

# Control of Introduced American Bullfrogs and Support of Chiricahua Leopard Frog Conservation in Southeast Arizona

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**Control of Introduced American Bullfrogs and Support of Chiricahua Leopard Frog  
Conservation in Southeast Arizona**  
Final Report for Task Order 23-5

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Chulo Tank (*photo: Raul Vega, University of Arizona*)

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## Executive Summary

1. This report summarizes field surveys conducted during July 2023 through April 2024 to control introduced American bullfrogs (*Lithobates [Rana] catesbeianus*; hereafter bullfrog) and support Chiricahua leopard frog (*Lithobates [Rana] chiricahuensis*) conservation in southeast Arizona. We conducted 394 field surveys across 141 sites in Chiricahua leopard frog Recovery Units 1 and 2 during this survey period.
2. During these surveys, we detected bullfrogs at 36 sites and removed a total of 452 bullfrogs. Bullfrog reproduction was only observed during this survey period at sites on private property where we did not have landowner permission to remove bullfrogs. We found bullfrogs and Chiricahua leopard frogs co-occurring at only a single site (Chulo Tank). Only a single bullfrog was present at this site, and it was removed.
3. Within the Cobre Ridge/Recovery Unit 1 region, we detected Chiricahua leopard frogs at 15 sites, with reproductive activity confirmed at two sites. We performed or assisted with Chiricahua leopard frog translocations at five sites. We detected Chiricahua leopard frog overwinter survival at two sites in this region although moribund and dead frogs were observed at one of these two sites.
4. We did not detect Chiricahua leopard frog within our Canelo Hills Buffer Zone or stock tanks along the foothills of the San Rafael Valley. We detected Chiricahua leopard frogs at four sites on the Appleton-Whittell Research Ranch with reproduction documented at two sites. We also removed two adult bullfrogs from a single site on the Appleton-Whittell Research Ranch.
5. We detected Chiricahua leopard frogs at 17 sites on the Las Cienegas National Conservation Area (LCNCA). While Chiricahua leopard frog reproduction was not confirmed during July–November of 2023, as of 24 April 2024 we detected Chiricahua leopard frog reproduction at three sites. We did detect a moribund Chiricahua leopard frog at Lower Empire Gulch in March 2024. No bullfrogs were detected on the LCNCA and a single adult bullfrog was removed from one site in the Elgin Buffer Zone.
6. We began bullfrog removal efforts at a new eradication site along the Babocomari River on the Babacomari Ranch. This planned four-year eradication project will remove a

significant non-urban bullfrog source population that threatens existing Chiricahua leopard frog metapopulations.



Chiricahua leopard frogs from Mojanera Tank in transit to Chulo Tank. (photo: Jace Lankow, University of Arizona)

## Introduction

American bullfrogs (*Lithobates [Rana] catesbeianus*; hereafter bullfrog) have been introduced across western North America and have contributed to widespread declines in native

herpetofauna, particularly in southeastern Arizona (Rosen and Schwalbe 1995, 2001, 2002). Bullfrogs are recognized as a major contributor to range-wide declines in the federally threatened Chiricahua leopard frog (*Lithobates [Rana] chiricahuensis*; USFWS 2007; Jones 2013). Bullfrogs represent a critical threat to Chiricahua leopard frogs and other native Ranid frogs for several reasons. First, bullfrogs are voracious predators (Bury and Whelan 1984) and likely predate upon and compete with Chiricahua leopard frogs (USFWS 2007). Second, bullfrogs contribute to the spread of diseases among native amphibians, particularly the fungal pathogen *Batrachochytrium dendrobatidis* (Bd) for which bullfrogs are a known carrier (Gervasi et al. 2013; Garner et al. 2006). Third, bullfrogs have very high reproductive potential (Bury and Whelan 1984) which allows them to reach extremely high local densities. Finally, bullfrogs have high dispersal potential and can successfully disperse over 10 km through upland desert and grassland habitats in southeast Arizona (Suhre 2010). These life-history traits have allowed bullfrogs to establish a wide distribution across southeastern Arizona in a variety of habitat types (Suhre 2010; Rosen and Schwalbe 1995; Rosen et al. 2013). A recent study across the Chiricahua leopard frog distribution in Arizona, New Mexico, and Sonora (Mexico) not only found a strong negative association between bullfrogs and Chiricahua leopard frogs but also a strong positive association between bullfrogs and Bd and Ranavirus (Hossack et al. 2023). Eliminating bullfrogs from potential Chiricahua leopard frog habitat is crucial for Chiricahua leopard frogs. However, such eradication efforts must be followed by regular annual monitoring to prevent reinvasion and allow other forms of Chiricahua leopard frog management (e.g., habitat restoration, translocation) a chance to be successful.

Previous efforts in southeast Arizona demonstrated that landscape-level bullfrog removal is feasible and effective for promoting Chiricahua leopard frog recovery (Rosen et al. 2013). For example, bullfrogs were eradicated from the Las Cienegas National Conservation Area during 2010–2013 which was accompanied by extensive habitat restoration efforts and Chiricahua leopard frog reintroductions (Rosen et al. 2013). Subsequent natural dispersal of Chiricahua leopard frogs among existing lentic and lotic habitats have allowed for the development of a robust Chiricahua leopard frog metapopulation with an increase in the number of sites with confirmed Chiricahua leopard frog reproduction from one in 2010 to nine in 2023 with a peak of 14 in 2017 (Hall 2019; Bauder and Prewitt 2023a). While landscape-scale bullfrog control is both feasible and effective, it requires multiple years of labor-intensive field work to remove all

bullfrog life phases (eggs, tadpoles, juveniles, and adults) and detect and remove recently metamorphosing individuals from earlier cohorts. Furthermore, given the high dispersal potential of bullfrogs themselves, additional monitoring is essential to avoid undoing previous management gains. The use of buffer zones (i.e., regions adjacent to bullfrog-eradicated areas that are regularly monitored to prevent recolonization) is an effective means of preventing widespread bullfrog recolonization (Rosen et al. 2013; Hall 2019). Finally, landscape-scale bullfrog control and monitoring has only been possible through the collaborative efforts of multiple entities including University of Arizona, Arizona Game and Fish Department, U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Forest Service, Sky Island Alliance, Southwestern Research Station, and private landowners, including ranchers (Rosen et al. 2013; Hall 2019).

In this report, we present the results of our ongoing field surveys for bullfrog control and Chiricahua leopard frog recovery in Chiricahua leopard frog Recovery Units 1 & 2 in southeast Arizona. Our reporting period for this report spans July 2023 through April 2024. Our work flows directly from previous bullfrog management efforts and is essential to maintain hard-won conservation gains over the past several years.

## **Area Descriptions**

Our surveys were conducted across Chiricahua leopard frog (hereafter CLF) Recovery Units 1 & 2 (RU1 and RU2, respectively). Within RU1, our sites were located primarily on U.S. Forest Service lands that are part of the Nogales District of the Coronado National Forest. These include a series of CLF sites and our traditional Cobre Ridge Buffer Zone, established in 2018, to protect these CLF sites from reinvasion by bullfrogs. Bullfrog eradication in this area began in 2016 and 36 sites were cleared of bullfrogs, of which four sites contained bullfrog reproduction. Survey sites in this area were either stock tanks, ponds, or wildlife ponds with elevations ranging from 1165–1346 m.

Within RU2, our sites can be loosely combined into four groups. The first group includes sites associated with the Bureau of Land Management's Las Cienegas National Conservation Area (LCNCA), which comprise a relatively large CLF metapopulation that has been free of bullfrogs since 2014, and its associated buffer zone, the Elgin Buffer Zone. Sites on the LCNCA



include wildlife ponds and riparian areas along Cienegas Creek. Elevations of these sites ranged from 1282–1593 m.

The second group consists of CLF sites on the Audubon Society’s Appleton-Whittell Research Ranch and sites associated with the Canelo Hills Buffer Zone, the latter being established in 2022. Bullfrog removals in the Canelo Hills Buffer Zone initially began in 2020 with removal efforts in O’Donnell and Turkey Creeks. We have identified several reproductively active bullfrog populations in adjacent private lands where we have yet to receive landowner permission to remove bullfrogs. As a result, continued monitoring of the Canelo Hills Buffer Zone is needed to limit bullfrog dispersal from these private lands. The Canelo Hills Buffer Zone serves in part to protect CLF sites on the Appleton-Whittell Research Ranch from dispersal by bullfrogs from private properties within and adjacent to the boundaries of the Sierra Vista District of the Coronado National Forest. The Canelo Hills Buffer Zone also prevents northward dispersal by bullfrogs from the San Rafael Valley and surrounding hills. Sites within the Canelo Hills Buffer Zone include stock tanks and riparian habitats along Turkey and O’Donnell Creeks. We also conducted surveys of stock tanks within the hills on the northeast side of the San Rafael Valley to identify potential sites for a University of Arizona graduate student research project on bullfrog ecology. Elevation of sites at Appleton-Whittell Research Range ranges from 1448–1536 m, in the Canelo Hills Buffer Zone from 1477–1683 m, and in the San Rafael Valley from 1522–1590 m.

Our third group of sites includes seven sites on the eastern slopes of the Santa Rita Mountains. These sites have supported CLF over the past decade or more and have been periodically monitored by the University of Arizona in conjunction with Arizona Game and Fish Department in part to identify potential dispersal from the CLF metapopulation on the LCNCA. The elevation of these sites ranges from 1449–1649 m. Our fourth group includes an approximately 7.5 mile stretch of the Babocomari River on the Babacomari Ranch. This is the site of a new bullfrog eradication project designed to eradicate bullfrogs from the Babacomari Ranch over a four-year period. We have divided our stretch of river into 17 survey stretches consisting of southwestern riparian vegetation communities. We also surveyed a single pond near the ranch headquarters. The elevation along the Babocomari River is approximately 1386 m.

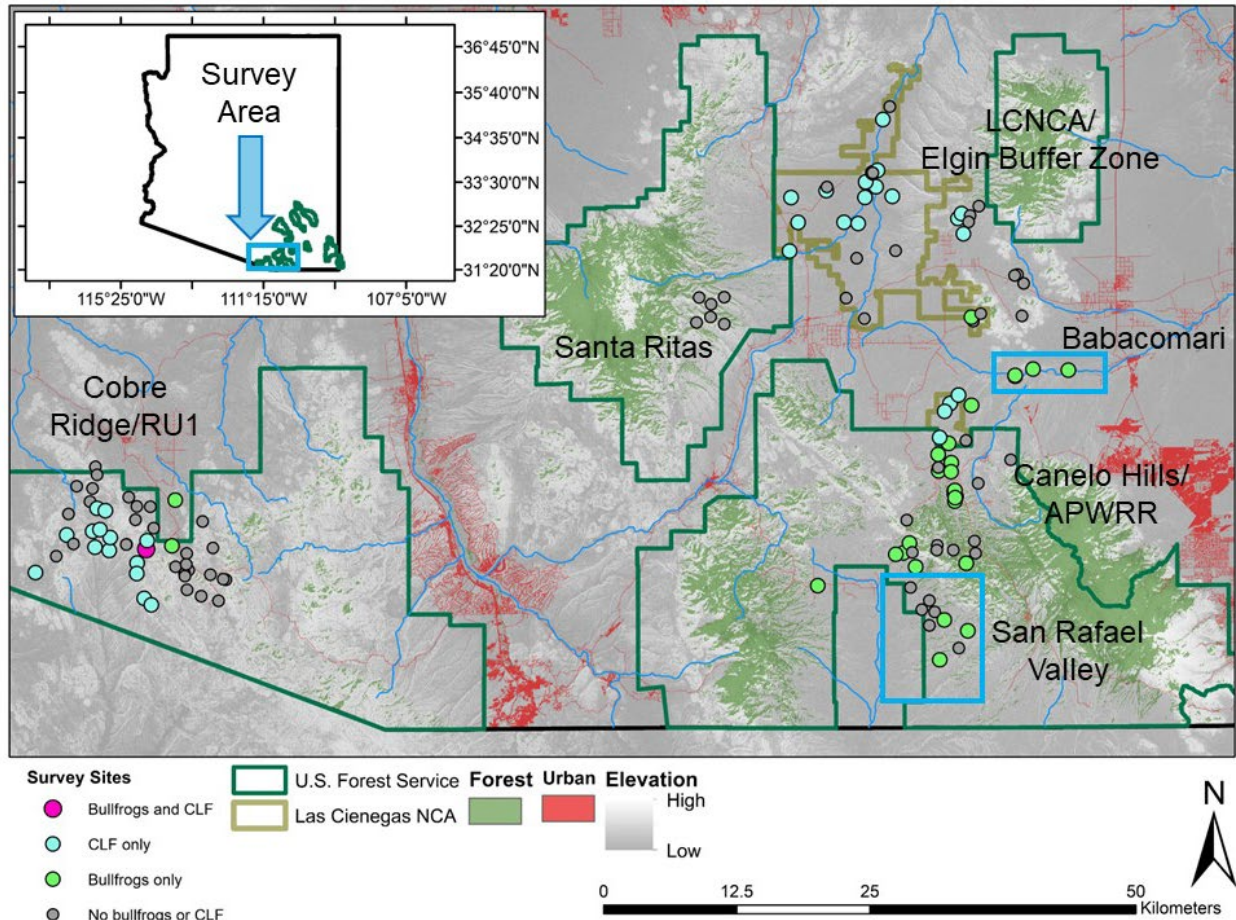
## Methods

Surveys began on 5 July 2023 and continued through 25 April 2024. We used standard Visual Encounter Survey (VES) techniques as outlined in the CLF recovery plan (USFWS 2007) and recorded all observations on the CLF/Riparian Herpetofauna VES Datasheet version 2.5 (Arizona Game and Fish Department, February 2020). We periodically performed dip-net surveys to determine the presence of CLF tadpoles. Surveys were conducted both during the day and night. Because this reporting period began during the 2023 monsoon season, we did not consider the presence of juvenile CLF after 5 July to represent local reproduction because we could not distinguish between juveniles resulting from successful reproduction at a given site or juveniles dispersing into a given site that were the result of successful reproduction elsewhere. We therefore make reference to site visits conducted during the spring and pre-monsoon summer of 2023 when discussing CLF reproduction. We considered the presence of larvae or juvenile CLF during our spring 2024 surveys as indicative of local reproduction.

We removed any bullfrogs we detected using dip nets, seines, hand collection, and .22 LR firearms. When possible, we assigned all bullfrogs to a size class using visually estimated or measured snout-vent length. We allocated additional survey effort to sites where bullfrogs were known to occur or had been observed during previous years to minimize opportunities for bullfrog reproduction.

**Figure 1. Map of survey sites across Chiricahua leopard frog Recovery Units 1 & 2 during the 2023-2024 field season (5 July 2023 through 25 April 2024).**

Symbols show locations of sites where bullfrogs and/or Chiricahua leopard frogs (CLF) were detected. Inset map shows the location of our survey area within the state of Arizona in relation to the boundary of the Coronado National Forest. Blue rectangles within the larger map show sites within our San Rafael Valley survey area and the Babacomari Ranch survey sites, respectively. LCNCA is the Las Cienegas National Conservation Area, APWRR is the Appleton-Whittell Research Ranch, and RU1 is Recovery Unit 1.



## Results

### *Cobre Ridge/Recovery Unit 1*

We conducted 137 surveys across the 46 sites comprising our Cobre Ridge Buffer Zone and surrounding regions. Nearly all of the sites contained water during the entirety of our survey period although four sites were dry on at least one survey during our survey period. During our survey period bullfrogs were detected at only three sites: Cemetery Tank (2023 only), Chulo

Tank (2023 only), and Dead Cow Tank (2023 and 2024). During our survey period, we removed one adult and one juvenile bullfrog from Cemetery Tank (27 July 2023), a single adult bullfrog from Chulo Tank (28 July 2023), and two juveniles from Dead Cow Tank (August 2023). A single juvenile was detected but not removed at Dead Cow Tank on 21 March 2024.

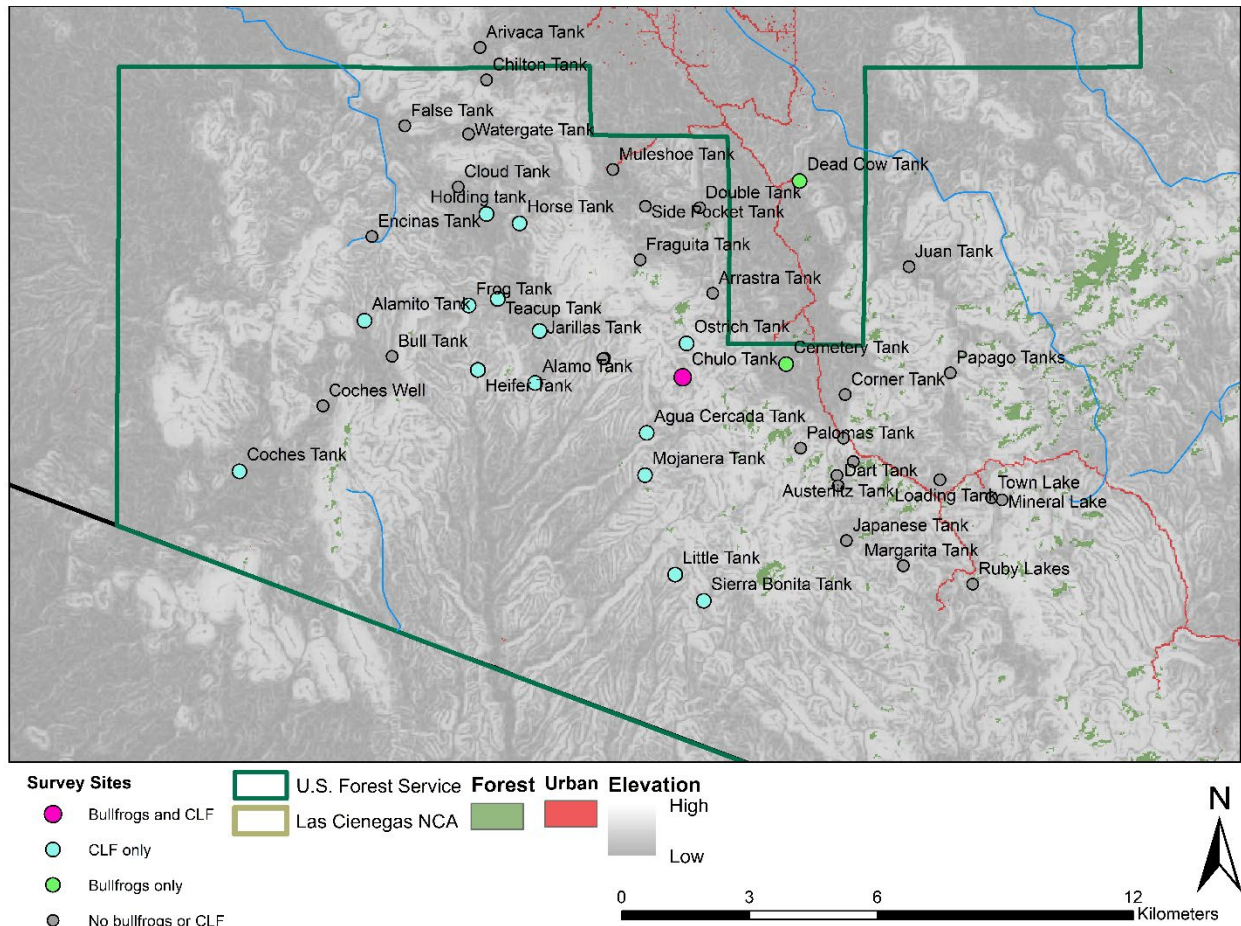
During our survey period we detected CLF at 15 sites in the Cobre Ridge area. Chiricahua leopard frogs were detected at all 15 sites during our 2023 survey period (July through November 2023). The numbers of CLF observed was greatest at Jarillas Tank where 400–590 adult and juvenile CLF were observed during surveys in August, September, and October 2023 (Bauder and Prewitt 2023*b*). Similar numbers were observed at Mojanera Tank where 470 adult and juvenile CLF were observed on 25 October 2023. Observations of Chiricahua leopard frogs at Chulo Tank were noteworthy because we removed a single adult bullfrog from Chulo Tank during this study period. We observed 28–86 adult and juvenile Chiricahua leopard frogs at Chulo Tank during July–September 2023. Chiricahua leopard frog reproductive activity during this time was confirmed at two sites. The first was Horse Tank where a spent egg mass was observed on 26 July 2023 and the second was Jarillas Tank where Chiricahua leopard frog larvae were observed on 22 August 2023. However, surveys conducted earlier in 2023 resulted in Chiricahua leopard frog reproduction confirmed in an additional three sites (Chulo Tank, Frog Tank, and Mojanera Tank; Bauder and Prewitt 2023*b*).

During our survey period, we translocated 50 adult Chiricahua leopard frogs from Jarillas Tank into Coches Tank, Agua Cercada Tank, and Alamito Tank, respectively, on 6 September 2023. We also assisted Arizona Game and Fish Department in translocating 45 adult and eight juvenile Chiricahua leopard frogs from Mojanera Tank into Little Tank and 54 adult Chiricahua leopard frogs from Mojanera Tank into Sierra Bonita Tank, both on 19 September 2023.

During 2024 we only observed Chiricahua leopard frogs at two sites. On a 21 March 2024 survey, we observed 14 adult and 14 juvenile Chiricahua leopard frogs at Mojanera Tank. This included one moribund frog and six dead adult frogs. On a 3 April 2024 survey, we observed three adult Chiricahua leopard frogs at Sierra Bonita Tank including one calling male.

**Figure 2. Map of survey sites within the Cobre Ridge Buffer Zone and Recovery Unit 1 (RU1) survey area (26 July 2023 through 21 March 2024).**

Symbols show locations of sites where bullfrogs and/or Chiricahua leopard frogs (CLF) were detected.



***Canelo Hills/Appleton-Whittell Research Ranch/San Rafael Valley***

We surveyed 29 sites in the Canelo Hills Buffer Zone, nine sites in the San Rafael Valley, and six sites on the Appleton-Whittell Research Ranch (APWRR). Three sites in the San Rafael Valley (Double Reed Tank, Section 17-18 Tank, and Dove Tank) and one site in the Canelo Hills (Spartacus Pond) were dry which resulted in a total of 41 sites containing water on at least one survey across a total of 140 surveys. We restrict further discussion to these 41 sites. We detected bullfrogs at 18 (64%) sites in the Canelo Hills, three (50%) sites in the San Rafael Valley, and one site (17%) on the Appleton-Whittell Research Ranch.

Within the Canelo Hills Buffer Zone, we conducted 15 surveys along Turkey Creek. This includes an approximately 2.4 km stretch of Turkey Creek flowing through the Lindsey Family Ranch, the Canelo Project, and U.S. Forest Service land. While supporting very little permanent bullfrog habitat, this stretch functions as a bullfrog dispersal corridor. Within this stretch, we detected and removed only four post-metamorphic bullfrogs during surveys in July and August 2023. No bullfrog reproduction was observed in this stretch of Turkey Creek during our 2023 surveys. No additional bullfrogs have been detected in this stretch as of 16 April 2024. We also conducted surveys on Canelo Springs Ranch, consisting of five ponds along this stretch of Turkey Creek, although we did not have landowner permission to remove bullfrogs, bullfrogs were detected. During our 2023 Canelo Springs Ranch surveys, we detected a total of 50 adult, 431 juvenile, and 40 larvae bullfrogs. As of 16 April 2024, we have only detected bullfrogs at one of the Canelo Springs Ranch ponds (five adult bullfrogs).

We conducted 25 surveys along an approximately 3.3 km stretch of O'Donnell Creek flowing through The Nature Conservancy's Cienega Creek Preserve and into the APWRR. We removed a total of one adult and six juvenile bullfrogs during 2023 and have not detected bullfrogs as of 19 March 2024. We did not detect any CLF during the survey period although we did detect a single CLF adult in the lower portion of O'Donnell Creek on 18 April 2023 (Figure 3; Prewitt and Bauder 2023). We suspect this individual may have dispersed into O'Donnell Creek following the prolonged 2022 monsoon season although this hypothesis remains unverified.

We conducted 61 surveys across 13 stock tanks consisting of our Canelo Hills Buffer Zone. We detected bullfrogs in six sites (Border Tank, Canelo Tank, Fritz Tank, Little Outfit Tank, Woodchopper Tank, and unnamed tank; Figure 3) during 2023 and no bullfrogs were detected as of 16 April 2024. These sites had previously been monitored by researchers from Virginia Tech University who also conducted bullfrog removal efforts. The Virginia Tech researchers concluded their field work in 2022. We subsequently detected adult and larval bullfrogs at sites within the Canelo Hills Buffer Zone, particularly Woodchopper Tank, during April 2023. After discussions with Arizona Game and Fish Department and the U.S. Forest Service, the decision was made to fully eradicate bullfrogs from these six sites. During 2023, we removed three adult and 165 juvenile bullfrogs, and no bullfrog larvae or egg masses were detected during this survey period. As of 16 April 2024, no bullfrogs have been detected at any

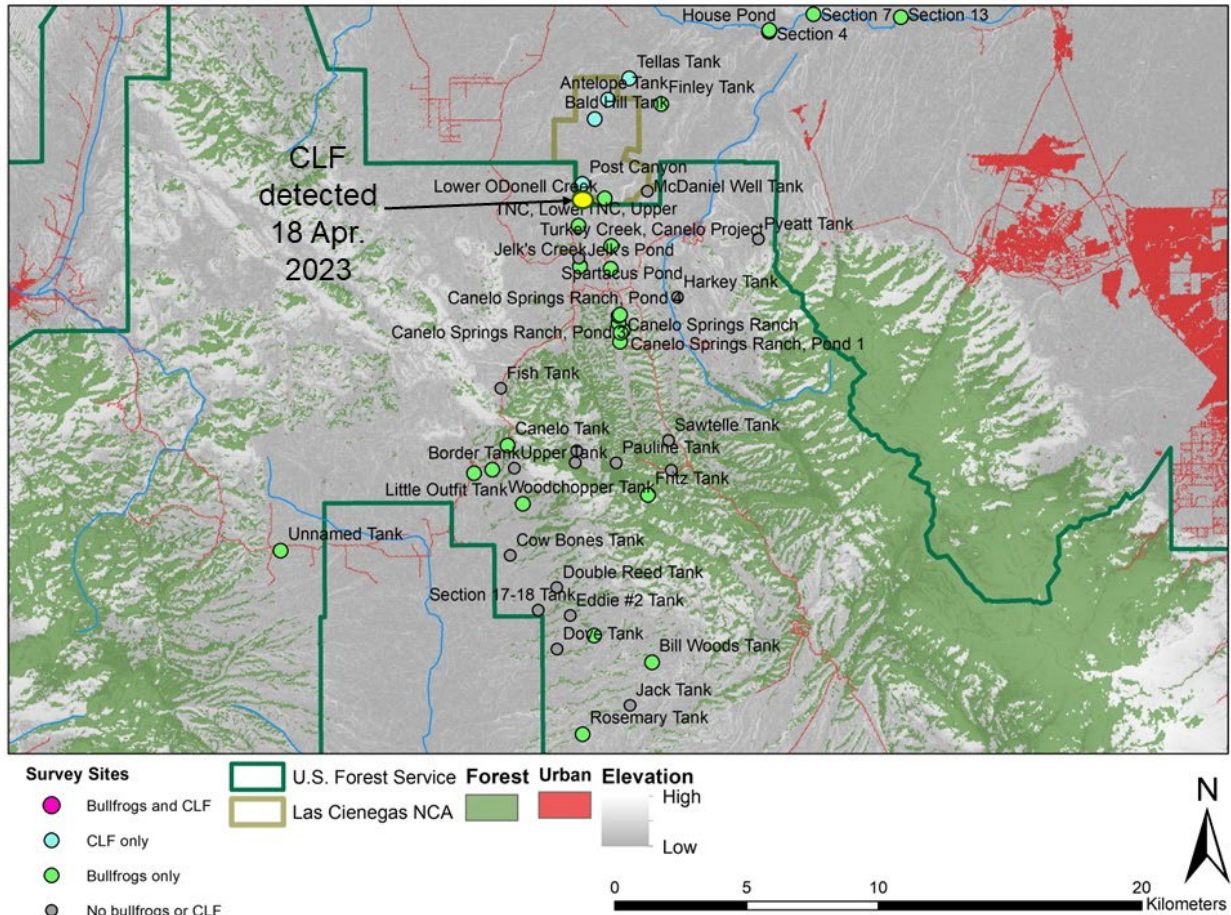
sites within the Canelo Hills Buffer Zone indicating that our 2023 removal efforts succeeded in halting bullfrog reproduction. However, there may still be bullfrog larvae within Woodchopper Tank as we cannot confirm that all larvae were removed during 2023. No Chiricahua leopard frogs were detected at these sites during our survey period.

We conducted an additional six surveys at six sites along the northeastern slopes of the San Rafael Valley. These surveys were part of site reconnaissance efforts for potential study sites for a bullfrog dispersal research study being initiated by a University of Arizona graduate student in May 2024. All six of these surveys were conducted during October 2023 and we detected bullfrogs at three sites (Bill Woods Tank, Leslie Tank, and Rosemary Tank). Because these sites may form part of this graduate student research project no bullfrogs were removed.

We conducted nine surveys across six sites at APWRR. We detected and removed only a single adult bullfrog from Finley Tank during September 2023 and no evidence of bullfrog reproduction was detected on the Appleton-Whittell Research Ranch in 2023 or 2024. We detected Chiricahua leopard frogs at four sites (Antelope Tank, Bald Hill Tank, Post Canyon, and Tellas Tank) during 2023 with reproduction confirmed at Post Canyon and Bald Hill Tanks during 2023.

**Figure 3. Map of survey sites within the Babacomari Ranch, Appleton-Whittell, Canelo Hills Buffer Zone, and San Rafael Valley survey areas (6 July 2023 through 16 April 2024).**

Symbols show locations of sites where bullfrogs and/or Chiricahua leopard frogs (CLF) were detected. The yellow oval shows the location of a single adult CLF observed on O'Donnell Creek on 18 April 2023.



### ***Las Cienegas National Conservation Area/Elgin Buffer Zone***

We surveyed 18 sites on the LCNCA, 10 sites in the Elgin Buffer Zone, and six sites in the Clyne/Sands Area for a total of 90 surveys. We only detected an adult bullfrog at a single site (Jack Daniels Dam, Elgin Buffer Zone) where it was removed on 16 August 2023 (Figure 4). We detected CLF at 17 sites, 14 sites on the LCNCA and three in Clyne/Sands. During July-December 2023, we did not observe evidence of CLF reproduction at any of our sites although earlier surveys in 2023 indicated CLF reproduced at nine sites (Table 1, Bauder and Prewitt 2023). Additionally, CLF reproduction at a tenth site, Hospital Tank (Figure 2, Bauder and Prewitt 2023a) was confirmed during spring of 2023. As of 25 April 2025, CLF were detected in

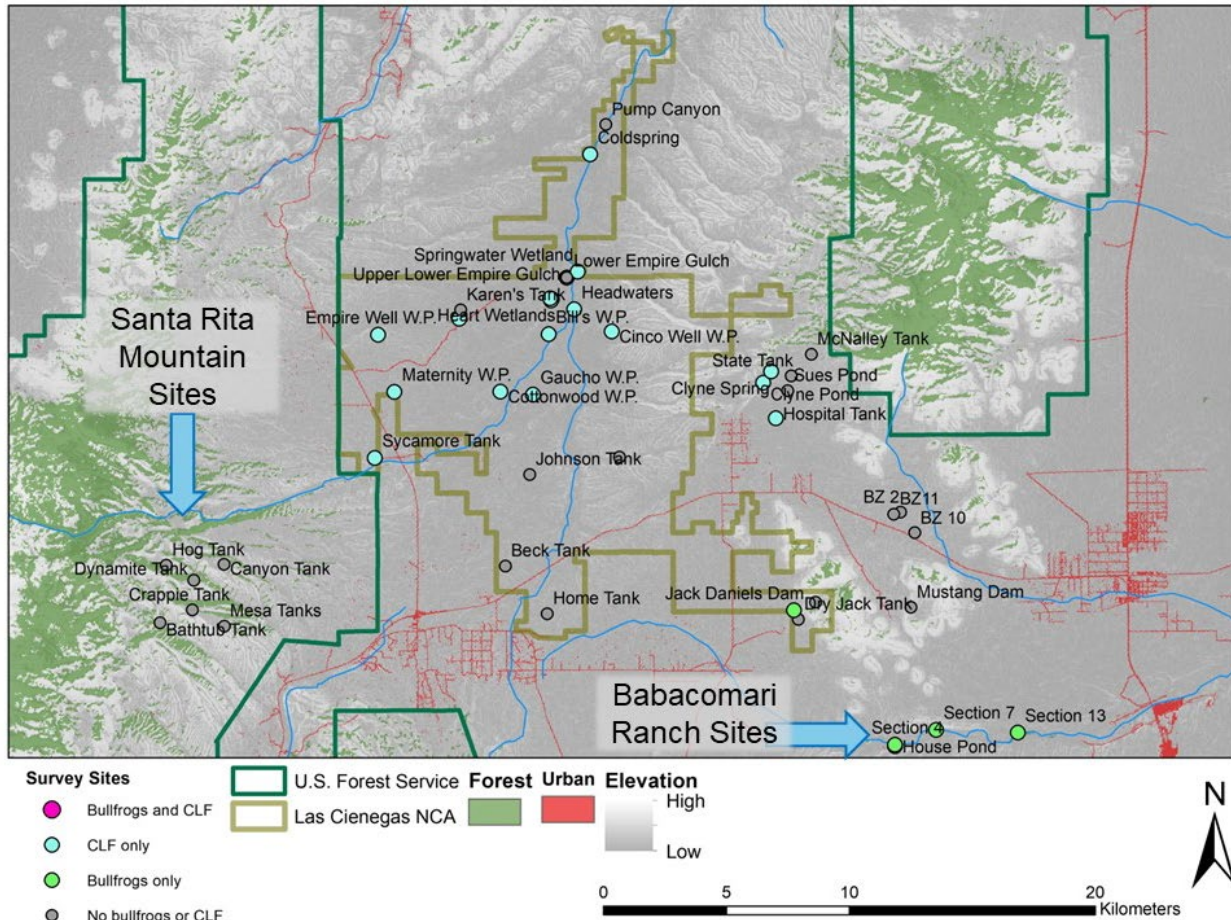


six sites on the LCNCA with reproduction (i.e., presence of tadpoles) confirmed at three sites (Cottonwood Wildlife Pond, Gaucho Wildlife Pond, and Maternity Wildlife Pond). All six of these sites had CLF during 2023. Of the three sites in 2024 with CLF present but with no evidence of reproduction, two were lotic (Headwaters and Lower Empire Gulch) and the third (Springwater Wetland) was lentic. One moribund CLF and one dead leopard frog of unknown species were observed during our 28 March 2024 survey at Lower Empire Gulch. We observed lowland leopard frogs (only adults) at Lower Empire Gulch on 28 March 2024.

During our study, we only conducted one CLF translocation across these sites and that was a single translocation of 71 juvenile CLF from Hospital Tank into Cinco Well Wildlife Pond on 5 July 2023. While we observed CLF at Cinco Well Wildlife Pond through 12 October 2023, we did not observe any CLF during two surveys on 20 March 2024.

**Figure 4. Map of survey sites within the Las Cienegas National Conservation Area, Elgin Buffer Zone, Santa Rita Mountains, and Babacomari Ranch survey areas (6 July 2023 through 16 April 2024).**

Symbols show locations of sites where bullfrogs and/or Chiricahua leopard frogs (CLF) were detected.



***Santa Rita Mountains***

On 23 August 2023 we surveyed seven sites on the southeast side of the Santa Rita Mountains (Figure 4). We detected Ranid frogs at a single site, Sycamore Tank, where we also observed three adult CLF. No evidence of Chiricahua leopard frog reproduction was observed at these sites.

***Babacomari River***

During March 2024 we began our new bullfrog eradication efforts along the Babacomari River in the Babacomari Ranch (Figure 4). We divided the Babacomari River into 17 survey

stretches which we define as sites for the purposes of reporting and summarizing eradication efforts. One manmade pond (the House Pond) is included within these 17 stretches. Eight new full-time technicians were hired as part of this project in mid-April. As of 25 April 2024, we conducted a total of 16 surveys across 10 of 17 stretches. During these surveys we have removed 194 adults, 59 juveniles, and one larval bullfrog. We have also observed a total of 132 larval bullfrogs. We are currently clearing vegetation within and along the edge of the river to remove bullfrog cover and make it easier to remove bullfrogs. Additionally, we are collecting bullfrog carcasses for a University of Arizona graduate student research project studying bullfrog reproductive ecology and diet. As of 6 May 2024, 78 bullfrogs have been dissected and data on body size, reproductive condition, and diet recorded.

## **Discussion**

Our monitoring and eradication of bullfrogs illustrates the success of our ongoing landscape level success in the recovery of Chiricahua leopard frogs in our survey areas. We found no evidence of bullfrog reproduction during our survey period with the exception of sites on private property where we do not have landowner permission to remove bullfrogs. Furthermore, the numbers of bullfrogs removed during this survey period were generally less than previous years. While these reduced numbers of bullfrogs are likely due in part to a dry 2023 monsoon season which limited bullfrog dispersal it also reflects the success of our previous eradication efforts at preventing bullfrog reproduction and limiting dispersal. Future strong monsoon seasons could result in greater numbers of bullfrogs detected, particularly given the nearby presence of confirmed bullfrog source populations. For example, a pond on Oro Blanco Ranch, within our Cobre Ridge Buffer Zone, was likely the source of bullfrogs detected at Cemetery Tank during both 2022 and 2023 (Bauder and Prewitt 2023*b*). In 2018, we observed a massive bullfrog dispersal into Cemetery Tank which resulted in approximately 26 egg masses and upwards of 177,000 eggs removed. The detection of only two bullfrogs in Cemetery Tank during 2023 highlights the success of our bullfrog removal and monitoring efforts. The potential for human-caused introductions of bullfrogs (e.g., the likely source of bullfrogs in Arivaca Tank during 2022 [Bauder and Prewitt 2023*b*]) also illustrates the importance of continual Buffer Zone monitoring since these human-caused introductions can occur independent of monsoon season rains.

Our increased number of Chiricahua leopard frog sites and the high abundance and reproductive output at these sites is encouraging for Chiricahua leopard frog recovery in this area. While the number of sites on the LCNCA where we confirmed Chiricahua leopard frog recovery was lower than in 2021 and 2022 this may in part reflect the dry 2023 monsoon season. We note that Chiricahua leopard frog translocations to Cinco Wildlife Pond on the LCNCA during 2022 have not yet resulted in confirmed reproduction (Bauder and Prewitt 2023a). We documented successful Chiricahua leopard frog reproduction at multiple sites following translocations in the Cobre Ridge/RU1 survey areas during 2022 (Bauder and Prewitt 2023b) highlighting the value of Chiricahua leopard frog translocations in aiding Chiricahua leopard frog recovery. Notable successes include the high reproductive output at Jarillas Tank and Mojanera Tank, both of which now provide source populations from within the Cobre Ridge area for future translocations. Several sites were dry during all or most of 2023 including known Chiricahua leopard frog sites which likely reflected the dry 2023 monsoon season. Additionally, we suspect that the lower than expected numbers of Chiricahua leopard frog juveniles observed at Bill's Wildlife Pond on the NCA during late 2023 may be due to declining water levels at that site (Bauder and Prewitt 2023a). Monitoring and maintaining adequate water levels at Chiricahua leopard frog sites will likely prove crucial to continued recovery efforts.

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View of Cobre Ridge study area (*photo: Raul Vega, University of Arizona*)

### **Literature Cited**

Bauder, J.M. and C.L. Prewitt. 2023*a*. Annual report: status of Chiricahua leopard frog populations on the Las Cienegas National Conservation Area, 2023. Unpublished report to the Bureau of Land Management.

- Bauder, J.M. and C.L. Prewitt. 2023b. Annual report for bullfrog control efforts in the Cobre Ridge Area, Nogales Ranger District, during 2023. Unpublished report to the U.S. Forest Service.
- Bury, R.B. and J.A. Whelan. 1984. Ecology and management of the bullfrog. United States Department of the Interior, Fish and Wildlife Service/Resource Publication. 155:1-23.
- Garner, T.W.J., M.W. Perkins, P. Govindarajulu, D. Seglie, S. Walker, A.A. Cunningham, and M.C. Fisher. 2006. The emerging amphibian pathogen, *Batrachochytrium dendrobatidis*, globally infects introduced populations of the North American bullfrog, *Rana catesbeiana*. *Biology Letters* 2:455–459.
- Gervasi, S.S., J. Urbina, J. Hua, T. Chestnut, R. A. Relyea, and A. R. Blaustein. 2013. Experimental Evidence for American Bullfrog (*Lithobates catesbeianus*) Susceptibility to Chytrid Fungus (*Batrachochytrium dendrobatidis*). *EcoHealth* 10:166–171.
- Hall, D.H. 2019. Local population dynamics of the Chiricahua leopard frog (*Rana chiricahuensis*) a federally listed frog within the Las Cienegas National Conservation Area in Arizona. Unpublished report. Available at [https://lccnetwork.org/sites/default/files/Resources/Frog%20Conservation\\_Ranid%20Recovery%20final%20report%20%28FINAL%29.pdf](https://lccnetwork.org/sites/default/files/Resources/Frog%20Conservation_Ranid%20Recovery%20final%20report%20%28FINAL%29.pdf).
- Hall, D.H. 2021. Bullfrog control within the Sentinel Landscape Project: Canelo Hills, Sierra Vista Ranger District, July 2020-November 2021. Final Report to the U.S. Forest Service.
- Hossack, B.R., E.B. Oja, A.K. Owens, D. Hall, C. Cobos, C.L. Crawford, C.S. Goldberg, S. Hedwall, P.E. Howell, J.A. Lemos-Espinal, S.K. MacVean, M. McCaffery, C. Mosley, E. Muths, B.H. Sigafus, M.J. Sredl, and J.C. Rorabaugh. 2023. Empirical evidence for effects of invasive American Bullfrogs on occurrence of native amphibians and emerging pathogens. *Ecological Applications* 33:e2785.
- Jones, T.R. 2013. A survey/monitoring plan for bullfrogs and native ranid frogs in the Pena Blanca Lake region, Santa Cruz County, Arizona. Arizona Game and Fish Department.
- McAuliffe, J.R. 1978. Biological survey and management of sport-hunted bullfrog populations in Nebraska. Nebraska Game and Parks Commission. Lincoln, Nebraska.
- Prewitt, C.L. and J.M. Bauder. 2023. Annual report for bullfrog control efforts in the Canelo Hills, Sierra Vista Ranger District, during 2023. Unpublished report to the U.S. Forest Service

- Rosen, P.C. and C.R. Schwalbe. 1995. Bullfrogs: introduced predators in southwestern wetlands. Pp. 452-454 in E.T. LaRoe, G.S. Farris, C.E. Puckett, P. D. Doran, and M. J. Mac. (eds.), Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C.
- Rosen, P.C. and C.R. Schwalbe. 2001. Bullfrog impacts on native wetland herpetofauna in southern Arizona. Final report to Arizona Game and Fish Dept. Heritage Program (IIPAM I97041), and USFWS.
- Rosen, P.C. and C.R. Schwalbe. 2002. Widespread effects of introduced species on aquatic reptiles and amphibians in the Sonoran Desert region. Pp. 220-240 in B.A. Tellman (ed.), Exotic species in the Sonoran Desert, University of Arizona Press, Tucson.
- Rosen, P.C., N. Steklis, D.J. Caldwell, and D.H. Hall. 2013. Restoring leopard frogs and habitat in Sky Islands grasslands (Arizona). Final report to the National Fish and Wildlife Foundation, Project 2010-0023-000, Grant 18411.
- Suhre, D.O. 2010. Dispersal and demography of the American bullfrog (*Rana catesbeiana*) in a semi-arid grassland. Masters thesis, University of Arizona, Tucson.
- USFWS. 2007. Chiricahua leopard frog (*Rana chiricahuensis*) recovery plan. U.S. Fish & Wildlife Service, Southwest Region, Albuquerque, NM. 149 pp. + Appendices A-M.)
- Wright, A.H. and A.A. Wright. 1949. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Co., New York.

**Appendix 1. Details of Chiricahua Leopard Frog translocations conducted during our 2023 survey period**

Date	Recipient Site	Source Site	Number/Ages Translocated	Notes
6-September-2023	Coches Tank	Jarillas Tank	50 adults	
6-September-2023	Agua Cercada Tank	Jarillas Tank	50 adults	
6-September-2023	Alamito Tank	Jarillas Tank	50 adults	
19-September-2023	Little Tank	Mojanera Tank	45 adults and eight juveniles	Assisted Arizona Game and Fish Department
19-September-2023	Sierra Bonita Tank	Mojanera Tank	54 adults	Assisted Arizona Game and Fish Department