

**Guajón or Puerto Rican Demon**  
**(*Eleutherodactylus cooki*)**

**5-Year Review:**  
**Summary and Evaluation**



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

**5-YEAR REVIEW**  
**Guajón or Puerto Rican Demon /**  
***Eleutherodactylus cooki***

**GENERAL INFORMATION**

**A. Methodology used to complete the review:** This following review was prepared by the Service's lead Recovery biologist for this species. This review was accomplished using information obtained from peer-reviewed scientific publications, several unpublished research projects, unpublished field observations by U.S. Fish and Wildlife Service (Service), State and other experienced biologists, and personal communications. On September 12, 2005, the Service also published a notice in the *Federal Register* (70 FR 53807) announcing the 5-year review of the guajón and requesting new information concerning the species. A 60-day comment period was opened. No information on the guajón was received. We also requested information and comments from species experts (see Appendix A).

**B. Reviewers**

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

**Lead Field Office:** Dr. Jorge E. Saliva, Caribbean Field Office, Boquerón, Puerto Rico. (787) 851-7297, extension 219.

**C. Background**

**1. FR Notice citation announcing initiation of this review:** September 12, 2005; 70 FR 53807.

**2. Species Status: 2010 Recovery Data Call:** Stable. We do not have information indicating that the species status has either improved or declined. Known guajón populations in the Sierra de Panduras should remain stable, if negotiations during ongoing consultation result in the protection or enhancement of its habitat. Populations in Las Piedras must be closely monitored to prevent impacts from residential developments in private properties. During FY 2010, changes to species distribution, threats and habitat conditions have not been reported.

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

**4. Listing History**

Original Listing

FR notice: 62 FR 31757

Date listed: June 11, 1997

Entity listed: Species

Classification: Threatened

**5. Associated rulemakings:** October 23, 2007, 72 FR 60067; Designation of critical habitat for the guajón.

**6. Review History:** The Recovery Plan for the guajón or Puerto Rican Demon (*Eleutherodactylus cooki*), approved and signed on September 24, 2004 (U.S. Fish and Wildlife Service 2004), is the most recent comprehensive analysis of the species status and is used as a reference point document for this 5-year review.

Recovery Data Call: 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010

**7. Species' Recovery Priority Number at start of 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.

**8. Recovery Plan:**

Name of plan: Recovery Plan for the Guajón or Puerto Rican Demon (*Eleutherodactylus cooki*).

Date issued: September 24, 2004.

## **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 1996 policy?** No.

### **B. Recovery Criteria**

- 1. Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes. The recovery plan established four recovery criteria and delisting as the Recovery Goal.
- 2. Adequacy of recovery criteria**
  - a. Do the recovery criteria reflect the best available (most up-to-date) information on the biology of the species and its habitat?** Yes.
  - b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and there is no new information to consider regarding existing or new threat)?** Yes.

**3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.**

The plan established four delisting criteria:

1. Permanently protect traditional, non-traditional, and unoccupied guajón habitat, and corridors between existing populations, through landowner agreements, conservation easements, habitat conservation plans, and public outreach.
2. Determine the viability of existing populations (*e.g.*, numbers, breeding success, population genetics, and ecology), and how many viable subpopulations are needed to ensure a self-sustaining overall population.
3. Determine the geographic distribution of all subpopulations needed to ensure a self-sustaining overall population.
4. Survey all potential habitats for new occurrences and evaluate suitability for species introduction.

None of these criteria have been met. The Service is making progress in addressing the existing delisting criteria with partners and has included the best available information on the guajón in Part C and the Five Factor Analysis below on distribution, localities, and threats. As shared in our recovery plan and in the Recommendations for Future Actions section of this 5-year review, we will need to revise the recovery plan to better define and possibly modify recovery criteria and incorporate recovery actions based on new information on distribution and spatial data obtained from recent studies.

## **C. Updated Information and Current Species Status**

### **1. Biology and Habitat**

**a. Is there relevant new information regarding the species' abundance, population trends (*e.g.* increasing, decreasing, stable), demographic features (*e.g.* age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends? Yes.**

López-Torres (2008) found that, out of 169 localities sampled, the guajón was present in 108 (64%). The species was very abundant in only 11 of the sampled sites, abundant in 25, and not abundant in 72. The municipality of Yabucoa contained most of the localities where the species was very abundant (63.3%), and San Lorenzo had the most localities where the species was present (37.9%). López-Torres (2008) further stated that these findings were alarming, considering that isolated populations with low abundance are at high risk of disappearing.

**b. Is there relevant new information regarding the species' genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)? No.**

**c. Is there relevant new information regarding taxonomic classification or changes in nomenclature? No.**

**d. Is there relevant new information regarding the species' spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species within its historic range, etc.)? Yes.**

López-Torres (2008) obtained new information about the distribution of the guajón, and created predicted and actualized distribution maps. He found a broader distribution from what was previously known and found new populations with high abundance. The past elevation range was considered to be from about 118 feet (ft) (36 meters (m)) up to 1,312 ft (400 m) above sea level; however, López-Torres (2008) found that populations of the guajón could be found at elevations ranging from about 83 ft (26 m) up to 1,381 ft (421 m) above sea level, and extending further west into the municipality of Patillas. This new range has two management issues that should be considered: expansion into lower elevations where there are more human populated areas prone to development, and expansion to higher elevations where the risk of finding guajón populations infected with chytrid fungus (*Batrachochytrium dendrobatidis*), or interacting with species that have the chytrid fungus increases (López-Torres 2008). López-Torres (2008) also stresses the importance of evaluating hydrological connectivity between guajón populations (hydrological corridors), because of the vulnerability to potential damage that may occur through hydrological changes within connected populations (López-Torres 2008).

**e. Is there relevant new information addressing habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem)? Yes.**

López-Torres (2008) identified 15,336.6 hectares (ha) (37 acres (ac)) as predicted habitat for the guajón. The hydrology and geology of the area were two very important factors to determine habitat suitability and predicting potential guajón habitat; and his success in locating new populations was dependent upon the presence of these two factors (López-Torres 2008). The guajón was mainly found in young and mature secondary forests, followed by shrubs, and to a lesser extent in abandoned plantations (López-Torres 2008). Municipalities with more development had lower habitat availability, possibly because of the difficulty of developing in areas where there is a high percentage of potential habitat for the species, whereas municipalities with less available habitat had lands easier to develop (e.g., grasslands) (López-Torres 2008).

## **2. Five Factor Analysis (threats, conservation measures, and regulatory mechanisms)**

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

The final rule lists deforestation, vegetation removal, earth movement for agricultural uses, and road construction activities as threats to the habitat or range of the guajón. The recovery plan adds that 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 sub-populations; potentially affecting the genetic variability and populations of the guajón (Burrowes 1999). Deforestation near streams increases flash flooding and can result in severe erosion. Sediment entering streams during these events fill 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 destruction of egg clutches or nests. Any stream modification (*e.g.*, channelization) or development (*e.g.*, tourist, urban) within the watersheds where the guajón exists could result in erosion and alteration of the streams' quality (*e.g.*, change in temperature and humidity levels within breeding crevices and caves), and result in direct mortality of individuals through dehydration (Rogowitz *et al.* 1999) or threaten the genetic diversity of the species (Burrowes 1997). López-Torres (2008) explains that some of these habitat-altering effects were witnessed during his study within *E. cooki*'s habitat, and may have drastically altered normal conditions in some areas.

For example, in the last decade, we have provided technical assistance and consultation under section 7 of the Endangered Species Act to the Puerto Rico Highway Authority and the Corps of Engineers, respectively, on several projects (*e.g.*, proposed building of a dam, tunnel construction, installation of culverts) that would directly or indirectly affect guajón habitat through the removal of boulder habitat, modification of stream characteristics, and sedimentation of crevices.

During consultation and technical assistance, the Service provides guidance to government agencies and private individuals, upon request, to prevent the violation of Federal statutes such as the ESA and Fish and Wildlife Coordination Act. However, adverse effects could not be avoided for these projects, but minimized. For example, in October 2008, the Caribbean Ecological Services Field Office worked with the U.S. Army Corps of Engineers on a consultation under section 7 of the Endangered Species Act, for the construction of a new water supply system known as Río Valenciano Dam and Reservoir. The project consisted of the construction of an on-stream dam, and a 546.95 acres reservoir within the Valenciano River of the Municipality of Juncos. The purpose of the proposed project is to supply potable water to the existing and future

population at the municipalities of Juncos, Las Piedras, San Lorenzo, Gurabo, and some sectors of Humacao and Caguas. The Service determined that the project would not jeopardize the guajón, and would not adversely modify its critical habitat. During the informal consultation process, biologists from the Caribbean Field Office provided technical assistance to avoid, minimize, and compensate for the effects of the proposed project to the guajón and to Unit 16 of its designated critical habitat (72 FR 60067). The proponent, Puerto Rico Aqueduct and Sewer Authority developed a comprehensive conservation plan with 12 conservation measures, including: 1) the implementation of a guajón monitoring and rescue program prior, during, and after construction; 2) the acquisition and enhancement of a total of 39.20 acres of land to conserve in perpetuity, identified as guajón habitat within the Action Area not previously designated as critical habitat for the species to connect occupied “guajonales” to the remaining designated critical habitat within the Action Area, and to create corridors between the remaining designated critical habitat known as Ceiba Sur Unit 16 and the natural areas occupied by the guajón near the project; and 3) the development and implementation of a Watershed Management Plan for the Río Valenciano Watershed to promote reforestation within a 50-meter buffer along the proposed reservoir.

The Service anticipated incidental take of all individuals of guajón within the 10.5 acres of guajón habitat to be inundated by the proposed reservoir. However, the comprehensive conservation plan minimized possible adverse effects and appropriately compensated for habitat loss. Once the conservation measures are implemented, the function of the remaining Ceiba Sur Unit 16 will be improved with the creation of ecological corridors to ensure genetic viability of the species within the Action Area. The remaining 6.37 acres of Unit 16 will be connected to the 39.20 acres conservation area containing three occupied “guajonales”.

López-Torres (2008) suggests that knowing the percent of available habitat can be very important for the management of the guajón habitat, because his study shows that, if there is a proposed development in the municipality of Maunabo, there is a 44.3% probability that it would be proposed within habitat occupied by the species (López-Torres 2008).

The destruction, modification, or curtailment of the species habitat or range continues to be an important factor threatening the survival and recovery of this species. 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 further reduce and fragment the species habitat, alter their distribution, and affect their chances of survival.

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

The final rule states, “While collection has not been documented as contributing to the decline of the guajón specifically, large numbers of *Eleutherodactylus* species, including several identified as species at risk, have been documented in scientific collections.”

Both the recovery plan and final rule indicate that collection of other species of *Eleutherodactylus* by local artisans for the confection of tourist souvenirs occurs, but this

has yet to be documented for the guajón. Similarly, though collection of specimens of the guajón for scientific or commercial purposes could pose a serious threat to the species, it has yet to be documented. Therefore, this factor is not considered a threat to the species at this time.

**(c) Disease or predation;**

The final rule states that “Disease has not been documented as a factor in the decline of the species” and that the effects of parasites and predators have yet to be studied – this is still the case. Pathogens and predation have been implicated in the decline of many frog species around the world, but there have not been studies about how disease and predators may affect guajón populations. Recent studies have documented many frog pathogens and diseases; a chytrid fungus (*Batrachochytrium dendrobatidis*) has been identified in the skin of Australian and Panamanian frogs whose populations have declined (Berger *et al.* 1998). Burrowes *et al.* (2004) suggested that the presence of this pathogen in Puerto Rico at approximately the same time that anuran populations declined and extirpations began, and when the climate was significantly drier than average, offered a likely etiology for the declines and disappearances of the amphibians. They hypothesized that 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). This pathogen has been discovered in nine species of *Eleutherodactylus* in Puerto Rico, so far; and guajones at an elevation of 1,335 ft (407m) were tested, but no infected individuals were found (Burrowes *et al.*, 2008). The range of the presence of *Batrachochytrium dendrobatidis* in Puerto Rico begins at an elevation of about 1,940 ft (600m) where the diversity of infected species was higher (Burrowes, *et al.*, 2008). According to Burrowes *et al.* (2008) the absence of chytrid fungus at low elevations in Puerto Rico might be explained by the high diurnal temperatures which are often above the thermal tolerance reported for this fungus. The expansion of the known distribution of this species to higher elevations increases the risk of finding populations of guajón infected, or interacting with species that have the pathogenic fungus *Batrachochytrium dendrobatidis* (López-Torres 2008).

Although some potential predators of the guajón have been suggested, predation events on adults and juveniles of this species have not been documented. The introduced bullfrog (*Rana catesbeiana*), is mentioned as a potential predator; since this species has been implicated in the decline of many frogs species elsewhere (Davidson *et al.* 2001). The terrestrial and semi-arboreal snakes *Alsophis portoricensis* and *Arrhyton exiguum*, whip scorpion (*Paraphrynus*), tarantula (*Cyrtopholis*) (Rivero 1998), and scorpions (*Tityus obtusus*) (Villanueva-Rivera 2000) are known predators of *Eleutherodactylus* species and small lizards, and are found within the range of the guajón.

Predation of guajón clutches by snails, black flies (Phoridae), and by conspecific male frogs have been reported, but there has not been an extensive examination on how this predation may adversely affect guajón populations, or if they have formed an evolutionary component of the species life history. Seven other species of *Eleutherodactylus*, as well as the white-lipped frog *Leptodactylus albilabris*, are found



within the same habitat as the guajón under rocks, logs, roots, or litter in the Cuchilla de Panduras mountain range (Rivero 1998). However, predation between these species and the guajón has not been documented. Parasitism by the tick *Ornithodoros talaje* has also been documented on preserved and live specimens of the guajón (Grant 1932), but the effects of this parasite on the species are not known (Joglar 1992; Joglar *et al.* 1996). At least three genera of nematodes, *Parapharyngodon*, *Aplectana*, and *Poekilostrongylus*, have been reported from other *Eleutherodactylus* (Rivero 1998), but their occurrence in the guajón has not been determined.

The magnitude of threat of disease and predation on the guajón is low, and the immediacy of threat to the species is non-imminent, because studies have not shown how disease and predation affect the guajón, and only circumstantial evidence has been found suggesting that the guajón is threatened by disease or predation.

**(d) Inadequacy of existing regulatory mechanisms; and**

In 1999, the Commonwealth of Puerto Rico approved the Law # 241 known as the “Nueva Ley de Vida Silvestre de Puerto Rico” (New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve, and enhance both native and migratory wildlife species; declare property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, regulate hunting activities, and regulate exotic species among others. In 2004, the Puerto Rico Department of Natural and Environmental Resources approved the “Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico” (Regulation 6766 to regulate the management of threatened and endangered species in Puerto Rico). The guajón has been included in the list of protected species and designated as “vulnerable”. This regulation under Article 2.06 prohibits collecting, cutting, removing, among other activities, listed animals within the jurisdiction of Puerto Rico.

Based on the presence of Federal and Commonwealth laws and regulations protecting the guajón, and the absence of evidence supporting lack of enforcement of regulations to protect the guajón or governmental measures to prevent destruction of its habitat, we believe that inadequacy of existing regulatory mechanisms is not a threat to the guajón.

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

The guajón was listed primarily due to its highly restricted geographical distribution and habitat requirements. Being a habitat specialist, the guajón is adapted to particular environmental conditions, and abrupt changes in these conditions could result in population declines. Each of the designated critical habitat units for the guajón in southeastern Puerto Rico is adjacent to at least one of the following manmade features: agricultural lands, roads, trails, homes, or other manmade structures. Many studies have documented negative impacts of agrochemicals on frogs; impacts include deformities, abnormal immune system functions, diseases, injury and death (Cook 1981; Reeder *et al.* 1998; Davidson *et al.* 2001; Hayes *et al.* 2002). The Final Rule states “The practice of planting crops right up to the entrance of guajonales may . . . increase the pesticide and

fertilizer run-off into the water flowing under the caves.” The recovery plan mentions that the use of pesticides, herbicides, and fertilizers in agricultural fields could have detrimental effects on survival of the guajón from runoff into waterways adjacent to guajón habitat.

Special management considerations and protection are required to protect the guajón and its habitat from threats posed by human activities, earth movement, and deforestation for road construction, agricultural, urban, and rural development near streams. These threats may result in changes in the composition and abundance of vegetation in and around guajón habitat, and degradation of water quality from illegal garbage dumping, household practices (*e.g.*, car washing, scrubbing of porches and terraces), disposal of untreated sewage, and agricultural practices (*e.g.*, use of herbicides, fertilizers, or insecticides). Presence of garbage generated by people has been documented within drainages of the Cuchilla de Panduras mountain range (Vega-Castillo, pers. comm. 2004; López-Torres, pers. comm. 2008), attracting potential predators and diseases for the guajón.

Seven other species of *Eleutherodactylus*, as well as the white-lipped frog *Leptodactylus albilabris*, are found within the same habitat as the guajón under rocks, logs, roots, or litter in the Cuchilla de Panduras mountain range (Rivero 1998). However, the extent of competitive interactions (*i.e.*, competition for shelter or food) between these species and the guajón has not been documented.

We believe that the magnitude of threat from other natural or manmade factors is high, and the immediacy of threat to the guajón is imminent, because most of the range and habitat of the guajón is within or near private lands subject to current or previous agricultural use. Streams and drainages inhabited by the guajón are found in slopes where runoff water from agricultural lands and private properties directly drain into them. No protection measures are taken to prevent runoff water from agricultural fields that drain into guajón habitat. Daily human activities; such as household cleaning, and car repairing and washing, result in detergent, oils, and chemicals discharging through gutters into nearby streams and drainages.

### **3. Synthesis**

The guajón is the second largest frog endemic to southeastern Puerto Rico. It is found in subtropical forests at elevations from 85 to 1381 ft (26 to 421 m) above sea level, in areas that contain plutonic/granitic boulders or patches of rocks that create caves, grottoes, and crevices in perennial or ephemeral streams that provide shelter essential for the reproduction of the species. The guajón also uses associated riparian vegetation that provide foraging habitat. This species shows sexual dimorphism: the ventral coloration of females is uniformly white, while males are smaller and with yellow extending from the vocal sac to the abdomen and flanks. Male and female vocalizations also differ. The guajón was listed as threatened on June 11, 1997; and its recovery plan was approved and signed on September 24, 2004. No new information on the guajón was received during the 60-day comment period for the 5-year review on the species that was published on September 12, 2005. The Service designated approximately 260.6 ac (105.6 ha) as

critical habitat for the guajón within the municipalities of Humacao, Juncos, Las Piedras, Maunabo, Patillas, San Lorenzo, and Yabucoa on October 23, 2007. There are no population estimates of the guajón, but we do not have information indicating that the species status has either improved or declined. We consider the species to be stable.

Changes in the composition and abundance of vegetation surrounding guajón habitat, degradation of water quality due to agricultural practices (*e.g.*, use of herbicides, fertilizers, or insecticides), and pollution of streams caused by human refuse threaten the survival and recovery of the guajón. Activities that may adversely alter the vegetation structure in and around creeks, streams, and drainages include, but are not limited to, vegetation cutting for expanding or maintaining roads, development of new roads and trails, and construction of new homes and commercial establishments. The elimination or alteration of vegetation structure could result in habitat fragmentation that may interrupt the connection between populations, alter guajón foraging activities and the availability of foraging resources, reduce the quality of breeding microhabitat (*e.g.*, change in temperature and humidity levels within breeding crevices and caves), and result in direct mortality of individuals through trampling and crushing or desiccation from sun exposure. Habitat fragmentation could also affect the dispersal and interactions between sub-populations, potentially resulting in restricting gene flow and jeopardizing the integrity of the species' gene pool.

There is no substantive data indicating that over utilization for commercial, recreational, scientific, or educational purposes is a threat to the species. Nor does current data indicate that disease or predation pose a threat to the species. The inadequacy of existing regulatory mechanisms is not a threat to the guajón.

The destruction, modification, or curtailment of the species habitat or range continues to be an important factor threatening the survival and recovery of this species. 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 further reduce and fragment the species habitat, alter their distribution, and affect their chances of survival. Therefore, we believe the guajón still meets the definition of threatened as defined by the ESA.

## **RECOMMENDATIONS FOR FUTURE ACTIONS**

1. Surveys for the guajón in traditional, non-traditional, and unoccupied habitat should be conducted, using the best available amphibian survey methodology, to determine population numbers, population fluctuations, and number of viable sub-populations (wild naturally reproducing populations large enough to maintain sufficient genetic variation, and evolve and respond to natural habitat changes) necessary to protect and stabilize the overall guajón population (meta-population study).
2. Proposed activities that may result in the deterioration of guajón habitat in public and private lands, such as road constructions/improvements, recreational use of streams,

agricultural practices, and urban, commercial, and tourist developments, should be carefully evaluated by the appropriate government agencies and parties interested in the recovery of the guajón. Long-term leases, conservation easements, designation of guajón conservation areas, enforcement of regulations protecting the guajón, habitat restoration, and land acquisition must be explored as strategies to minimize loss of guajón habitat. This will assure that the resources necessary to support a successful breeding population of the guajón are not compromised.

3. The impact of predators, competitors, and parasites on the population dynamics of the guajón should be evaluated to determine if competitor and predator/parasite management techniques are necessary. In view of the studies concerning the potential for chytrid fungus infection in the guajón, guajón populations at higher elevations must be monitored for the presence of this fungus.

4. The effect of natural disturbances, such as flooding during storms and hurricanes, on the population dynamics (*e.g.*, change in distribution, dispersal) and survival of the guajón should be assessed through monitoring of guajón populations before and after natural disturbances (*e.g.*, monitor changes in: habitat characteristics, location of individuals, mortality, dispersal). To determine which hydrological areas are important, hydrological/hydraulic (H/H) studies must be done, not only in forest areas where the species is present, but also in urban areas, and localities where the species is not present to assess all threats.

5. Conserve hydrological units as corridors for the species.

6. Distribution models developed by Gould *et al.* (2007) and López-Torres (2008) can be employed to find other populations, and for evaluating land management practices that may threaten guajón habitat. Information on the percent of available habitat should be monitored by the Service, taking into account these recent studies.

7. Effective public education and outreach programs are key to the recovery of the guajón. Such programs need to develop interest among stakeholders (*e.g.*, landowners, government agencies, legislators, consultants for development projects, academic community, and general public) about their contributions to the recovery activities of the guajón. Understanding the species needs would involve different groups into working towards common goals. This outreach and education program should balance the needs of the target audiences and the guajón, and include the development and distribution of information (*e.g.*, species reports, audiovisual presentations, meetings, media sources) on the recovery needs of the species.

8. GIS and genetic analysis should be done to evaluate possible connectivity between populations thru hydrological systems, and the opportunity to establish these biological corridors should also be considered as a priority for conservation.

9. The recovery plan should be revised to better define and possibly modify recovery criteria and incorporate recovery actions based on new information on distribution and spatial data obtained from recent studies.

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**U.S. FISH AND WILDLIFE SERVICE**  
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**Current Classification**    Threatened

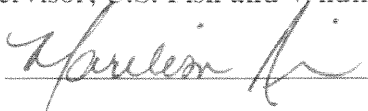
**Recommendation resulting from the 5-Year Review**

X No change is needed


**Review Conducted By** Jorge E. Saliva

**FIELD OFFICE APPROVAL:**

**Lead Field Supervisor, U.S. Fish and Wildlife Service**

Approve  Date 3/8/2011

**REGIONAL OFFICE APPROVAL:**

 **Lead Regional Director, Fish and Wildlife Service**

Approve  Date 4/20/11

**FY 2017 Approval follows Appendix A:**

## Appendix A

### Summary of peer review for the guajón 5-year review

This 5-year review was reviewed internally by Marelisa T. Rivera and Edwin E. Muñiz. They mostly provided editorial comments. Once the comments were added to the document, it was sent to five outside peer reviewers (see below) via electronic mail. The outside peer reviewers were chosen based on their qualifications and knowledge of the species. We indicated our interest in all comments the reviewers may have about the guajón, more specifically any additional information on the status and current threats to the species.

The deadline for submission of peer review comments was October 26, 2009. Comments were received from two independent peer reviewers during the comment period. Peer reviewers' comments (C) and the Service's responses (R) are provided below.

#### Comments by Mr. Alberto López-Torres:

C: *The lack of scientific data cannot be considered to determine the status of the species.*

R: The status of the species in previous years was stable (see Recovery Data Call 2000-2009). A change in status was not deemed appropriate because the threat analysis for this species did not vary in 2009.

C: *We found that municipalities with higher quantities of development cases had lower habitat availability. This occurs probably because of the difficulty of developing in areas where there is a high percentage of potential habitats for the species, and municipalities with less available habitat have lands easier to develop, like grasslands for example. This seems to be good news at first, because there is a larger development tendency occurring where there is a lower possibility of encountering *E. cooki* populations, but it is also alarming, because populations that have little potential habitat are more at risk because of the high tendency of urban expansion. This is an aspect that government agencies should take into account when approving developments in these municipalities, and they ought to be more vigilant when reviewing flora and fauna studies made by developers in these areas.*

R: The Service included the comment in the Recommendations section.

C: *This is definitely the major threat for this species. Because of this I do not concur with the opinion of the USFWS that unoccupied habitats cannot be determined as essential for the conservation of the species. The USFWS should include unoccupied habitats that are suitable for the species and its surroundings to insure that the hydrology of the area is conserved. To*



*determine which are these hydrological important areas, hydrological/hydraulic (H/H) studies must be done, not only in forest areas, but also in urban areas to assess all threats. This is another reason why the USFWS should also extend the buffer zones for the species, depending upon the results of the H/H studies.*

R: Reviewer refers to habitat alterations affecting the guajón which are discussed in Synthesis. The Service included in Recommendations a hydrological/hydraulic study, and conserving hydrological units as corridors for the species.

C: *The new areas where the presence of E. cooki was confirmed should be considered as critical habitats by the USFWS, due to the limited distribution of the species and the high degree of specialization of the species.*

R: Areas that support populations, but are outside the critical habitat designation, will continue to be subject to conservation actions implemented under section 7(a)(1) of the Act and to the regulatory protections afforded by the section 7(a)(2) jeopardy standard, as determined on the basis of the best available information at the time of the action. Federally funded or permitted projects affecting listed species outside their designated critical habitat areas may still result in jeopardy findings in some cases. Similarly, critical habitat designations made on the basis of the best available information at the time of designation will not control the direction and substance of future recovery plans, habitat conservation plans, or other species conservation planning efforts if new information available to these planning efforts calls for a different outcome.

Comments by Ms. Sondra Vega-Castillo:

C: *Creo que para poder entender el estado de situación de esta especie hay que obligadamente realizar estudios meta poblacionales.*

R: Reviewer refers to the need to conduct meta-population studies to understand the status of the species. The Service concurs and included the comment in the Recommendations section.

C: *Creo que para concluir que esta especie esta libre del hongo se necesita un muestreo mas amplio, ya que es una especie asociada con agua.*

R: Reviewer refers to the guajón being no longer affected by the chytrid fungus. The Service included in the Recommendations section a task to monitor frog populations for threats like the fungus.

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FY 2017 APPROVAL\*

Lead Field Supervisor, Fish and Wildlife Service

Approve

Edwin M. Cruz

Date

8/1/2017

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

Field Supervisor signature on this document reflects:

1.        We have no new information, received no new public comments, and the original five factor analysis remains an accurate reflection of the species current status.
2. X We have obtained a small amount of new information that we have summarized in Addendum 1, received no new public comments, and the original five factor analysis remains an accurate reflection of the species current status.

**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of the guajón frog (*Eleutherodactylus cooki*)**

**ADDENDUM 1. Summary of new information obtained since the 2011 5-Year Review.**

The following information updates the referenced sections of the 2011 5-year review (USFWS 2011). Sections of the 2011 5-year review **not** referenced herein, do not contain new information related to this addendum.

**C. Updated Information and Current Species Status**

**1. Biology and Habitat**

- a. Is there relevant new information regarding the species' abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g. age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends? Yes.**

Between January and June 2014, a relocation and monitoring effort was implemented for the guajón frog as a consequence of the mitigation and conservation measures for the construction of the Río Valenciano dam and reservoir within and outside the species Ceiba Sur critical habitat (CH) unit 16 (USFWS 2007). At the first two guajón habitat areas (*guajonales*), relocation efforts captured a total of 134 individuals in 10 nights and another 269 individuals in 19 nights within another two *guajonales* (López-Torres et al. 2016).

Based on the available information for the species, the total number of frogs collected during the Río Valenciano project was unexpected. The project's applicant had conducted surveys during the planning phases of the project and reported a total of 22 guajón individuals in three sites within the action area (USFWS 2008). Thus, the Service underestimated the number of frogs that could potentially be found within the project area. This information is particularly important when conducting future guajón surveys that should thoroughly assess the methodologies being used to obtain the best information.

From November 2012 to March 2014, a cooperative agreement with the Proyecto Coquí organization served to conduct population surveys of the guajón frog at 16 designated critical habitats (CH) in addition to 4 other non-CH localities (20 in total). The purpose was to provide a snapshot of the population status using visual and acoustic surveys at all localities sampled. The species had high abundance (100+) in 13/20 (65%) of the sites, medium abundance (50-99) in 5/20 (25%) and low abundance (0-49) in 2/20 (10%) of the sites (López-Torres and Longo 2015). The species was not found at the Jacaboa CH unit 5 in Patillas. Although we are unable to determine specific population trends from this data, the information at least suggests there are populations that seem stable (i.e. those of high and medium abundance) and a few that may be declining or even extirpated (i.e. the two low abundance sites).

**b. Is there relevant new information regarding the species' genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)? Yes.**

López-Torres and Longo (2015) identified the species levels of genetic diversification and inferred its evolutionary history using mitochondrial and nuclear markers. Using mitochondrial DNA (cytochrome b gene) of the 19 sampled populations, revealed very little genetic variation with no apparent population structure. In addition, in order to assess the degree of connectivity between habitats, a multivariate analysis revealed that the 19 sampled populations are divided into five genetic clusters.

López-Torres and Longo (2015) also found that gene flow was limited to very short distances, resulting in greater genetic differentiation as the geographic distance between populations is greater. The authors further explain that these patterns of isolation by distance are crucial to explain local extinctions. For example, as in the case of the Jacabo CH where a local extinction might have occurred influenced by the limited dispersal of the species and the Jacabo CH unit being completely isolated from other critical habitats.

López-Torres and Longo (2015) also calculated the inbreeding coefficient for all of the individuals sampled at 19 populations. Results show that most individuals showed high levels of inbreeding (> 50%), providing additional support to the assumption of extremely low migration rates.

López-Torres and Longo (2015) further explain the conservation implications from the new genetic information available. For example, they explain that guajón populations within CH exhibit high degrees of gene flow within each genetic cluster as a result of landscape features (corridors) contributing to species dispersal. In contrast, if geographical barriers exist (i.e. Río Grande de Loíza) between CH in close proximity (i.e. Guayabota vs. Marcela/Verraco), individuals will not be part of the same genetic cluster due to lack of dispersal. If further conservation efforts require translocating individuals, one should first evaluate whether or not these individuals are part of the same genetic cluster.

López-Torres and Longo (2015) also recommend that CH with high gene flow should be designated as a single unit, for example, Pandura and Talante; Marcela and Verraco; and Playita, Guayanés and Calabazas. They also recommend designating new CH for genetic clusters with few representative populations, specifically the Marcela/Verraco genetic cluster.

**d. Is there relevant new information regarding the species' spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species within its historic range, etc.)? Yes.**

During the November 2012 to March 2014 population surveys, the species was found in 19 out of the 20 sites visited (López-Torres and Longo 2015). The species was not

found in the Jacoboa CH in Patillas, where it seems to have disappeared for unknown reasons. The species was known to occupy the Jacoboa CH at the time of listing (1997) and CH designation (2007). This site was thoroughly searched once during the dry season and once during the wet season, the same as for all other sites. We will try to investigate this potential localized extinction further within the next 5 years.

Other new occupied habitats within the species known range continue to be found. Some of the areas are within habitat managed for conservation as is the case of the guajón populations within Las Casas de la Selva (private organization) property in Patillas (Greenhawk 2013) and Para La Naturaleza (PR Conservation Trust) in their Sierra La Pandura property in Yabucoa/Maunabo and Marín Alto property in Patillas.

**e. Is there relevant new information addressing habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem)? Yes.**

During the November 2012 to March 2014 population surveys, some *guajonales* were found to have lots of trash and to be modified by erosion and agricultural activity (López-Torres and Longo 2015).

Initial results from the artificial *guajonales* created as part of the mitigation and conservation measures for the construction of the Río Valenciano dam and reservoir seem to: provide suitable habitat for the species; have been successfully integrated into natural areas; serve as corridors with other natural areas; and served as suitable breeding areas (CSA Group 2015). However, this project has not been completed and we do not have any more information since the 2014 annual report (CSA Group 2015).

Through a cooperative agreement with Envirosurvey, Inc., partners are engaging private landowners within guajón habitat in order to implement habitat restoration practices for the benefit of the species and the landowner.

**f. Is there new other relevant information? Yes.**

During the November 2012 to March 2014 population surveys, López-Torres and Longo (2015) found the pathogenic chytrid fungus (*Bd*) in all of the 20 sites visited. López-Torres and Longo (2015) explain that they found several lethargic guajón individuals with high loads of *Bd*, suggesting that the fungus is detrimental for the species persistence. They also found more infected frogs during the dry season surveys than during the wet season, a trend also documented for the common coquí (*E.coqui*). López-Torres and Longo (2015) did not find any effects of age, sex, or type of stream on the species probability of infection with *Bd*. Thus, *Bd* risk seems uniform across all age classes and stream type (López-Torres and Longo 2015).

The parasitic tick (*Ornithodoros talaje*) was found in frogs within 14 of the 20 localities surveyed by López-Torres and Longo (2015). Ticks were only found on adults and mostly found on males, suggesting there is selection or that smaller

individuals die after infection (López-Torres and Longo 2015). In addition, tick loads revealed that during the wet season, frogs carried less ticks. In addition, it was found that localities with higher tick loads are characterized by having ephemeral streams (usually *guajonales*). López-Torres and Longo (2015) did find a marginal effect of frog body condition index (snout-vent-length) on tick load, suggesting that ticks may carry a fitness cost for adult frogs.

López-Torres et al. (2016) uniquely marked all captured adult frogs by toe-clipping and all individuals were externally covered with a non-toxic fluorescent powder before being released. This allows tracking the initial movement of animals once relocated. Recapture data suggest that released animals dispersed rapidly from their new habitat towards the edges; moved greater distances during the first 24 hours of being released; and juveniles and sub-adults appear more sedentary and remained closer to their relocation habitat near their release point (López-Torres et al. 2016).

López-Torres et al. (2016) suggest that they were initially able to relocate individuals in both natural and artificial sites, but numbers declined over time. They explain that low recapture rates may have been caused by the timing of relocation during the dry season, and/or by the dispersal of individuals from their relocated habitat after the fluorescent dyes wore off. They recommend that future research should focus on estimating survival probabilities across time using mark and recapture modeling.

Educational efforts as part of the cooperative agreement with Proyecto Coquí were most effective while seeking out the private landowners and community stakeholders within the 20 sites, rather than only advertising a website ([www.coquiguajon.org](http://www.coquiguajon.org)) with the species information and educational material.

## **2. Five Factor Analyses**

### **a. Present or threatened destruction, modification, or curtailment of its habitat or range.**

This threat continues to be an important factor affecting the *guajonales*. For example, the construction phase of the Río Valenciano dam and reservoir started in 2013 within and outside the species Ceiba Sur critical habitat (CH) unit 16 (USFWS 2007), and affected approximately 10.5 acres of occupied *guajonales* (USFWS 2008, CSA Group 2015). Conservation measures were being implemented as part of a Biological Opinion (BO) and a permit for the project. However, the most current (July 2015) information is that neither the authorized work nor the mitigation have been completed, possibly interfering with the species recovery at that impacted site. The species was only monitored for at least 60 days after relocation, but we have no further information on the status of the relocation effort or the implementation of the conservation measures. Although initial relocation results were promising, we cannot determine the long-term results of this project. For example, we do not know if the relocated individuals are heading back to their original *guajonales*, especially if the project was stopped and suitable habitat still remains in some of the areas that would have been affected by the project. If frogs have indeed moved back, the applicant

will need to relocate animals again. The long-term results of the artificial *guajonales* or on the population are unknown.

More detrimental examples of habitat modification were documented during the most recent surveys (November 2012 to March 2014) for the species. López-Torres and Longo (2015) specified threat levels for all of the sampling sites weighing anthropogenic habitat threats (i.e. presence/absence of habitat modification, erosion, trash, and agriculture) and natural threats (i.e. disease prevalence, presence of invasive predators, parasites, and perceived relative abundance). Habitat modification was identified in 7 of the 20 sites; erosion in 8; presence of trash in 10; and agriculture in 9 (López-Torres and Longo 2015). Habitat modification and erosion were the most significant threats observed during their study (López-Torres and Longo 2015). However, it is not clear how these threats might be affecting the populations. Only 4 of the 20 sites presented both habitat modification and erosion, and were found to have all three categories (low to high) of perceived relative abundance: 1 high, 1 medium, and 2 low (López-Torres and Longo 2015).

**b. Overutilization for commercial, recreational, scientific, or educational purposes.**

This factor is still not considered a threat to the species at this time.

**c. Disease or predation.**

As previously explained, there is evidence that the pathogenic chytrid fungus (*Bd*) is widespread throughout the species distribution. A parasitic tick was also found in most of the sites visited during the most recent surveys (López-Torres and Longo 2015). Although there is information that suggests *Bd* and the tick may be detrimental for the species persistence (López-Torres and Longo 2015), there is no additional information to assess the species resilience to *Bd* infections or to correlate with relative abundance. There is also no additional information to assess how the tick may be affecting individuals or the population as a whole.

We now have concrete evidence that this factor is a threat to the species. However, the magnitude and severity of this threat is difficult to assess without continued research and surveys. Other factors (e.g. weather) that may influence *Bd* and tick infection over time, may result in relatively rapid declines. We will continue to explore options towards effectively monitoring these threats.

**d. Inadequacy of existing regulatory mechanisms.**

This factor is still not considered a threat to the species at this time.

**e. Other natural or manmade factors affecting its continued existence.**

This threat continues to be an important factor affecting the *guajonales*. Documented during the most recent surveys for the species, agricultural practices near *guajonales* continue to occur within CH areas (López-Torres and Longo 2015). We do not have



any updated information on how these and other natural or manmade factors are specifically affecting the species continued existence.

## **Synthesis**

This 5-year review provides updates to several sections of the previous guajón's 2011 5-year review (USFWS 2011). Most of the new information comes from two projects: the implementation of conservation measures for the construction of the Río Valenciano dam and reservoir within and outside the species Ceiba Sur critical habitat (CH) unit 16; and from the implementation of surveys to assess the species population status, genetics, disease and parasite threat.

From November 2012 to March 2014, rapid assessment population surveys were conducted within 16 CH units and another 4 non-CH sites (20 total). Although we are unable to determine specific population trends from this data, the information at least suggests there are populations that seem stable and a few that may be declining or even extirpated. The species seems to have disappeared from the Jacaboa CH unit 5 in Patillas. Genetics research suggests certain populations are isolated and others well connected through streams and forest corridors. The pathogenic amphibian fungus *Bd* and a parasitic tick were detected within all and most of the areas, respectively.

When necessary, relocation efforts within artificial and natural habitat for the species may be an appropriate conservation measure when suitable habitat is present and monitoring implemented adequately.

Main threats to the species continue to be anthropogenic habitat modification, erosion, and agricultural practices that degrade the species habitat. Disease is now well documented for the species, but there is no specific information as to how disease is affecting the population dynamics of the species.

Based on the most recent information, we believe the guajón frog should continue to be listed as a threatened species.

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