacts from hurricanes, which is concerning as hurricane numbers and

intensity is expected to increase in the future. The amphibian pathogenic chytrid fungus and a parasitic tick are now well documented to affect the coqui guajón and are likely to impact the species throughout its range (Factor C). Because of the limited distribution and number of guajón and the threats described, we believe the species continues to meet the definition of a threatened species.

RESULTS

U.S. FISH AND WILDLIFE SERVICE
STATUS REVIEW of Guajón or Puerto Rican Demon

(*Eleutherodactylus cooki*)

Status Recommendation:

On the basis of this review, we recommend the following status for this species. A 5-year review presents a recommendation of the species status. Any change to the status requires a separate rulemaking process that includes public review and comment, as defined in the Act.

____ Uplist to Endangered
____ Delist *(Indicate reasons for delisting per 50 CFR 424.11)*:
____ *The species is extinct*
____ *The species does not meet the definition of an endangered or threatened species.*
____ *The listed entity does not meet the statutory definition of a species.*
_X_ No change needed; species remains listed as threatened

Review Conducted By: Angel G. Colón-Santiago and Jan P. Zegarra, Caribbean Ecological Services Field Office.

FIELD OFFICE APPROVAL*:

Field Supervisor, Caribbean Ecological Services Field Office, Fish and Wildlife Service

Approve EDWIN MUNIZ Digitally signed by EDWIN MUNIZ Date: 2022.08.31 10:34:35 -04'00'

* Since 2014, Southeast Region Field Supervisors have been delegated authority to approve 5-year reviews that do not recommend a status change.

RECOMMENDED FUTURE ACTIVITIES

1. Develop plans for each municipality to protect the watersheds that contain guajón frog populations in a manner that promotes population growth, dispersion, and resilience.

2. Protect guajón suitable habitat and designated critical habitat through long-term mechanisms such as conservation easements.

3. Continue to support guajón research that contributes to our understanding of threats and population fluctuations.

4. Promote habitat conservation strategies with public, private and government entities to ensure that the ecological integrity of the species' habitat is not affected by adverse anthropogenic habitat modification, including effects of upstream/downstream land uses.

5. Increase public awareness of the species through public education and outreach programs that develop interest among stakeholders (e.g., landowners, government agencies, legislators, consultants for development projects, academic community, and general public).

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