# Chiricahua Leopard Frog Status in the Galiuro Mountains, Arizona, With a Monitoring Framework for the Species' Entire Range

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***Abstract—****The Chiricahua leopard frog (*Rana chiricahuensis*) was historically widespread in suitable habitat throughout its range. Reports of recent population declines led to inventories of Chiricahua leopard frog localities. Surveys reported here establish a new baseline of occurrence in the Galiuros: only two of 21 historical localities were found to be occupied in 2003. One of these sites may represent the only source population for the species in that mountain range. The species' reduced occurrence in the Galiuros may reflect its situation elsewhere. To aid in tracking recovery action efficacy, we offer a framework for future monitoring of this threatened species.*

# Introduction

The Chiricahua leopard frog (*Rana chiricahuensis*) is found in Arizona, New Mexico, Sonora, and Chihuahua (Platz and Mecham 1979). Its range is divided into at least two portions. One consists of northern montane populations along the southern edge of the Colorado Plateau in central and eastern Arizona and west-central New Mexico (=Mogollon Rim population). Another includes southern populations located in the mountains and valleys south of the Gila River in southeastern Arizona and southwestern New Mexico and extends into Mexico along the eastern slopes of the Sierra Madre Occidental (=Madrean populations).

Populations of all of Arizona's native ranid frogs (leopard frogs, *Rana pipiens* complex, and the Tarahumara frog, *R. tarahumarae*) have declined in recent years (Clarkson and Rorabaugh 1989, Sredl et al. 1997). The Chiricahua leopard frog (*Rana chiricahuensis*) is one of these species, and it has undergone large-scale population declines throughout much of its range (Jennings 1995, Painter 2000, Sredl et al. 1997). In 2002, it was listed as threatened by the U.S. Fish and Wildlife Service (USFWS 2002).

In order for the Coronado National Forest (Coronado) to assess the status of the Chiricahua leopard frog across some of its administered lands, it contracted surveys in 2002 (reported on by Hays [2002]). This included some of the historical (substantiated with reliable locality records) and potential (previously undocumented) sites in the Galiuro Mountains and five other Madrean Sky Islands. As a follow-up, in 2003, one of us (LLCJ) conducted surveys of all historical sites in the Galiuros. In this paper we report on the 2003 surveys, with an update on the current knowledge of the status of the species in the Galiuros. We also introduce a framework for intensive future monitoring strategies to assess the efficacy of recovery actions across the species' range.

# Survey History Before 2003

Surveys of ranid frogs in Arizona were sporadic and poorly documented before the 1990s, about the time when the World Congress of Herpetology noted a global decline in certain amphibian taxa. Surveys of the Chiricahua leopard frog and other native ranids were conducted throughout the 1990s, primarily by Arizona Game and Fish Department (AGFD). Personnel searched for animals visually and by sweeping pools and the vegetation with a dip net to cause movement and detection (Sredl et al. 1997). During each visit, field personnel collected data on amphibian species present, habitat characteristics, and other variables, such as weather and time of day. They also assessed the suitability of the site for leopard frogs. These surveys detected frogs at 20 sites (figure 1). Populations occurred along the lower eastern flank of the Galiuro Mountains from at least the Ash Creek/High Creek drainages on the south to at least Deer Creek on the north. In 1995 and 1996, the first years with relatively intensive surveys, frogs were found to be present in about 80% of the sites surveyed (figure 1). In subsequent years, occupancy rates were lower: 47% in 1997, 20% in 1998, and 35% in 1999. Although visits were irregular and data were collected under various conditions, results still indicated a pattern of decline.

No data were collected in 2000 or 2001, but the Coronado's 2002 surveys (Hays 2002) shed additional light on recent site occupancy. The surveys covered all five of the Forest's Districts. Sites for surveys for ranid frogs (not just *R. chiricahuensis*) were selected by District Biologists, and pre- and post-monsoon surveys were conducted. Ranid frogs were found in 3/50 (6%) historical and potential sites. Hays (2002) surveyed 16 sites in the Galiuros (6 historical and 10 potential). Ranids were found in one new locality (site #21, figure 1). These were reported to be Plains leopard frogs (*R. blairi*) based on a single larval individual held through metamorphosis, but no vouchers

were retained. A "plop" (from an unidentified anuran suspected to be a leopard frog) was recorded at another site.

In addition to the surveys reported by Hays (2002), one of us (LLCJ) surveyed 5 additional sites in the Galiuros (4 historical, 1 potential). One historical site (#9) had Chiricahua leopard frogs, and one potential site had a possible but unconfirmed observation. Of the sites surveyed, 50% were dry during the pre-monsoon surveys. Pre-monsoon water level minima were recorded consistently for the first time in 2002. The District also surveyed in the Pinaleños at 34 sites, but none were seen although leopard frogs (probably *R. yavapaiensis*, the Lowland leopard frog) were once common in the range (Nickerson and Mays 1969).

## *2003 Surveys*

All known historical sites of Chiricahua leopard frogs in the Galiuros were surveyed in 2003. Sites to be surveyed were based on records gleaned from AGFD's Heritage Data Management System and Riparian Herpetofauna Database, Hays (2002), unpublished data (LLCJ 2002), and other sources. The primary intent was to establish a new baseline of occurrence in the Galiuros. Twenty-one sites had credible observations and were considered historical sites (figure 1), while four sites had questionable data and were not included. Three potential sites were additionally surveyed. Surveyors used the standardized sampling protocol (USFWS 2003) and visited sites during the pre-monsoon season. If water was present when they arrived during daylight, the site was also visited at night. In addition to USFWS (2003), a supplemental data form was used to summarize the changes in water level and other site parameters. Digital images of all sites were recorded in the four cardinal directions.

Two of the 21 sites were found to be occupied (#9 and #21), which were also the only sites found to be occupied in 2002. Site 9 is a stock tank and Site 21 a natural lotic system; these may be close enough together to be part of a single population, but they are in separate tributaries of a larger drainage.

Sites 9-12 (refer to figure 1) are a series of tanks representing a metapopulation, but only the largest tank (Site 9), which never dried up, was found with frogs in 2002 and 2003. The site was visited twice in 2003, with up to 4 frogs recorded, although there had apparently been some recruitment, as a metamorphic individual was seen on one occasion. The tank at Site 9 is

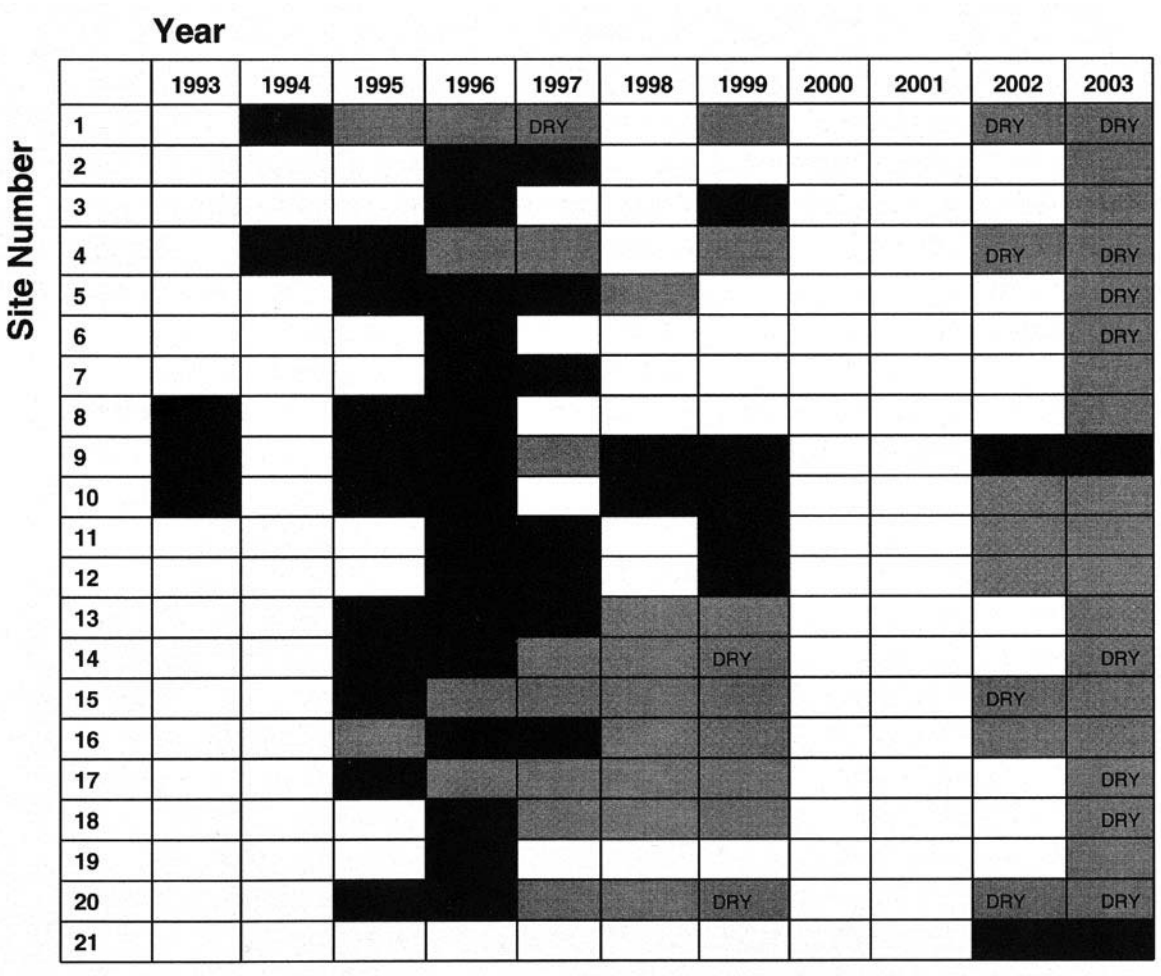


**Figure 1**—Occurrences of Chiricahua leopard frogs in the Galiuro Mountains from 1993 to 2003. Black = detection, gray = no detections, and white = no data or no surveys. Low-flow/pre-monsoon surveys were only consistently done in 2002 and 2003, so designating sites as dry (or not) were only valid for those years during the pre-monsoon period.

contained by an earthen dam in a tributary of a lotic system near site 21. The lotic system below Site 9 had little water during the dry season in 2002 and 2003, and was represented by a few small isolated pools during the dry season. Because so few frogs were detected at Site 9, we were concerned that this population was on the verge of extirpation.

Site 21 was visited on 7 occasions from June 10 to November 11. The identification of the resident ranids needed to be confirmed, because we questioned the likelihood of *R. blairi*, given its distribution. On a night visit (June 30), photographic vouchers were taken of various aspects of three captured frogs. We identified them as *R. chiricahuensis*, although the rear thigh pattern was not unlike *R. blairi*.

Because this Site 21 could possibly be the only viable population for the species in the Galiuros, subsequent visits were conducted to: determine the extent of the population along the lotic system; characterize and map the pools during low and high water; determine if native and non-native predators were present; look for evidence of a die-off by the recently identified chytrid fungus (Berger 1998); and identify other potential threats. On each visit, as many as 25 frogs were counted, with all age classes except eggs (i.e., adults, juveniles, metamorphs, and larvae) present. Frogs occupied several of the approximately 25 large pools (during low water), but one pool in particular seemed to be the epicenter of the population.

# Potential Threats to the Galiuros Populations

At Sites 9 and 21, no exotic predators were seen. However, during low water at Site 21, belostomatids and Black-necked Gartersnakes (*Thamnophis cyrtopsis*) were evident native predators. In the low-water situation, belostomatids, in particular, seemed likely to be a serious threat, because their numbers far outweighed frog numbers. There was no evidence of chytrid fungus disease at either site, but frogs from the Galiuros have never been tested. Cattle were absent from most of Site 21 because it is a steep, bedrock-dominated system. Cattle were present at the occupied stock tank. One obvious threat across the Galiuros was the lack of water, as evidenced by the apparent local extirpation that occurred concomitantly with the drought beginning in 1996/1997, and the large number of previously occupied sites that were dry during 2002-3 surveys. Because these frogs require essentially perennial waters to live and reproduce, there is an obvious direct effect. The drought exacerbates other negative effects by reducing the number of aquatic sites in a metapopulation. This increases vulnerability of predators, increases cattle use, and reduces emergent and bank vegetation. On the other hand, periodic drying of tanks and pools can rid a system of unwanted predators (including noxious non-native species) and may block the spread of disease.

Beyond these two extant populations, the prognosis is dismal. The few splashes heard in 2002 suggest there may be a few *R. chiricahuensis* in the southern part of the Galiuros, but it is not known if populations would be viable if conditions improve. Also, non-native predators have been documented in some of the southern populations. Clearly, this species urgently needs conservation measures in this and other mountain ranges.

# Measures of Species Status and a Framework for Monitoring Ranid Frog Conservation

The pattern of decline seen in the Galiuros is typical of the Madrean populations in the United States. Based on intensive surveys in recent years, most of the Sky Islands managed by the Coronado have Chiricahua leopard frog populations at only one or two distinct sites. The difficulty in describing increasing or decreasing trends in populations is exacerbated when trying to describe these trends from a baseline of only one or two subpopulations. In this section, we propose survey and monitoring programs to include in the recovery plan to describe species status and detect threats (Brigham et al. 2002, Campbell et al. 2002). Our suggestions take into consideration the difficulties inherent in describing status changes in small populations, the need to identify threats early, the necessity to document progress in reintroduction programs (which also involve small number of reintroduced animals), and the importance of providing objective, measurable delisting criteria.

## *Focal Area Surveys*

One of the criteria to delist the Chiricahua leopard frog will likely be the maintenance of some minimum number of metapopulations within each recovery unit. Each metapopulation will include occupied and unoccupied sites and will be part of an area where considerable conservation effort will be focused. One measure of metapopulation health is the ability to disperse into available habitat patches and to maintain subpopulations in a high proportion of these sites. Recently, proportion area occupied (PAO) has been proposed as a measure of this ability (MacKenzie et al. 2002). PAO uses comparable survey data within and between years at a set of identified sites to describe the probability of encountering or detecting the species if it is present, and then estimate the probable proportion of sites that are occupied. Even if a given site is occupied, if detection probabilities are low, consideration of simple observations only might lead to scoring that site unoccupied. Two great benefits have been identified for this type of population status descriptor. First, it allows the estimation of the proportion of occupied sites that may have been scored as unoccupied due to low detection probabilities, which apply to southwestern ranids (Blomquist 2003). Also, this technique can be implemented more easily and less expensively than the methods used for abundance estimation, such as traditional mark-recapture. For these reasons, this method should be attractive to a large-scale monitoring program, as will be needed for the recovery plan of the Chiricahua leopard frog. PAO estimation performs best when detection probabilities are greater than 0.3 (MacKenzie et al. 2002), so opportunistic sampling may have to be replaced with seasonal sampling designed to target each site when detection is most likely.

## *Applied Conservation Surveys*

The objective of applied conservation surveys will be to assess the potential of a particular unoccupied site or area in conservation of native ranid frogs or to detect threats to extant populations. Data sheets for these surveys will reflect this goal by including detailed information on: 1) abundance and habitat use of resident frogs, 2) availability of potential habitat for all life stages, 3) habitat characteristics such as water permanence and quality, dispersal corridors, foraging areas, and quality of aquatic and terrestrial vegetation, 4) possible impacts such as land use, presence and abundance of introduced species or diseases, 5) needed habitat renovations, 6) land ownership, and 7) site accessibility.

## *Translocation Monitoring*

Because translocation has already been used and will probably continue to be used for conservation of this species (Sredl and Healy 1999), it will be important to institute monitoring to describe the success or failure of each translocation effort. Sredl and Healy (1999) presented an approach to evaluate stages of success of translocations, including the timeline and frequency of data collection, to efficiently and effectively track the course of success or the point at which failure occurs. They defined stages of success as: 1) initial survival of released animals, 2) over-winter survival of released animals, 3) long-term survival of released animals, 4) reproduction of released animals at the site of release, and 5) recruitment in a population of released animals. To measure dispersal, nearby non-release sites also need to be monitored. When suitable habitat exists in the vicinity (1.5-4 km), surveys should be conducted sporadically to determine whether colonization occurs. Surveys during stage 1 can use daytime visual survey assuming all tadpoles or juveniles encountered are from a recent release. Surveys addressing the remaining stages of success, except stage 4, would use intensive nighttime searches, involving capture and identification of cohort.

We view this monitoring framework as a starting point; the Chiricahua Leopard Frog Recovery Team (Technical and Stakeholder subgroups) will develop the final monitoring scheme as part of the recovery plan. Whatever the final categories of field monitoring are called, we feel it is important for each category to have explicit objectives that facilitate recovery and measure progress toward delisting in a cost-efficient and defensible manner.

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# Literature Cited

Berger, L., R. Speare, P. Daszak, D.E. Green, A.A. Cunningham, C.L. Goggin, R. Slocombe, M.A. Ragan, A.D. Hyatt. 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America Proceedings of the National Academy of Science 95:9031-9036.

Blomquist, S.M. 2003. Inventory and habitat assessment for the Chiricahua Leopard Frog *Rana chiricahuensis* on Coconino National Forest. Nongame and Endangered Wildlife Program Technical Report 211. Arizona Game and Fish Department, Phoenix, AZ.

Brigham, C.A., A.G. Power, and A. Hunter. 2002. Evaluating the internal consistency of recovery plans for federally endangered species. Ecological Applications 12 (3):648-654.

Campbell, S.P., J.A. Clark, L.H. Crampton, A.D. Guerry, L.T. Hatch, P.R. Hosseini, J.J. Lawler, and R.J. O'Conner. 2002. An assessment of monitoring efforts in endangered species recovery plans. Ecological Applications 12:674-681.

Clarkson, R.W., and J.C. Rorabaugh. 1989. Status of leopard frogs (*Rana pipiens* Complex) in Arizona and southeastern California. Southwestern Naturalist 34:531-538.

Hays, T. 2002. 2002 leopard frog surveys on the Coronado National Forest. Unpublished report, on file with Coronado National Forest, Tucson, AZ.

Jennings, R.D. 1995. Investigations of recently viable leopard frog populations in New Mexico: *Rana chiricahuensis* and *Rana yavapaiensis*. New Mexico Department of Game and Fish, Santa Fe, NM.

Jones, L.L.C., and C.W. Painter. This volume. Herpetology of the Coronado National Forest: managing our natural heritage.

MacKenzie, D.I., J.D. Nichols, G.B. Lachman, S. Droege, J.A. Royle, and C.A. Langtimm. 2003 Estimating site occupancy rate when detection probabilities are less than one. Ecology 83: 2248-2255.

Nickerson, M.A., and C.E. Mays. 1969. A preliminary herpetofaunal analysis of the Graham (Pinaleno) Mountain region, Graham Co., Arizona with ecological comments. Transactions of the Kansas Academy of Science 72:492-505.

Painter, C.W. 2000. Chiricahua leopard frog, *Rana chiricahuensis* Platz and Mecham 1979. Pp. 10-21 and appendix, *in* Completion Report to the U.S. Fish and Wildlife Service, Albuquerque, NM.

Platz, J.E., and J.S. Mecham. 1979. *Rana chiricahuensis*, a new species of leopard frog (*Rana pipiens* Complex) from Arizona. Copeia 1979:383-390.

Sredl, M.J., and B.L. Healy. 1999. Conservation and management zones: evaluating an approach to conserving Arizona populations of the Chiricahua leopard frog (*Rana chiricahuensis*). Nongame and Endangered Wildlife Program Technical Report 149, Arizona Game and Fish Department, Phoenix, AZ.

Sredl, M.J., J.M. Howland, J.E. Wallace, and L.S. Saylor. 1997. Status and distribution of Arizona's native ranid frogs. Pp. 45-101 in M.J. Sredl (ed). Ranid frog conservation and management. Nongame and Endangered Wildlife Program Technical Report 121, Arizona Game and Fish Department, Phoenix, AZ.

USFWS (U. S. Fish and Wildlife Service). 2002. Endangered and threatened wildlife and plants; listing of the Chiricahua leopard frog (*Rana chiricahuensis*); final rule. Federal Register 67: 40790-40811.

USFWS. 2003. *Rana chiricahuensis*—Fish and Wildlife Service Survey Protocol for Project Evaluation. Unpublished report, March 2003.