CONSERVATION AGREEMENT
AND
CONSERVATION ASSESSMENT AND STRATEGY FOR THE RELICT LEOPARD FROG (*RANA ONCA* [=*LITHOBATES ONCA*])

FINAL

Prepared by the Relict Leopard Frog Conservation Team

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ACKNOWLEDGMENTS

The Conservation Agreement and Conservation Assessment and Strategy for the Relict Leopard Frog (*Rana onca* [=*Lithobates onca*]) was prepared by the ad hoc Rewrite Committee of the Relict Leopard Frog Conservation Team. The Rewrite Committee members included: Michael Burroughs (USFWS), Ross Haley (NPS), Jef Jaeger (UNLV), Rebeca Riviera (UNLV), Brandon Senger (NDOW), Mike Sredl (AGFD), and Brian Wooldridge (USFWS).

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ACRONYMS

AGFD	Arizona Game and Fish Department
Bd	*Batrachochytrium dendrobatidis*
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CAS	Conservation Agreement, and Conservation Assessment and Strategy
ESA	Endangered Species Act of 1973 as amended
IPCC	Intergovernmental Panel on Climate Change
MSHCP	Clark County Multiple Species Habitat Conservation Plan
NDOW	Nevada Department of Wildlife
NEPA	National Environmental Policy Act
NPS	National Park Service
PECE	Policy for Evaluation of Conservation Efforts
PMZ	Priority Management Zone
NRA	National Recreation Area
SSA	Species Status Assessment
SUL	Snout-Urostyle Length
UDWR	Utah Division of Wildlife Resources
UNLV	University of Nevada, Las Vegas
USFWS	U.S. Fish and Wildlife Service

GLOSSARY OF SELECTED TERMS

Agreement: Refers to the Conservation Agreement portion of this document.

Augmentation: Refers to the intentional release of relict leopard frogs into an established population with the intent of increasing demographic or genetic viability of the population.

Conservation Team: Refers to the Relict Leopard Frog Conservation Team.

Historical Range: The geographic areas inhabited by relict leopard frogs at the time of modern exploration and settlement, as verified by field surveys, museum vouchers or documented in the published literature.

Metapopulation: Any assemblage of discrete local populations with possible migration (dispersal) among populations within the assemblage, regardless of the rate of individual population turnover.

Population: A group of individuals of the same species inhabiting a given geographic area at the same time and among which mature individuals interbreed or are likely to interbreed. Ecological interactions and genetic exchange are more likely among the individuals within a population than with individuals in other populations.

Priority Management Zone (PMZ): A discrete geographical area in which the conservation goal and objectives are established for the relict leopard frog, and that represents a reasonable approximation of the historical range of the species. Within this zone, appropriate conservation strategies are implemented and their effects monitored. The PMZ supersedes the previous Potential Management Zone, and reflects better knowledge on some of the factors used to determine the zone. These factors include: (1) hydrological units (HUC 10 digits) in which locations of the relict leopard frog have been documented from museum records, literature references, and field surveys; (2) an elevational limit of 1430 m where these frogs are known to persist; and (3) the exclusion of areas in the Western Grand Canyon east of the Grand Wash Cliffs where a related frog species is known to occur.

Site: A geographic location representing a distinct area of habitat occupied by relict leopard frogs (populations occupy sites) or being considered for potential translocation.

Snout-urostyle length: The direct line distance from the tip of the snout to the urostyle, the terminal bone of the spinal column of metamorphosed frogs.

Strategy: Refers to the Conservation Assessment and Strategy portion of this document.

Translocation: Refers to the intentional release of relict leopard frogs in an attempt to establish a new population. An initial attempt to establish a population requires translocations over a five-year period.

Viable Population: A population of relict leopard frogs demonstrating reproduction and successful recruitment, with the presumed ability to survive into the foreseeable future.

EXECUTIVE SUMMARY

This Conservation Agreement and Conservation Assessment and Strategy for the Relict Leopard Frog (*Rana onca* [=*Lithobates* onca]) is a collaborative effort by the voluntary Relict Leopard Frog Conservation Team (Conservation Team) to manage and conserve this species. The document consists of two parts: the Conservation Agreement (Agreement) identifies parties that intend to cooperatively organize and implement the conservation strategy for the relict leopard frog; and, the Conservation Assessment and Strategy (Strategy) provides a summary of species biology, threats, conservation needs, and outlines a conservation program.

The relict leopard frog experienced a dramatic decline in overall range and population size during the 20th century, and by 2001, populations were restricted to two areas in southern Nevada within Lake Mead National Recreation Area (NRA). In May 2002, following a phylogenetic study that confirmed the systematics and taxonomy of the relict leopard frog, the U.S. Fish and Wildlife Service (USFWS) was petitioned by two conservation organizations to list the species under the Endangered Species Act (ESA). The decision by the USFWS in June 2002 was that while the species warranted listing it was precluded because of higher priorities. Prior to that time in March 2001, the Conservation Team had already begun managing the species and developing the initial Conservation Agreement and Rangewide Conservation Assessment and Strategy (CAS), which was signed by numerous Federal and State agencies in 2005.

Conservation efforts under the 2005 CAS have successfully increased the number of sites occupied by the relict leopard frog on federal lands, including areas outside of Lake Mead NRA in Clark County, Nevada and Mohave County, Arizona. Systematic monitoring of the species also indicated an increase in regional abundance. This success, however, has not eliminated all threats to the species, and predominant among these are the continued limited regional population size and lack of connectivity among many populations.

Currently, the USFWS is reevaluating the status of the relict leopard frog for actions under the ESA, and their evaluation will be partly based on a Species Status Assessment (SSA) developed by the agency in 2016. The SSA is intended to identify and evaluate current threats that would affect the status and distribution of the species into the future. The development of the current Agreement and Strategy incorporates components of the SSA, and acknowledges the importance of continuing conservation efforts for the species. The development of these documents also demonstrates the continued dedication of the Conservation Team to the persistence and expansion of the relict leopard frog.

The current Agreement and Strategy focuses on continuing implementation of conservation and management actions for the relict leopard frog over 10-years through a cooperative multiagency approach. The conservation goal and objectives stipulated in these documents aim to specifically conserve, manage, and expand populations of relict

leopard frogs within a diversity of habitats and localities that reflect areas of the known historical range. The specified conservation objectives tier to specific conservation actions and commitments from partnering Federal and State agencies and other entities. Actions to update or modify the Strategy will ensue under an adaptive management framework that ensures scientific rigor and efficacy of conservation efforts to avoid future potential listing of the species under the ESA.

CONSERVATION AGREEMENT FOR THE RELICT LEOPARD FROG (*RANA ONCA* [=*LITHOBATES ONCA*])

INTRODUCTION AND PURPOSE

This Conservation Agreement (Agreement) and accompanying Conservation Assessment and Strategy (Strategy) has been developed to expedite implementation of conservation actions for the relict leopard frog (*Rana onca* [=*Lithobates onca*]) for 10 years and supersedes the Conservation Agreement and Rangewide Conservation Assessment and Strategy (CAS) signed in 2005 (Relict Leopard Frog Conservation Team [Conservation Team] 2005). These documents have been cooperatively developed among Federal and State agencies and local governmental organizations with the intent to effectively conserve this species throughout its range. Agencies and other entities electing to participate in this voluntary Agreement will be referred to as "Parties" to the Agreement and will be viewed as members of the Conservation Team.

The purpose of this Agreement and the associated Strategy is to collectively identify practical conservation objectives and strategies that will facilitate the implementation of proactive actions across the range of the species. With this Agreement, the Parties identified in the Conservation Goal and Objectives (see below) will organize and implement a cooperative, range-wide approach to relict leopard frog management and conservation.

This Agreement will further allow the Parties to work towards a comprehensive conservation framework that can be extended to potential non-Federal landowner partners, exemplifying cooperative conservation.

The terms of this Agreement shall be governed by and construed in accordance with applicable Federal and State laws. Nothing in this Agreement is intended to limit the authority of the U.S. Fish and Wildlife Service (USFWS), Bureau of Land Management (BLM), National Park Service (NPS) or other Federal agencies to fulfill their responsibilities under Federal laws. Additionally, nothing in this Agreement is intended to supersede or limit applicable State agency authorities and State laws. All actions undertaken pursuant to this Agreement are intended to be in compliance with all applicable State and Federal laws and regulations. The Parties agree to implement conservation actions set forth in this Agreement through the duration of the Agreement, consistent with available resources.

CONSERVATION GOAL AND OBJECTIVES

Conservation Goal

The conservation goal of this Agreement and Strategy is to coordinate conservation actions among the Parties that create and maintain populations and metapopulations (Table 1) of relict leopard frogs in a diversity of habitats and localities for the duration of this Agreement. The status of the relict leopard frog will be evaluated annually by the Conservation Team through an adaptive management framework to assess program progress.

Conservation Objectives

The conservation goal outlined above will be met through implementation of the following conservation objectives. Included with each conservation objective is an explanation of how the objective will benefit the relict leopard frog and the desired outcome for key factors positively affecting populations of relict leopard frogs. These conservation objectives tier to specific conservation strategies, actions, and commitments that are outlined in the Strategy (Implementation Schedule, Table 3).

Objective 1. Identify, remove, or substantially minimize threats to relict leopard frog populations.

> *Benefit*: Ensure persistence of relict leopard frog populations and habitat within the Priority Management Zone (PMZ) for the duration of the Agreement.
>
> *Desired Outcome*: Adequate habitat is maintained at all extant relict leopard frog sites. Detrimental nonnative species are eliminated or reduced, and steps are taken to minimize the likelihood of future introductions or immigration of these species. Novel diseases are not introduced to occupied aquatic systems. Vegetation is managed to maintain favorable habitat. State and Federal regulations pertaining to the relict leopard frog are enforced and the public made aware of the regulations.

Objective 2. Enhance or create relict leopard frog habitat.

> *Benefit*: Enable relict leopard frog populations to use the full potential of existing occupied habitats and expand into currently unoccupied or potential habitat.
>
> *Desired Outcome*: Reduce risk of extinction through enhancement and creation of habitat that allow increases in number of occupied sites and sizes of populations.

Objective 3. Establish additional populations and augment existing populations of relict leopard frogs as necessary.

Benefit: More and larger populations reduces the risk of extinction. If individual populations are extirpated, other extant populations can serve as donor populations to re-establish extirpated sites or establish new ones. Reintroducing relict leopard frogs to river systems historically occupied by the species would provide potentially extensive contiguous habitat and opportunity for the species to substantially expand its current range, distribution, and abundance.

Desired Outcome: Successful populations persist for the duration of the Agreement. Existing sites are managed or new sites are established to ensure no net loss of number of sites, populations, or number of frogs. Relict leopard frogs occupy a diversity of sites within the historical range (PMZ). Additionally, a minimum of one refugium population is maintained in suitable habitat outside the PMZ for the duration of the agreement.

Objective 4. Maintain an adaptive monitoring program to assess the status of relict leopard frog populations and report progress on meeting the goals and objectives of this Agreement.

Benefit: Monitoring informs the Strategy through assessments of population trends and threats, information that is incorporated through adaptive management.

Desired Outcome: Evidence that the long-term range-wide population trend remains stable or increases, with documented reproduction and recruitment of juveniles at a majority of sites. Existing, new, or enhanced habitats are monitored to determine success in achieving self-sustaining populations, and maintaining relict leopard frogs in a variety of habitats.

Objective 5. Investigate the conservation biology of the relict leopard frog, and use the results of such investigations to better meet the overall conservation goal and objectives.

Benefit: Biological and ecological data from research is essential for evaluation and documentation of trends, determining appropriate conservation actions, and refining conservation strategies.

Desired Outcome: Results of research activities identified by the Conservation Team and implemented by investigators are incorporated into the Strategy through the adaptive management.

Objective 6. Increase public awareness and appreciation for relict leopard frogs and their habitat by making information available to interested parties and decision makers.

Benefit: Increased public awareness and appreciation may increase conservation of the relict leopard frog and its habitat on public and private lands. Enabling

interested parties and decision makers to have access to information will benefit the coordination of research and conservation efforts.

Desired Outcome: Parties share information on the relict leopard frog as identified in the Strategy. Information is shared with other interested parties and the general public. A centralized data repository is maintained for the life of the program. Management and conservation of relict leopard frogs coordinated with actions for other wildlife species.

CONSERVATION PARTNERS

Signatory Parties:

Arizona Game and Fish Department (AGFD)

Bureau of Land Management (BLM)
- Arizona State Office
- Nevada State Office
- Utah State Office

National Park Service (NPS)
- Pacific West Region

Nevada Department of Wildlife (NDOW)

U.S. Fish and Wildlife Service
- Region 2
- Region 6
- Region 8

Utah Division of Wildlife Resources (UDWR)

Non-signatory Partners:

Bureau of Reclamation (BOR)

Clark County

Southern Nevada Water Authority (SNWA)

University of Nevada, Las Vegas (UNLV)

AUTHORITIES

This Agreement is subject to and is intended to be consistent with all applicable Federal and State laws. Section 6 of the Endangered Species Act (ESA) provides authorization and encouragement to the states and other interested parties, through Federal financial assistance and a system of incentives, to develop and maintain conservation programs that meet national and international standards. This is key to meeting the United States' international commitments and to better safeguard, for the benefit of all citizens, the nation's heritage in wildlife and plants.

The authorities for the signatory Parties to enter into this voluntary Conservation Agreement derive from the following legislation:

Arizona Game and Fish Department
- Arizona Revised Statute 17-231.B-7

Bureau of Land Management
- Federal Land Policy Management Act of 1976, 43 U.S.C. 1701 et seq.

National Park Service
- National Park Service Organic Act of 1916, as amended
- Endangered Species Act of 1973, as amended
- National Parks Omnibus Management Act of 1998

Nevada Department of Wildlife
- Nevada Revised Statutes 503.351 and 503.584

U.S. Fish and Wildlife Service
- Endangered Species Act of 1973, as amended
- Fish and Wildlife Act of 1956, as amended
- Fish and Wildlife Coordination Act, as amended

Utah Division of Wildlife Resources
- Utah Code Title 23 Chapter 22.1

Additional authorities, directives, and plans exist for each involved party as outlined below.

Arizona Game and Fish Department

An important component to the mission of the AGFD, as detailed in its Strategic Plan (AGFD 2012a) Nongame and Endangered Wildlife Program narrative, is to manage rare species to maintain biological diversity and to maintain and restore native species diversity, population numbers and habitats. Additional documents such as Arizona's State

Wildlife Action Plan (AGFD 2012b) further support these conservation objectives. The activities described in this Agreement and Strategy are consistent with the objectives outlined in those documents. Arizona Game and Fish Commission Order 41 provides protection to certain native amphibians, including the relict leopard frog.

Bureau of Land Management

The BLM is a Federal land management agency responsible for the management of public lands in accordance with the Federal Land Policy and Management Act of 1976. The mission of BLM is to sustain the health, diversity and productivity of the public lands for the use and enjoyment of present and future generations. Sensitive species are designated by each BLM State Director. The BLM manages these sensitive species and their habitats to minimize or eliminate threats affecting the status of the species or to improve the conditions of the species habitat (BLM Manual section 6840.06. 2 C.).

National Park Service

The NPS was established by an act of Congress passed in 1916 generally referred to as "The Organic Act" (16 U.S. Code I). This law states that it is the mission of the NPS to "conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations" in the areas under their jurisdiction.

NPS Management Policies 4.1.4 encourages parks to pursue opportunities to improve natural resource management within parks and across administrative boundaries by cooperating with public agencies and interested parties. The NPS recognizes that cooperation with other resource and land managers can accomplish ecosystem stability and other resource management objectives, when the best efforts of a single manager might fail. Therefore, parks will develop agreements with Federal, State, Tribal, and local governments and organizations, and private landowners, when appropriate, to coordinate plant, animal, water and other natural resource management activities in ways that maintain and protect, not compromise, park resources and values. Such cooperation may involve coordinating management activities in two or more separate areas, integrating management practices to reduce conflicts, coordinating research, sharing data and expertise, exchanging native biological resources for species management or ecosystem restoration purposes, establishing native wildlife corridors, and providing essential habitats adjacent to, or across, park boundaries (NPS 2001 Management Policies, 4.1.4).

Nevada Department of Wildlife

A key mission component of NDOW is to protect, preserve, manage and restore wildlife and its habitat. The Nevada Wildlife Action Plan serves as a comprehensive, landscape level guidance plan, which identifies species of greatest conservation need and the key

habitats on which they depend, with the intent to prevent wildlife species from becoming threatened or endangered. NDOW and the USFWS developed the Programmatic Candidate Conservation Agreement with Assurances for the relict leopard frog in Clark County, Nevada to facilitate conservation and provide a voluntary mechanism for landowners to implement elements of this Agreement and Strategy on non-Federal lands. Nevada Revised Statute 503.584 recognizes the state's obligation to conserve and protect imperiled, native species. Nevada Administrative Code 503.075 extends protected wildlife statutes to certain native amphibians, including the relict leopard frog.

U.S. Fish and Wildlife Service

Sections 2, 7, and 10 of the ESA, as amended, allow the USFWS to enter into this Agreement. Section 2 of the ESA states that encouraging interested parties, through Federal financial assistance and a system of incentives, to develop and maintain conservation programs is a key to safeguarding the Nation's heritage in fish, wildlife, and plants. Section 7(a)(1) of the ESA requires the USFWS to review programs that it administers and to utilize such programs in furtherance of the purposes of the ESA. By entering into this Agreement, the USFWS is using its Candidate Conservation Programs to further the conservation of the Nation's fish, wildlife, and plants pursuant to section 10 of the ESA.

Utah Division of Wildlife Resources

State and Federal agencies have implemented cooperative agreements for a variety of fish and wildlife programs on Federal Lands, and state law, as applicable, under Title 23 Chapter 22.1 of the Utah Code stating that the "Utah Division of Wildlife Resources may enter into cooperative agreements and programs with other state agencies, federal agencies, states, educational institutions, municipalities, counties, corporations, organized clubs, landowners, associations, and individuals for purposes of wildlife conservation."

Regional Conservation Programs that Benefit the Relict Leopard Frog

Clark County Multiple Species Habitat Conservation Plan

The Clark County Multiple Species Habitat Conservation Plan (MSHCP) provides for conservation of 78 plant and animal species, including the relict leopard frog, and their habitats throughout Clark County. The permit issued by USFWS under the authority of Section 10(a)(1)(B) of the ESA to Clark County authorizes take of listed species on no more than 145,000 acres of non-Federal land over a 30-year period. Disturbance fees collected from developers fund conservation actions for the covered species on Federally- and non-Federally-managed land to offset impacts from development on non-Federal land in Clark County. Conservation actions are described in the MSHCP and may include public information and education, research, inventory and monitoring, protective measures, and habitat restoration and enhancement. Specifically, the permit requires

Clark County to participate with the Federal land management agencies in the development of conservation management plans for certain areas or covered species, including desert riparian habitats, such as the Muddy and Virgin rivers and Meadow Valley Wash, and low elevation springs, which contain habitat for covered birds, amphibians, snails, and bats. Clark County has fulfilled this permit condition in part by providing financial and staff support to the Conservation Team for the development and implementation of the CAS.

Virgin Spinedace Conservation Agreement and Strategy

The Virgin Spinedace Conservation Agreement and Strategy (Lentsch et al. 1995) provides procedures for controlling, stocking, introduction, and spread of nonnative aquatic species specifically in the Virgin River basin. Stocking of salmonids is restricted to areas where salmonid populations already exist or areas where they will not conflict with native species of special concern. Stocking of other nonnative species, including channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), and bluegill sunfish (*Lepomis macrochirus*), is prohibited without a certificate of registration. Certificates of registration are issued only for stocking of standing water impoundments, including reservoirs and isolated ponds. Stocking of these nonnative species is not permitted where conflicts with native species of special concern could occur.

Recovery Plan for the Rare Aquatic Species of the Muddy River Ecosystem

The recovery plan for the Muddy River ecosystem was written after the ESA listing of the Moapa dace and covers seven other sensitive species in 9.5 km of stream habitat in five thermal headwater spring systems and the main stem of the upper Muddy River (USFWS 1996). This plan does not specifically address the relict leopard frog, but conservation measures aimed at the covered species (e.g., removal of nonnative fish) should benefit relict leopard frogs.

CONSERVATION ACTIONS AND RESPONSIBILITIES OF INVOLVED PARTIES

To meet the goals of this Agreement, the Parties agree to undertake specific conservation actions, as described in the accompanying Strategy. Leads and co-leads responsible for specific conservation actions (Table 3) will be identified on a voluntary basis by the Conservation Team through the annual work planning process. Where responsibility for undertaking specific actions has not yet been assigned or have failed to be implemented, the Parties agree to take appropriate steps to implement or modify actions by changing the Strategy as necessary. Nothing in the Agreement shall be construed as obligating any Party hereto in the expenditure of funds, or for the future payment of money, greater than appropriations authorized by law.

ADMINISTRATION OF AGREEMENT AND ACCOMPANYING STRATEGY

The coordination and implementation of conservation actions and review of progress will be conducted by the Conservation Team. This Agreement and accompanying Strategy will be implemented as follows:

Coordinating Conservation Actions

- The Conservation Team will consist of a designated representative from the Parties to the Agreement and representatives from the conservation partners.

- Implementation and oversight of the Agreement will be the responsibility of the Conservation Team.

- Meeting minutes and reports will be distributed to all Conservation Team members and technical advisors. The duties for taking and developing meeting minutes and developing progress reports will be rotated among team members or on a volunteer basis by any team member.

- The Conservation Team will meet at least twice annually to review progress in implementing conservation actions, develop work plans, implement adaptive management, and review resources.

- The Conservation Team will provide annual and five-year reports on conservation status and accomplishments under the Agreement. The duties for developing annual and five-year progress reports will be rotated among team members or on a volunteer basis by any team member.

- The Conservation Team will revise the Strategy as needed and upon agreement of all Parties.

Implementing Conservation Actions

- A total of 10 years is anticipated for completion of all actions identified in the Strategy. The timeline for completion of specific actions is identified in Table 3 in the Strategy. Where no time for completion is stated, the timing of such actions will be determined by the Conservation Team. The timing of certain actions may not be determinable at this time or may be dependent on the completion of other identified actions.

- The Conservation Team will coordinate and monitor progress in achieving conservation objectives identified in the Agreement.

Funding Conservation Actions

- This Agreement does not obligate funds from any of the Parties. Subject to the availability of funds, Parties agree to fund their own expenses associated with this Agreement, subject to budget authorization and approval by the appropriate agency or government appropriation. Nothing contained in this Agreement shall be construed as obligating any Federal agency to any expenditure or obligation of funds in excess or advance of appropriations, in accordance with the Anti-Deficiency Act, 31 U.S.C. § 1341.

- Funding opportunities will be pursued independently or in collaboration with other Parties or partners under separate funding agreements.

- An annual progress report and assessment will be completed by the Conservation Team using the adaptive management framework and provided to signatories to the Agreement. The assessment will consider the effectiveness of conservation activities in achieving desired outcomes and the conservation goal and objectives of the Agreement and whether modifications to the Strategy are needed.

ADMINISTRATIVE PROVISIONS

Effective Date and Duration

This Agreement is made and entered into as of the last date of signature by and between the Parties.

The duration of the Agreement is for 10 years following the last date of signatures by the Parties. The Parties will review the Strategy and its effectiveness at least annually to determine whether it should be revised. During the last year in which it is valid, the Agreement must be reviewed and either modified, renewed, or terminated. If some portion of the Agreement cannot be carried out, or if cancellation is desired, the party requesting such action must notify in writing the other Parties within 60 days of the changed circumstances.

Termination or Modification

A Party may terminate this Agreement by delivering to the other Parties a written notice of intent to terminate at least ninety (90) days prior to the proposed termination date. Termination of this Agreement shall not affect the effectiveness of the Agreement amongst the non-terminating Parties.

This Agreement may be amended with the written agreement of all Parties.

Applicability of State and Federal Law

Notwithstanding any other provision in this Agreement, nothing in this Agreement is intended to be nor shall it be interpreted to be inconsistent with any applicable Federal or State law or regulation.

The Federal agencies will comply with the Federal Advisory Committee Act to the extent it applies.

EFFECT OF THE AGREEMENT IN EVENT OF SPECIES LISTING DECISION

It is the intent and expectation of the Parties that the execution and implementation of this Agreement will lead to the conservation of the relict leopard frog within the PMZ. If, subsequent to the effective date of this Agreement, the Secretary of the Interior should determine pursuant to section 4(a) of the ESA (16 USC §1533(a)), that Federal listing of the relict leopard frog is warranted, the Parties may participate in recovery planning for the species. It is also the expectation of the Parties that the conservation and management commitments made in this document and conservation accomplishments will be considered by the USFWS in their listing determination in the event the relict leopard frog is proposed for listing under the ESA.

NATIONAL ENVIRONMENTAL POLICY ACT AND OTHER REGULATORY REQUIREMENTS

This Agreement and Strategy is being developed for planning purposes and will require no new regulatory mechanisms (e.g., laws, regulations, ordinances). Before any Federal actions can occur on public lands, a determination must be made whether or not an analysis under the National Environmental Policy Act (NEPA) is required by the Federal agency authorizing funding or carrying out those conservation actions. Certain actions by States are not subject to NEPA analysis, with some exceptions where Federal funding is utilized.

All Parties will coordinate efforts to ensure implementation of introductions, translocations and augmentations meet all State and Federal regulatory and permitting requirements and are processed and implemented in a timely manner.

The Parties will comply with the provisions of Executive Order 11246 on non-discrimination and will not discriminate against any person because of race, color, religion, gender, or national origin.

No member of, or delegate to, Congress or resident Commissioner, shall be admitted to any share or part of the Agreement, or to any benefit that may arise therefrom.

This document was designed to meet the requirements of a conservation agreement as specified in the USFWS Policy for Evaluation of Conservation Efforts (PECE) (68 Federal Register 15100, 3/28/2003). These criteria are designed to ensure the certainty that the conservation efforts will be implemented, and that when implemented the conservation efforts will be effective. To ensure PECE compliance, USFWS staff: (1) reviewed the 2005 CAS for compliance with PECE, and (2) contributed extensively during the development of the initial document by serving on the Conservation Team.

SIGNATURES

In Witness Whereof, the Parties have caused this Conservation Agreement for the relict leopard frog to be executed as of the date of the last signature below.

Approved:

Arizona Game and Fish Department
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CONSERVATION ASSESSMENT AND STRATEGY FOR THE RELICT LEOPARD FROG (*RANA ONCA* [=*LITHOBATES ONCA*])

INTRODUCTION

The relict leopard frog was once thought to be extinct (e.g., Platz 1984), an assessment that proved to be incorrect (Jaeger et al. 2001). In the 1990s, populations were only known from a few sites in three relatively small areas (Jaeger et al. 2001). By 2001, populations had disappeared from one of the areas, leaving populations in only two areas of southern Nevada, the Northshore of Lake Mead along the former Virgin River drainage and in Black Canyon along the Colorado River below Lake Mead (Bradford et al. 2004). The dramatic reductions in range and regional population size compared to historical records raised concerns about the continued persistence of this species. In 2002, the USFWS was petitioned by nongovernmental conservation organizations to list the relict leopard frog under the ESA. At that time, the USFWS decided that the listing was warranted, but precluded by other higher priorities (Conservation Team 2005).

The decision not to move immediately forward with listing was based, to a fair extent, on the presence of a voluntary Conservation Team that had been established in March 2001. The Conservation Team had already initiated development of a conservation and monitoring program for the relict leopard frog, and its first annual work plan was developed in 2002. The Conservation Team included voluntary representatives from State and Federal resource agencies, Federal land managers, universities, as well as local governmental organizations. By 2005, the Conservation Team had developed and implemented a formal CAS. The 2005 CAS expedited implementation of monitoring and conservation actions for the relict leopard frog in Clark County, Nevada and Mohave County, Arizona as a collaborative and cooperative effort among Federal, State, and local partners.

The 2005 Strategy was successful at increasing the number of sites occupied by the relict leopard frog over its 10-year period, including establishing several populations outside of NPS lands and in Arizona. This was accomplished through an aggressive headstarting and translocation program. Several of the populations established under that program are now the largest, and the majority of relict leopard frogs exist in populations initiated by translocations (see Current Range and Distribution below). Systematic monitoring of populations begun in 2004 has also documented a regional increase in the overall abundance of relict leopard frogs (see Recent Population Trends below).

The USFWS is currently reevaluating the status of the relict leopard frog for actions under the ESA. The evaluation will be partly based on a Species Status Assessment (SSA) conducted by the USFWS in 2016, which identified and evaluated stressors to the relict leopard frog; herein, these stressors are addressed as threats (see Threats and

Conservation Needs below). The current revised Strategy supersedes the 2005 Strategy, and continues monitoring and conservation actions for the relict leopard frog over a 10-year period. The intent and expectation of the Parties that execute and implement the current Agreement is that the actions conducted under the current Strategy will lead to continued conservation of relict leopard frog populations within a diversity of habitats and localities that reflect areas of the known historical range and original distribution (see Historical Distribution, and Current Range and Distribution below). The conservation objectives are intended to reduce or eliminate the potential for future species decline by removing or reducing threats, maintaining or expanding habitat conditions favorable to the species, expanding the number and sizes of viable populations, and conducting related conservation and management research, among other actions (See Conservation Objectives, Strategies, and Actions below).

SPECIES BIOLOGY

Taxonomy and Systematics

The relict leopard frog was described in 1875 from a frog collected within the Virgin River drainage, probably in the vicinity of Saint George, Washington County, Utah (Cope 1875 in Tanner 1929). In recent revisions of New World ranid frog (true frog) taxonomy, the relict leopard frog was moved from the genus *Rana* into *Lithobates*, within a reorganized family Ranidae (Frost et al. 2006, Fei et al. 2012). The new nomenclature was accepted by the Committee on Standard English and Scientific Names (recognized by several prominent herpetological associations and used in recent documents published by USFWS), which currently uses the name *Lithobates onca* to refer to the relict leopard frog (Crother 2008). This revision, however, was not without controversy (e.g., Hillis 2007) and has recently been challenged (Zhi-yong et al. 2016). Based on a more detailed phylogenetic analysis and a lack of diagnostic morphological characters, Zhi-yong et al. (2016) rejected the genus *Lithobates* as used by Frost et al. (2006) and Fei et al. (2012), and retained the genus *Rana* as traditionally used. Therefore, we use the name *Rana onca* herein to refer to the relict leopard frog.

At the species-level, the systematics and associated taxonomy of the relict leopard frog has a controversial history centered on two major uncertainties. One long-debated uncertainty was whether or not the relict leopard frog and the Vegas Valley leopard frog (*Rana fisheri* [=*Lithobates fisheri*]) represented distinct species (Jaeger et al. 2001). The latter taxon was described from the Las Vegas Valley, Clark County, Nevada (Stejneger 1893), but those populations have since gone extinct. Hekkala et al. (2011), in a genetic assessment that included preserved specimens of Vegas Valley leopard frogs, found that these samples were genetically distinct from the relict leopard frog. The other uncertainty was whether or not extant populations of leopard frogs in the general range of the relict leopard frog, represented disjunct populations of the lowland leopard frog (*Rana yavapaiensis* [=*Lithobates yavapaiensis*]), a species described by Platz and Frost (1984).

Using genetic and morphological evidence, Jaeger et al. (2001) concluded that extant populations of relict leopard frogs represented a valid taxon, and distinct from what appears to be the closely related lowland leopard frog.

Species Description

As generally described by Stebbins (2003), the relict leopard frog is a medium-sized ranid frog with short legs. Adults range in length from 44–89 mm (snout-urostyle length [SUL]). Relict leopard frogs have a brown, grey or greenish dorsum with greenish-brown or brown spots that are often reduced or obscure anteriorly (Figure 1). Jennings et al. (1995) evaluated morphological characters on numerous specimens and noted that relict leopard frogs typically lack spots above and between the eyes, but can also be found with one or two of these spots. The venter is white with occasional grey or brown mottling, and yellowish on hind limbs. The dorsolateral folds (ridges that run along the upper sides of ranid frogs) often end well before the groin. Jennings et al. (1995) described the folds as having a short posterior segment that is broken and inset medially. The short inset segment may be represented by a linear series of bumps or warts rather than a solid glandular ridge. These authors also described highly variable posterior thigh patterns are generally reticulate, consisting of a network of light and dark areas that range from weak and fuzzy to rather bold and contrasting.

Figure 1. Photo of relict leopard frog (photo by J. Jaeger).

Life History, Resource Needs and Habitat

Relict leopard frogs appear to require habitat heterogeneity in the aquatic and terrestrial riparian environments (Hayes and Jennings 1986). As habitat generalists, relict leopard frogs historically occupied a variety of habitats including springs, streams, and associated wetlands. Observations suggest that adults prefer relatively open shorelines where dense vegetation does not dominate (Bradford et al. 2005b), and optimal habitat would seem to provide a balance among open water, open bank, and emergent vegetation. Such habitat features may require intermediate disturbance (e.g., flooding or grazing). Shallow water with emergent and perimeter vegetation provides cover, foraging, and basking habitat for both larvae (tadpoles) and metamorphosed frogs, whereas, deeper water, root masses, undercut banks, and debris piles provide refuge from predators and potential overwintering sites (Jennings and Hayes 1994, Conservation Team 2005). Relict leopard frogs require some perennial water, particularly pools that persist long enough to allow tadpole development. Egg clusters are attached to stems of living or dead vegetation in shallow, low-velocity pools generally 5–7 cm deep. Pools with little to moderate cover seem to be preferred for oviposition (Conservation Team 2005), although, this may be influenced by differences in detection.

Male relict leopard frogs may reach reproductive maturity at 42 mm SUL based on the appearance of nuptial pads (pigmented thumb pads) and calling within the first year following metamorphosis (Bradford et al. 2005b). The age of females at maturity is unknown, but in captivity juvenile relict leopard frogs bred after one year (Malfatti 1998). In newly established sites, egg masses have been observed a little over a year after initial translocations, which means that the females were breeding at less than 1.5 years of age. Relict leopard frogs can live at least four years in the wild (Bradford et al. 2005b), which is similar to other leopard frog species. Mark-recapture studies have shown that adult relict leopard frogs are generally shorter-lived, surviving about 2 to 3 years (e.g., Bradford et al. 2004).

Observations of eggs masses in the field indicate that relict leopard frogs have an extended breeding period focusing on spring and fall. Most egg masses are observed from January through April which suggests the preferred breeding period. A typical egg mass is a globular cluster 40–60 mm in diameter (Conservation Team 2005) consisting of many hundreds of eggs (Bradford et al. 2005b); one large egg mass was estimated to contain 1100 eggs. The number of clutches a female produces annually is unknown. Field and laboratory observations indicate hatching occurs in approximately one week (Conservation Team 2005). In captivity, tadpoles reared at 24–25° C and fed *ad libitum*, metamorphosed in two (Goldstein 2007) to three (within rearing facilities) months after hatching. Tadpoles in the wild have been observed to occasionally overwinter.

The diet of juvenile and adult relict leopard frogs has not been studied, but is presumed similar to other leopard frog species (Bradford et al. 2005b), consisting predominantly of aquatic and terrestrial invertebrates and some small vertebrates (e.g., smaller anurans).

Tadpoles feed on algae, other plant matter, and detritus, but likely also consume a wide variety of small aquatic microorganisms (McDiarmid and Altig 2000). Tadpoles have been observed to cannibalize conspecific eggs (Drake 2010).

Extant relict leopard frog populations are restricted to narrow zones around springs and streams with sharply defined boundaries between riparian habitat and desert. Relict leopard frogs have rarely been observed outside of riparian areas. Some spatial separation among adult and juvenile relict leopard frogs also seems to occur, as has been observed in the lowland leopard frog (Seim and Sredl 1994). Relict leopard frogs are active year-round, but activity appears to decline during extreme weather in winter and summer. Most movement data comes from studies along an isolated ~ 0.5 km upper reach of Blue Point Spring. In a three-year mark-recapture study, the longest distance recorded between any recaptures was 120 m (Bradford et al. 2004). Similarly, radio-tracking of adult relict leopard frogs documented a maximum distance traveled of 121 m for frogs observed more than 10 times during an 8-month period (data derived from Harris 2004). Other researchers recorded a marked male that traveled ~ 200 m (Jennings et al. 1995) and a marked female that traveled ~ 333 m (Jef Jaeger, unpublished data).

Historical Distribution

Based on museum specimens, field observations, and literature, Bradford et al. (2004) described the known historical distribution of the relict leopard frog as: (1) springs, streams, and wetlands within the Santa Clara River and Virgin River drainages downstream from the vicinities of Gunlock and Hurricane, Utah; (2) along the Muddy River, Nevada; and (3) along the Colorado River from its confluence with the Virgin River downstream to Black Canyon below Lake Mead, Nevada and Arizona. The few known historical localities (n = 24) are all at, or within, a few km of these rivers (Figure 2), but the seemingly restricted proximity to these rivers may be an artifact of historical collections. Jennings and Hayes (1994) reported that relict leopard frogs were never recorded from the Colorado River proper, but one observation at a site now inundated by Lake Mead indicates that the species occurred in marsh habitat adjacent to the river (Cowles and Bogert 1936). There are no known records of relict leopard frogs along the Colorado River upstream from the confluence with the Virgin River. Leopard frogs occur at Surprise Canyon within the western Grand Canyon, but these frogs have been identified as the lowland leopard frog based on mtDNA analysis (Olah-Hemmings et al. 2010) and general appearance. The historical distribution of relict leopard frogs below Black Canyon along the Colorado River is not known, but lowland leopard frogs exist within the Bill Williams River, and elsewhere in its watershed above the confluence with the Colorado River (Jaeger et al. 2001).

Although apparently never widespread, the relict leopard frog has experienced population declines and broad range contractions (Clarkson and Rorabaugh 1989, Bradford et al. 2004). By 2001, relict leopard frogs were only known from a few sites within two general areas of southern Nevada. Factors presumed to be associated with the decline include: (1)

alteration and loss of aquatic habitat due to agriculture and water development, (2) the introduction of exotic predators, (3) overgrowth of vegetation due to the loss of disturbance regimes, and (4) possibly disease (Bradford et al. 2004, Bradford et al. 2005a, Forrest and Schlaepfer 2011). These factors will be addressed under the Threats and Conservation Needs section.

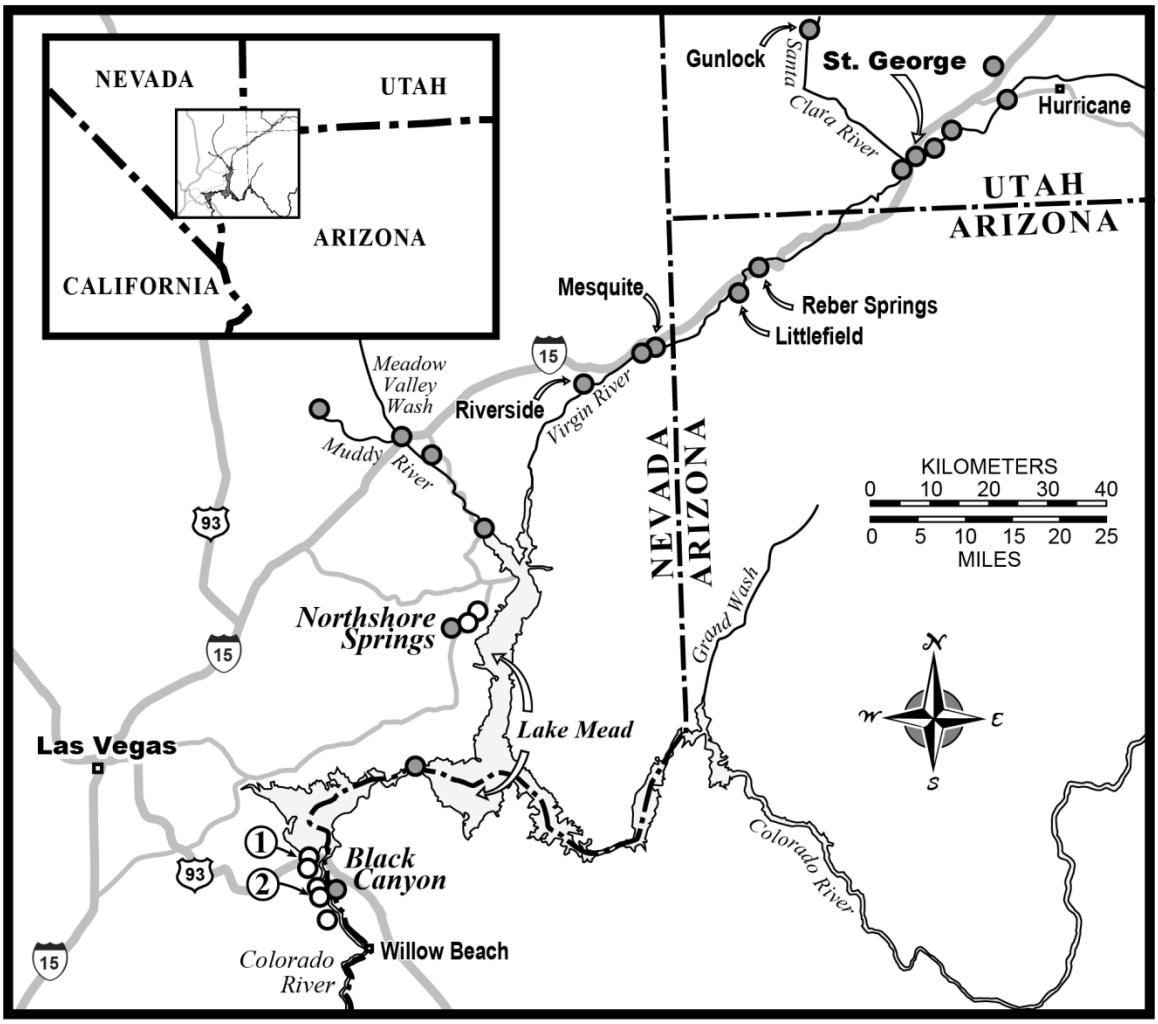

Figure 2. Known historical locations for the relict leopard frog from Bradford et al. (2004), with two additional occupied sites not known at that time (sites 1 and 2). Open circles represent sites with extant natural populations, darkened circles represent sites that no longer contain relict leopard frogs. Inset indicates general location in relationship to several States.

Current Range and Distribution

The current range of the relict leopard frog includes remnant natural sites and sites established by translocation within several areas of Nevada and Arizona on lands managed by Lake Mead National Recreation Area (Lake Mead NRA), Grand Canyon-Parashant National Monument, BLM, and USFWS (Table 1; Figure 3). Two translocations were also conducted on city and county lands, but those attempts failed to establish populations. Demographic data for the relict leopard frog is generally organized by site, which represents a meaningful unit of analysis because relict leopard frogs at most sites appear to function predominantly as independent populations. Relict leopard frogs currently occur at 20 sites (Table 1; Figure 3).

Metapopulations

All natural and a few translocation sites cluster geographically and appear to form two metapopulations through the possible movement of frogs among sites over time. The clustered sites occur within the Northshore Springs Complex (Northshore) at the base of the Muddy Mountains along the former Virgin River drainage of Lake Mead, and Black Canyon along the Colorado River below Lake Mead (Figure 2). Any connectivity between populations in the Northshore and Black Canyon was certainly severed as a result of the damming of the Colorado River and formation of Lake Mead in 1935. At least one population of relict leopard frogs located between the Northshore and Black Canyon areas was eliminated at that time (Cowles and Bogert 1936, Bradford et al. 2005a).

The Northshore metapopulation exists in a complex of thermal springs that originate from a fault that extends along the southern base of the Muddy Mountains. All sites are located within 3.6 km of each other (Bradford et al. 2004), and dispersal of frogs may be possible during particularly wet years. Ephemeral drainages can serve as effective corridors for leopard frogs in the Southwest during wet periods (Sredl et al. 1997). The estimated linear extent of habitat in the Northshore area is 6.1 km, although this distance does not reflect the quality or occupancy of habitat, and much of these systems are thought to be unoccupied because of dense vegetation, subsurface tunneling of the water, introduction of small, predatory nonnative fishes, and water quality issues at lower ends of the streams. The complex consists of three occupied natural sites, Upper and Lower sections of Blue Point Spring and Rogers Spring, and one site extirpated since 1995, Corral Spring (Bradford et al. 2004). Relict leopard frogs have been observed occasionally at Gnatcatcher Spring, although it is uncertain as to whether this site ever supported a population (USFWS 2016).

The Black Canyon metapopulation consists of seven occupied sites associated with thermal springs, although at one site, Black Canyon Spring, most relict leopard frogs occur in an associated unnamed cool water spring. In general, all the springs in this complex flow through narrow, rocky canyons before draining into the Colorado River.

Flash flooding has created more vegetatively open habitat. Total linear habitat at these sites is estimated at about 4.4 km. All sites are within 7.8 km of each other along the river, with dispersal of frogs among sites likely, at least downriver, given that frogs (including one marked individual) have been observed at Willow Beach 10 km from the nearest occupied site (Conservation Team 2005). The complex consists of five natural sites: Boy Scout Springs, Dawn's Canyon, Salt Cedar Canyon Spring, Black Canyon Spring, and Bighorn Sheep Spring. Relict leopard frogs were translocated to three additional sites upriver in the canyon, resulting in the establishment of populations at Pupfish Refuge Spring and Goldstrike Canyon; attempts at establishing a population at Sugarloaf Spring were terminated in 2006.

Independent Populations

Most translocation sites are isolated from other sites, and relict leopard frogs occupying these sites form independent populations. The sites, however, are broadly situated into definable geographic regions. A group of four small sites occurs in the Gold Butte area: Quail, Horse, Bearpaw Poppy, and Red Rock springs. Further east are two sites associated with the Grand Wash drainage, including Lime Spring which was established to assess whether relict leopard frogs could exist at high elevations (~1430 m) and Tassi Spring in Grand Canyon-Parashant National Monument. Just south of the Gold Butte area across the Colorado River, a large population has been established at Grapevine Spring on Grapevine Mesa. To the south of Black Canyon, translocations occurred to sites in the mountains on either side of the Colorado River, with Union Pass Spring in the Black Mountains now probably containing the largest population of relict leopard frogs. Translocations to a site adjacent to the Muddy River failed to establish a population, but there are plans to translocate frogs to a new site adjacent to this river at Kaolin Spring in 2016. On the upper Virgin River, relict leopard frogs existed at Reber Springs until 1998. Attempts to establish refugial populations have occurred at an artificial wetland park in Boulder City that no longer exists, and to a restored spring system at Corn Creek in the Desert National Wildlife Refuge on the north-end of the Las Vegas Valley.

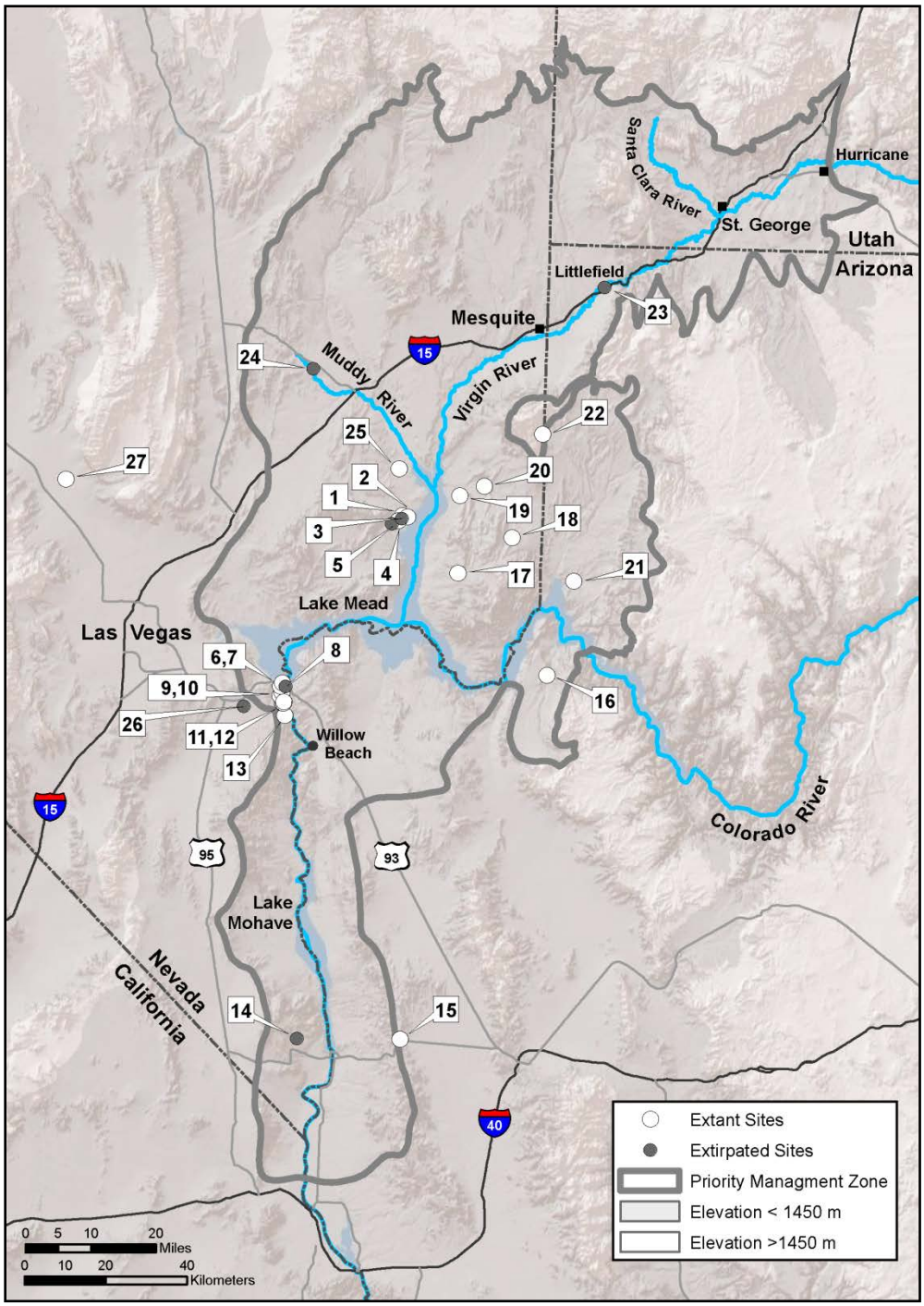

Figure 3. Priority Management Zone for the relict leopard frog and sites recently occupied (as referenced in the text). Numbers associated with sites reference locations listed in Table 1.

Table 1. Sites recently occupied by relict leopard frogs, including land managers, site type (natural, augmented, translocated), extent of habitat (meters) at extant sites, and highest counts of frogs during visual encounter surveys in 2014 and 2015. The initial year of releases is indicated for translocation sites. Included are recently extirpated sites mentioned in the text and indicated on Figures 2 and 3. Map numbers reference Figure 3.

General Location, Site Name	Map No.	Manager/ Ownership	Site Type	Extent Linear Habitat	No. of Frogs Observed, (2014, 2015)
Northshore					
Upper Blue Point, NV	1	NPS	Nat/Aug	555	14, 14
Lower Blue Point, NV	2	NPS	Nat/Aug	2400	17, 14
Gnatcatcher Spring, NV	3	NPS	Nat	-	Extirpated
Rogers Spring, NV	4	NPS	Nat/Aug	3200	14, 11
Corral Spring, NV	5	NPS	Nat	-	Extirpated
Black Canyon					
Pupfish Refuge Spring, NV	6	BOR	Trans (2003)	260	39, 30
Goldstrike Canyon, NV	7	NPS	Trans (2004)	870	26, 19
Sugarloaf Spring, NV	8	NPS	Trans (2002)	-	Extirpated
Dawn's Canyon, NV	9	NPS	Nat	240	6, 4
Boy Scout Springs, NV	10	NPS	Nat	760	36, 21
Salt Cedar Canyon Spring, NV	11	NPS	Nat	360	48, 64
Black Canyon Springs, NV	12	NPS	Nat	1500	49, 44
Bighorn Sheep Spring, NV	13	NPS	Nat	450	54, 37
South of Black Canyon					
Lower Grapevine Spring, NV	14	NPS	Trans (2006)	-	Extirpated
Union Pass Spring, AZ	15	BLM	Trans (2011)	250	204, 292
Grapevine Mesa					
Grapevine Spring, AZ	16	NPS	Trans (2004)	1300	150, 159
Gold Butte					
Quail Spring, NV	17	BLM	Trans (2008)	100	164, 122
Horse Spring, NV	18	BLM	Trans (2012)	150	51, 37
Bearpaw Poppy Spring, NV	19	BLM	Trans (2012)	200	60, 51
Red Rock Spring, NV	20	BLM	Trans (2005)	730	20, 13
Greater - Grand Wash Drainage					
Tassi Spring, AZ	21	NPS	Trans (2006)	300	107, 89
Lime Spring, NV	22	BLM	Trans (2012)	200	15, 10
Greater - Upper Virgin River					
Reber Springs, AZ	23	Private	Nat	-	Extirpated
Muddy River					
Perkins Pond, NV	24	Clark County	Trans (2010)	275	1, Extirpated
Kaolin Spring, NV	25	BLM	Trans (2016)	-	-
Refuge Sites					
Wetlands Park, NV	26	Boulder City	Trans (2000)	-	Extirpated
Corn Creek, NV	27	USFWS	Trans (2015)	700	- , 3

Recent Population Trends

Bradford et al. (2004) estimated the range-wide population of adult relict leopard frogs in 2001 at about 1100 frogs (range = 693–1833), when populations were only known from Northshore and Black Canyon. Using similar methodology, Jaeger and Rivera (2013) estimated the population in 2012 at 1584 (range = 1381–2082) or 1682 (range = 1442–2326) frogs depending on assumptions of the model. The modest increase between 2001 and 2012 reflects the successful establishment of new populations by translocations, predominantly outside of the Northshore and Black Canyon areas. Since 2004 when systematic monitoring of all sites began, annual visual encounter survey data indicates an increasing trend in overall abundance of relict leopard frogs (Figure 4). These data also reflect the importance of translocations in establishing additional populations and increasing overall abundance of relict leopard frogs.

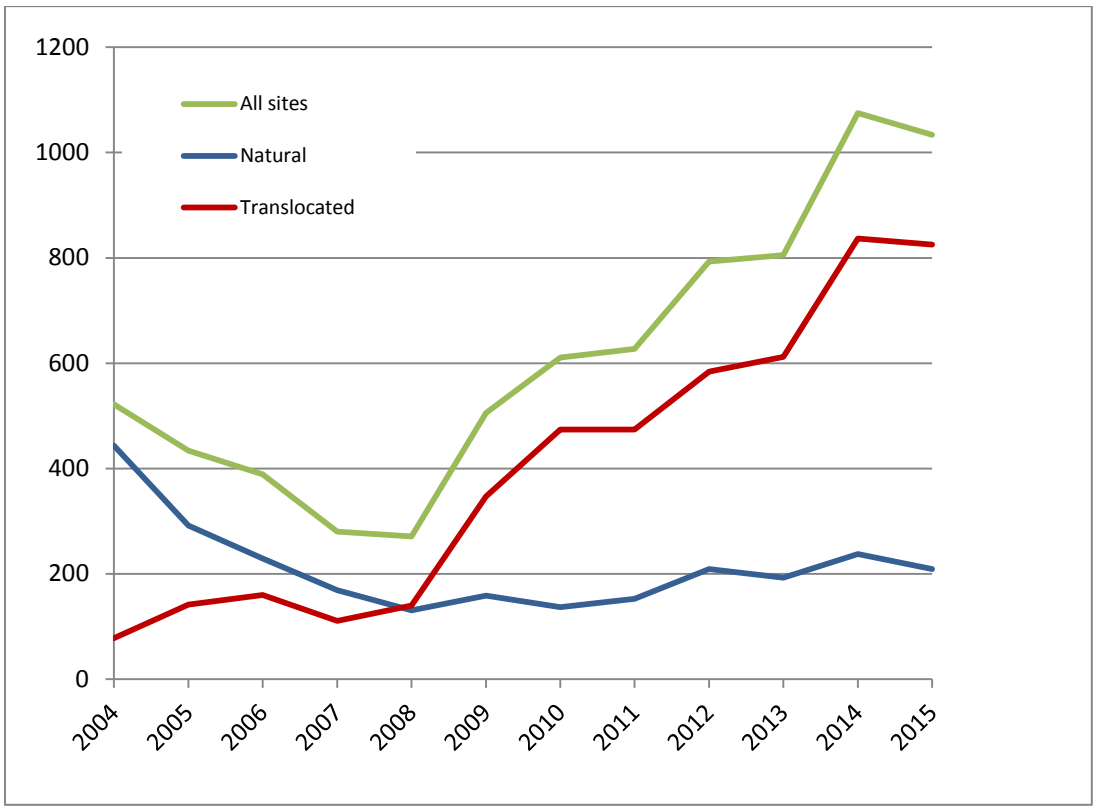

Figure 4. Counts of relict leopard frogs from visual encounter surveys by year and type of site. Values presented are the totals of the highest counts of metamorphosed frogs across sites each year.

THREATS AND CONSERVATION NEEDS

Introduction to Threats Discussion

The success of this conservation program depends on reducing or eliminating threats to the existence of populations and ultimately the species. The threats identified below are derived from an assessment of stressors and potential effects recently conducted by the USFWS (USFWS 2016). These threats are arranged under headings used by the USFWS in Section 4 of the Endangered Species Act (16 U.S. Code 1533) and implementing regulations (50 Code of Federal Regulations part 424), and include the following five factors:

A. Present or threatened destruction, modification, or curtailment of habitat or range
B. Overutilization for commercial, recreational, scientific, or educational purposes
C. Disease or predation
D. Inadequacy of existing regulatory mechanisms
E. Other natural or manmade factors affecting its continued existence.

Although the 2005 CAS for the relict leopard frog (Conservation Team 2005) identified potential threats from over-utilization (Factor B) and inadequacy of existing regulation (Factor D), the USFWS did not identify any potential stressors currently associated with these factors in their SSA (USFWS 2016). The 2005 CAS also identified several threats (i.e., recreational impacts, roads, air pollution, mollusks, and turtles) under the other factors for which there are few data to support the contention that these are actual threats. Factors B and D are not considered further.

The threats identified below are currently affecting at least one relict leopard frog population, except for wildfire. Evidence also indicates that there are no current substantial negative impacts from disease and American bullfrog (*Rana catesbeiana* [= *Lithobates catesbeianus*]) predation on any relict leopard frog population, but these threats may affect particular populations in the near future. The regional presence of these threats also greatly hinders conservation strategies, particularly by limiting the pool of potential sites to which new populations could be established. The threats identified are not independent and potential interactions may have additive or synergistic affects (USFWS 2016). The threats identified as most pervasive and of higher potential severity are all directly or indirectly related to habitat conditions and small population size (Table 2).

Factor A. Habitat Degradation

Habitat degradation, reduced connectivity and groundwater diversion and withdrawal

Summary:

- Loss and degradation of historical habitat has resulted in the contraction of relict leopard frog range, fragmentation of remaining habitat, isolation of remaining populations, and facilitated the establishment of nonnative predators. Many sites currently occupied by relict leopard frogs appear to reflect available rather than optimal habitat conditions.
- A large number of relict leopard frog populations lack connectivity to other populations which poses a moderate level of threat from demographic and genetic isolation (Table 2). The threat is reduced at sites in Northshore and Black Canyon where metapopulation dynamics still occur.
- Groundwater development is a moderate level threat restricted to sites occupied by relict leopard frogs where water sources have a substantial regional groundwater component (Table 2). The current threat is minimized by State water regulations.

The aquatic and riparian habitats of the Colorado River system have undergone decades of anthropogenic alterations that have negatively impacted relict leopard frogs (Bradford et al. 2004). Inundation of large sections of river by the construction of dams, along with associated changes to hydrologic and sedimentation patterns in remaining river sections, eliminated large areas of historical habitat for the relict leopard frog. Spring capping, stream diversions, and modification of wetlands for agriculture and urban development further reduced and degraded habitat. This habitat loss was exacerbated by the introduction of nonnative predatory fishes, crayfish, and bullfrogs (see below). The result was an overall contraction of relict leopard frog range, fragmentation of remaining habitat into small patches, and isolation of remaining populations.

Many relict leopard frog populations are threatened by inadequate or poor quality habitat, which manifests as reduced recruitment into the adult population and limited population size. This is particularly the case for sites in the Northshore area. Many sites currently occupied appear to reflect available rather than optimal habitat conditions (Conservation Team 2005). Many populations are also threatened by the lack of connectivity with other populations, which can increase extinction risk by reducing demographic and genetic exchange, and the chance of recolonization should local extirpations occur (Cushman 2006). Amphibian populations can experience relatively frequent population turnover within local habitat patches, thus connectivity among sites is important to overall persistence within a region (Cushman 2006). Natural patterns of demographic colonization and recolonization, as well as gene flow, are nonexistent outside of the two remaining metapopulations in Northshore and Black Canyon. These metapopulations may also have once been connected by movements of frogs through sites situated along the former Colorado and Virgin rivers; however, the formation of Lake Mead by Hoover

Dam eliminated the intervening habitat, including one known historically occupied site on the Colorado River. Furthermore, the cold water spilling from Hoover Dam, along with water backed-up by Davis Dam, likely limits upriver movements of frogs among sites in Black Canyon.

Groundwater development and water diversions are a continuing threat to the relict leopard frog at some sites where water sources have a substantial regional groundwater component. Because of legal appropriations under Arizona, California, Nevada, and Utah water laws and land use practices on public, private, and Tribal lands, water diversions continue to occur and may be problematic for relict leopard frog conservation and management of leopard frog habitats. Hydrological information has not been compiled on many of the springs where relict leopard frogs have recently been established by translocations, although many of these springs appear to be locally recharged. More focus has been given to understanding the sources of flows to springs occupied by the two metapopulations. Of most concern are the regional components of flows to Blue Point and Rogers springs where groundwater development in the California Wash Valley or the Lower Moapa Valley may impact these springs because of the potential for groundwater connectivity between springs and potential developments. Groundwater development in Coyote Spring Valley and the Muddy River Springs area is currently being pursued. In an agreement between the Department of Interior, Las Vegas Valley Water District, and the Southern Nevada Water Authority, a plan has been developed to monitor and mitigate impacts to the springs in the Muddy River area that might occur from groundwater pumping. The monitoring and thresholds to reduce or cease pumping are anticipated to preclude or minimize future potential impacts to Rogers and Blue Point springs associated with the regional component of their flows. Flows at both Rogers and Blue Point are monitored by gauging stations.

Pohlmann et al. (1998) classified many of the springs in Black Canyon as being "subregional" in origin. The local recharge component of these springs is believed to originate from the surrounding Black and Eldorado mountains, the subregional groundwater source in Eldorado Valley. This source, however, is somewhat uncertain because of limited groundwater sampling in the area. The Eldorado Valley is a "closed basin", which means that except for potential temporary mining permits, the Nevada State Engineer will not issue any additional permits for water extraction. Furthermore, water quality is poor because of high salinities, thus making it an undesirable source for human use (Conservation Team 2005). These factors indicated that the potential for negative impacts from future groundwater withdrawal on springs in Black Canyon are low.

<u>Overgrowth of emergent vegetation, burro and cattle grazing, and nonnative plants</u>

Summary:

- Overgrowth of emergent vegetation is an ongoing, moderate to high level threat to a large number of relict leopard frog populations (Table 2). Historically, livestock

and burros have been a major cause of disturbance minimizing vegetation overgrowth. The loss of moderate levels of such disturbance is an ongoing threat at many sites. At other sites, flash floods reduce vegetation overgrowth and are an important factor in maintaining habitat heterogeneity.

- Nonnative, invasive plants are an ongoing, moderate level threat to a large number of relict leopard frog populations by reducing habitat heterogeneity and breeding sites (Table 2).

Habitat heterogeneity in aquatic and riparian environments is important to the relict leopard frog. As known for other leopard frog species, favorable habitat includes both shallow water and deeper pools, semi-open banks with emergent and perimeter vegetation, and root masses, debris piles and undercut banks (Jennings and Hayes 1994, Conservation Team 2005). Unchecked by disturbance, both native and nonnative emergent plant species quickly form tall, dense stands, eliminating open habitat and shorter plant species used by relict leopard frogs. Emergent vegetation species of particular concern at relict leopard frog sites include: cattail (*Typha domingensis*), sedges (*Scirpus* spp.), common reedgrass (*Phragmites australis*), and sawgrass (*Cladium californicum*), all of which can rebound quickly following disturbance. Overgrowth of habitat by sedges was implicated in relict leopard frog extirpations at two sites (Bradford et al. 2004), and this threat appears most pronounced at sites in the Northshore.

The potential mechanisms of disturbance that maintain habitat at spring sites occupied by relict leopard frogs are limited. At many sites, flooding events are important. Yet, in others, grazing and trampling by livestock and burros have maintained open water and stream bank habitats. Bradford et al. (2004) reported on the loss of relict leopard frogs at Corral Spring following construction of a fence around the site in 1991 that eliminated burro use. By 1995, emergent vegetation that had been previously grazed and trampled by burros had overgrown all open water habitat, and subsequently, relict leopard frogs disappeared. Since then, surface water at the site has declined substantially. Similarly, Bradford et al. (2004) described the loss of relict leopard frogs at Reber Springs sometime after 1998, as occurring concomitantly with the loss of open water habitat due to rapid overgrowth of native, emergent vegetation in the absence of previous livestock grazing.

The levels of grazing that appear to benefit relict leopard frog habitat would be described as low to moderate, but the effects of livestock grazing on amphibians may be positive or negative (Jennings 1988, Rosen and Schwalbe 1998, Sredl and Saylor 1998). High levels of use by livestock and burros can negatively impact amphibian habitat by essentially removing all bankside cover, destroying bank structure (e.g., eliminating undercut banks), and adding high levels of organic wastes (Conservation Team 2005). Overuse may also degrade amphibian habitat by increasing runoff and sedimentation rates (Belsky and Blumenthal 1997). In general, the low to moderate extent of grazing in recent years appears to have been a positive factor for relict leopard frogs. The recent loss of this

disturbance factor at Northshore sites has led to vegetation overgrowth of open water habitat and the apparent decline of frog abundance in this metapopulation.

Tamarisk (*Tamarix* spp.) and palm trees (various genera) occur at many relict leopard frog sites, and if allowed to proliferate, these plants can substantially degrade habitat. Tamarisk has influenced the type locality of the relict leopard frog, changing geomorphology, soil chemistry, plant and insect communities, and disturbance regimes (Conservation Team 2005). At some Black Canyon sites, tamarisk roots directly fill important breeding pools, trapping sediments. Shed needles also fill pools, and branches limit the light striking pools in spring and summer; thus, reducing algae growth that is important for tadpole development. Invasive palm trees (*Washingtonia filifera* and *Phoenix dactylifera*) degrade habitats at Rogers and Blue Point springs where they can form dense stands not favored by relict leopard frogs. Management actions have minimized the impact of these invasive plants at relict leopard frog sites, but treatments will need to continue into the future.

Factor C. Disease, Predation, and Competition

Disease

Summary:

- Disease does not currently appear to be a substantial or pervasive threat to relict leopard frog populations.
- The amphibian pathogen *Batrachochytrium dendrobatidis* (*Bd*) has been detected in relict leopard frogs at one site (Table 2), although recent research suggests that the relict leopard frog may not be highly susceptible to the disease chytridiomycosis caused by this pathogen, and in general, the high temperature of geothermal waters at many sites may provide protection from disease.

Disease does not appear to be a substantial negative factor currently affecting relict leopard frog populations, although the pathogenic chytrid fungus, *Bd*, has been detected in relict leopard frogs at one site. This fungus causes the infectious disease chytridiomycosis, associated with numerous amphibian declines and extinctions (Stuart et al. 2004). The mechanism by which the pathogen spreads from site to site is not fully understood, although treefrogs (tentatively recognized regionally as *Hypochondriaca regilla*) and bullfrogs are known vectors (Daszak et al. 2004, Reeder et al. 2012). There have been no observations of population collapses of relict leopard frogs linked to *Bd*, even though *Bd* has been detected in these frogs at Lower Blue Point, as well as in Woodhouse's toads (*Bufo woodhousii = Anaxyrus woodhousii*) at Corn Creek and treefrogs at Perkins Pond (Jaeger et al. *In press*). Marked relict leopard frogs have been observed to persist in the wild for more than a year after initially testing positive for *Bd* (Jaeger et al. *In press*). Laboratory susceptibility studies of relict leopard frogs using virulent strains of *Bd* isolated from anuran epizootics in California suggest the possibility that these frogs may have inherent resistance to the pathogenic fungus, or have recently

evolved such resistance (Jaeger et al. *In press*). Those authors caution, however, that these initial findings observed under laboratory conditions may not translate to situations in the wild and that the *Bd* isolates used may have attenuated under laboratory conditions.

Geothermal waters at temperatures approaching the upper thermal tolerance of *Bd* (generally above 28º C), have been shown to provide amphibians a refuge from *Bd* (Forrest and Schlaepfer 2011). Relict leopard frogs currently occupy many spring sites that have source temperatures above 30º C including in Northshore (Blue Point and Rogers springs) and Black Canyon (e.g., Bighorn Sheep Spring, Boy Scout Springs, Salt Cedar Spring and Black Canyon Spring; Bradford et al. 2004). The high temperature, geothermal waters may help explain why relict leopard frogs have persisted at the Northshore and in Black Canyon (Forrest and Schlaepfer 2011, Jaeger et al. *In press*). The current isolation of many relict leopard frog sites may also reduce the overall threat from future disease by reducing the potential for disease spread among populations.

Crayfish Predation and Competition

Summary:

- Crayfish are a moderate level threat currently restricted to a couple of relict leopard frog populations (Table 2).
- Crayfish could become a more substantial threat at other sites should these sites be colonized. The presence of crayfish within the region also limits translocation options.

Omnivorous crayfish directly prey on ranid tadpoles and eggs (Saenz et al. 2003), and can affect native aquatic species by competing with, and preying upon, aquatic invertebrates and vertebrates (Creed 1994, Conservation Team 2005). Crayfish remove aquatic vegetative matter and disrupt normal nutrient cycling, thus decreasing aquatic macroinvertebrate diversity (Conservation Team 2005). Crayfish inhabit historical sites where relict leopard frogs have been extirpated, and their presence is a suspected factor in loss of those populations (Bradford et al. 2004, 2005a). Crayfish presence would be expected to significantly negatively impact the viability of relict leopard frog populations (USFWS 2016).

The red swamp crayfish (*Procambarus clarkii*) has been introduced into the Colorado River drainage, and inhabit the lowest stretch of Salt Cedar Canyon Spring where the stream connects with the Colorado River in an area where relict leopard frogs are occasionally observed. Crayfish also occupy Corn Creek, and the recent introduction of relict leopard frogs to this site was intended in part to assess whether a population could establish in a highly heterogeneous system where crayfish and Woodhouse's toads are common. The virile crayfish (*Orconectes virilis*) was introduced in the 1970s into the Virgin River drainage in Utah (Johnson 1986) and have expanded into the historical range of the relict leopard frog.

Crayfish may colonize some relict leopard frog habitat, particularly in cooler, flowing water habitats. Crayfish, however, do not appear to thrive in geothermally influenced waters like those at Boy Scout Springs where these animals are absent even though the stream often reaches the Colorado River. It is also unlikely that crayfish would thrive in the thermally influenced, high mineral content waters at Blue Point and Rogers springs.

Nonnative Predatory Fishes

Summary:

- Small, nonnative predatory fish are a moderate level threat to relict leopard frog populations in the Northshore area, although they may become introduced at other sites, such as Corn Creek where they were recently removed (Table 2).
- Large sportfish may have a low level negative impact on connectivity among existing populations, particularly in Black Canyon.

Nonnative predatory fish negatively impact relict leopard frogs primarily through predation, particularly early life stages (USFWS 2016). Two spring systems in Northshore (Blue Point and Rogers springs) are occupied by a variety of nonnative tropical fish species including: mosquitofish (*Gambusia affinis*), cichlids (*Cichlasoma* spp.), mollies (*Poecilia* spp.), and tilapia (*Tilapia* sp.). These fishes reduce tadpole survivorship and likely limit recruitment. Although specific threats from some of the smaller aquarium fish species are not fully understood, predation on anuran larvae by mosquitofish has been well documented (McDiarmid and Altig 2000). Areas of the Muddy and Virgin rivers within the historical range of the relict leopard frog are dominated by introduced, invasive fish species, including: blue tilapia (*Oreochromis aurea*), red shiner (*Cyprinella lutrensis*), and mollies. Dietary studies of blue tilapia in headwater spring outflows of the Muddy River have shown them to be aggressive, opportunistic predators on a variety of aquatic species (Conservation Team 2005).

Large aquatic habitats in the current range of the relict leopard frog including the Colorado River and lakes Mead and Mohave are occupied by predatory sport fish, particularly bass and sunfish (family, Centrarchidae) and catfish (family, Ictaluridae; Deacon et al. 1964, Minckley 1973). Although the impact of these predators on establishment of potential populations of the relict leopard frog in habitat along river systems is not well documented, it is likely that the occurrence of sport fish limits dispersal along large aquatic systems (e.g., Bradford et al. 1993).

Bullfrog Predation and Competition

Summary:

- American bullfrogs are not currently a substantial threat at sites occupied by relict leopard frogs (Table 2), but they remain a potentially serious threat should they colonize particular sites.
- Their presence regionally also limits translocation options.

The American bullfrog is an invasive ranid species not native to western North America and now occurs within the range of the relict leopard frog. This competitor and predator is implicated in the decline of many ranid frogs (Moyle 1973, Hayes and Jennings 1986, Casper and Hendricks 2005), and is also a vector of disease and parasites (Casper and Hendricks 2005, Monello et al. 2006). Bullfrogs have become established in wetlands along portions of the Muddy and Virgin rivers, and are present at many sites from which relict leopard frogs have disappeared, including Reber Springs (Bradford et al. 2004).

The cold water and strong current of the Colorado River coupled with steep topography may limit bullfrog dispersal to the Black Canyon sites. These sites are downstream from Hoover Dam, which also forms a significant upstream barrier. Rogers and Blue Point springs are somewhat vulnerable to colonization by bullfrogs moving upstream from sites along the shoreline of Lake Mead or through introduction by visitors to the springheads.

The Conservation Team considers the presence of bullfrogs a threat to relict leopard frogs and an important negative factor when assessing potential translocation sites. Prior to translocations to Corn Creek, bullfrogs appear to have been eradicated following extensive spring system restoration. Bullfrogs were also eradicated from Perkins Pond and an exclusion fence constructed prior to translocations to that site; however, bullfrogs recolonized the pond just prior to water loss and failure of the site. Bullfrogs do not occur at any sites currently occupied by relict leopard frogs.

Factor E. Other Factors

Small Population Size

Summary:

- Most relict leopard frog populations occur in small, isolated desert spring sites where small population size is a pervasive threat (Table 2).
- Only two sites, Grapevine and Union Pass springs, have relatively large populations that may mitigate the threat.
- The cluster of sites within Black Canyon, however, appear to form a metapopulation large enough to maintain viability over at least decades of time.

Anuran populations fluctuate dramatically; therefore, the number of individuals at a given time may not be indicative of population stability (Sherman and Morton 1993, Weitzel and Panik 1993). Small populations can quickly lose demographic and genetic variability (Frankham 2005), which threatens population viability. In such situations, the spatial distribution of sites is important to allow natural immigration and emigration in order to maintain overall demographic and genetic viability (Sjögren-Gulve 1994). Genetic diversity can help buffer a species from short-term environmental fluctuations and provide resiliency in response to longer-term changes (Frankham 2005). Anthropogenic activities, such as damming and diversion of water and introductions of nonnative predators, have limited relict leopard frogs to spring sites located in two metapopulations

and other isolated populations in desert springs. The fragmentation of riverine dispersal corridors decrease the likelihood of dispersal and accentuate the isolation of sites.

Current genetic data suggest relatively low genetic diversity across remaining populations of the relict leopard frog (Jaeger et al. 2001). This may indicate a historical population bottleneck or overall small effective population size, although these data are limited. Only the metapopulation in Black Canyon and two isolated sites, Grapevine and Union Pass springs, appear to currently contain populations large enough to slow loss of genetic diversity (each of these sites are estimated to contain several hundreds of adult frogs; Jaeger and Rivera 2013). The metapopulation in Black Canyon, however, declined in 2006 following a flooding event that decimated the large population of relict leopard frogs at Bighorn Sheep Spring and substantially degraded that habitat. The decline was in spite of the successful establishment of two new sites in Black Canyon by translocations of animals from Bighorn Sheep Spring.

The metapopulation at Northshore has declined in recent years (Jaeger and Rivera 2013) following management actions that decreased disturbance from cattle and burros, and allowed emergent vegetation to overgrow relict leopard frog habitat (see Factor A above). All other sites generally maintain relatively small, isolated populations. Periodic management will be required to maintain viability of these small populations, and at a minimum, most populations will require occasional augmentation through translocations of animals from remaining natural sites. The populations that currently comprise the Northshore metapopulation already receive augmentations (starting in 2008) with animals headstarted from eggs collected at those various springs. This decision to augment was made by the Conservation Team because of concerns about the immediate demographic viability of those populations.

Climate Change: flash flood events and drought

Summary:

- Climate change is a pervasive threat to relict leopard frog populations (Table 2), but the severity of this threat remains somewhat speculative. If climate change predictions for the Southwest are correct, severe droughts would result in moderate level threats to most of the springs occupied by relict leopard frogs because these springs have some component of local recharge. Declines in spring flows would likely be detrimental to habitat.
- An increase in intensity or frequency of severe storms has also been predicted. The resulting increase in the frequency and intensity of flash floods may be detrimental to habitat and populations at some sites, particularly in Black Canyon (Table 2), but other sites may benefit through an increase in disturbance that limits overgrowth of vegetation.

The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). Climate refers to the mean and variability of different types of

weather conditions over time, with 30 years being a typical period for such measurements. The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables such as habitat fragmentation (IPCC 2007). The U.S. Environmental Protection Agency (2015) projects the following for the Southwest:

- Springtime precipitation is likely to decrease significantly, making it more difficult to meet water demands during the summer, when conditions are typically the driest.
- Climate change will likely stress groundwater-based systems and result in decreased groundwater recharge.
- While severe droughts are already part of the Southwest climate, human-induced climate change will likely result in more frequent and more severe droughts with associated increases in wildfires.
- Projected temperature increases, river-flow reductions, dwindling reservoirs, and rapid population growth will increase the competition for water resources across regions, States, Tribes, and even between the United States and Mexico.

Extremes in precipitation (i.e., drought and severe storms) affect relict leopard frogs and their habitats and may increase as a result of climate change. Drought conditions resulting in a substantial reduction in annual rainfall would likely result in less recharge of aquifers, reduced spring outflows, and decreased habitat for frogs. Most of the springs occupied by relict leopard frogs are dependent to varying extent on local or regional recharge (Conservation Team 2005) and therefore would be negatively impacted.

Flash flood events affect habitat at numerous relict leopard frog sites. Flash floods could result in substantial damage to habitat and populations, as occurred at Bighorn Sheep Spring in 2006. Habitats at other sites, however, benefit from occasional flash floods that often remove dense emergent vegetation, and increase habitat heterogeneity for breeding, feeding, and sheltering of all life-stages. If climate change increases the intensity or frequency of severe storms, this may damage habitat and populations at some sites, but modest increases in the intensity or frequency of flooding may be beneficial at other sites. The direct effects of flash floods on relict leopard frogs themselves depend on the severity and seasonal timing of flooding; egg masses and tadpoles are particularly vulnerable.

Wildfire

Summary:

- Wildfire that could negatively impact relict leopard frog populations mostly appears to be restricted to a few sites where dense vegetation and high visitor use provides a moderate level of threat (Table 2).

The effects of natural and uncontrolled human-caused wildfires, as well as human controlled burning, on native amphibians in the Southwest are poorly known and likely depend on local conditions. The threat of fire to populations of relict leopard frogs appears predominantly limited to a few sites, mostly those with dense vegetation and high visitor use (Table 2). The threat could become greater at others sites, however, if nonnative grasses and other plants (fine fuels) proliferate and increase the frequency at which wildfires burn into spring systems.

Sites in the Northshore are heavily vegetated and visitor caused fires have occurred at these sites in the past; these fires were typically small in size, burning mostly invasive palms (Conservation Team 2005). Wind driven fire, however, could impact substantial sections of aquatic and riparian habitats in these systems, particularly along Rogers Spring where fire adapted sawgrass dominates. Fire may benefit populations of relict leopard frogs under controlled conditions by providing disturbance of riparian vegetation and keeping succession from eliminating the aquatic habitat (e.g., Hobbs and Huenneke 1992). An experimental burn of sawgrass at Rogers Spring, however, left behind a thick layer of ash which was likely toxic to frogs, and the emergent vegetation grew back quickly, returning to its previous condition within a year (Jaeger et al. 2009).

Table 2. Severity of current potential threats at sites occupied by the relict leopard frog. The severity of each threat is based on the following criteria at any given site: High- capable of reducing extent of habitat or numbers of relict leopard frogs by 71–100%, Moderate- capable of reducing extent of habitat or numbers of relict leopard frogs by 31–70%, Low- capable of reducing extent of habitat or numbers of relict leopard frogs by 30% or less (USFWS 2016).

General Locations, Sites Names	Connectivity	Overgrowth of emergent vegetation	Nonnative plants	Groundwater effects	Excessive disturbance [1]	Disease	Bullfrogs	Crayfish	Nonnative fish	Small population size	Climate change	Flash floods	Wildfire
Northshore													
Upper Blue Point	L	H	M	M	L	L	L	L	M	H	M	L	L/M
Lower Blue Point	L	H	M	M	L	L/M	L	L	M	H	M	L	L/M
Rogers Spr.	L	H	M	M	L	L	L	L	M	H	M	L	L/M
Black Canyon													
Pupfish Refuge Spr.	L	L/M	L/M	L	L	L	L	L	L	H	M	M	L
Goldstrike Canyon	L	L	L	L	L	L	L	L	L	H	M	M	L
Dawn's Canyon	L	L	L	L	L	L	L	L	L	M	M	L/M	L
Boy Scout Sprs.	L	L	L	L	L	L	L	L	L	M	M	L	L
Salt Cedar Canyon	L	M	M	L	L	L	L	M	L	M	M	M	L
Bighorn Sheep Spr.	L	L	L	L	L	L	L	L	L	M	M	H	L
Black Canyon Spr.	L	M	M	L	L	L	L	L	L	M	M	M	L
South of Black Canyon													
Union Pass Spr.	M	L	L	L	L	L	L	L	L	M	M	L	L
Grapevine Mesa													
Grapevine Spr.	M	L	L	L	L	L	L	L	L	M	M	L	L
Gold Butte													
Quail Spr.	M	L/M	L/M	L	L	L	L	L	L	M	M	L	L
Horse Spr.	M	L/M	L	L	L/M	L	L	L	L	H	M	L	L
Bearpaw Poppy Spr.	L	L	L	L	L	L	L	L	L	H	M	L	L
Red Rock Spr.	M	L	L	L	L/M	L	L	L	L	H	M	L	L
Grand Wash Drainage													
Tassi Spr.	M	L/M	M/L	L	L	L	L	L	L	M	M	L	L
Lime Spr.	M	L	L	L	L	L	L	L	L	H	M	L	L
Refuge Sites													
Corn Creek	M	L	L	L	L	L	L	M	M	H	M	L	L/M

[1]Includes excessive disturbance by livestock and burros, and excludes flash flood disturbance

CONSERVATION PROGRAM

Conservation Approach

A major approach to relict leopard frog conservation has been to establish more populations and increase regional population size (Conservation Team 2005). The potential size of each new population has not been a primary decision factor in where to attempt translocation, mostly because potential sites that lack nonnative predators are generally limited in number and area of habitat. Establishment and maintenance of larger populations, however, is preferred because such populations are more likely to maintain demographic and genetic diversity over time. Management approaches to maintain or increase the size of populations are also important, for example through improvements in habitat quality and quantity. Many amphibian populations, however, vary greatly in size over time, and total numbers are not necessarily indicative of population stability (Bragg 1960, Sherman and Morton 1993, Weitzel and Panik 1993, Green 1997, Meyer et al. 1998, USFWS 2000). Because of such demographic fluctuations and habitat limitations, the spatial distribution of populations is important. Where possible, new sites should be established that allow natural immigration and emigration with neighboring sites in order to maintain genetic and demographic viability within metapopulations (Sjögren 1991, Sjögren-Gulve 1994). A matrix of sites in the PMZ will be managed to include those that are more isolated and those that facilitate metapopulation dynamics. Ideally, such a diversity of populations and metapopulations would not be impacted by the same threats. Attempts to establish populations along major river systems should also be prioritized, since such sites may allow natural colonization of neighboring areas along river corridors, thus naturally establishing metapopulation dynamics.

Adaptive Management

This Strategy depends upon the successful implementation of an adaptive management framework. This framework is designed to bring new information immediately into new management direction (Holling 1978). All cooperators agree and recognize, consistent with the goals of this Agreement, that monitoring actions and conservation measures implemented through the Strategy will be conducted experimentally consistent with the concepts of adaptive management. The effectiveness of all conservation actions and monitoring methods will be periodically reviewed and evaluated by the Conservation Team. Based on such evaluation, appropriate modifications to strategies and actions will be made to ensure scientific rigor and efficacy of conservation actions. The signatories to this Agreement are committed to seeking the resources necessary to ensure successful implementation of adaptive management and its principles.

The essential steps of the adaptive management are summarized as follows:

Step 1. Implement conservation actions and strategies.
Step 2. Implement annual work plans for management, monitoring, and research.
Step 3. Review conservation goal, objectives and strategies, and adjust as necessary based on updated information.
Step 4. Prioritize locations for implementation of conservation actions, and identify and prioritize research needs.
Step 5. Initiate site-specific actions to reduce or eliminate threats and complete identified research projects.
Step 6. Implement monitoring plan (Table 3) to determine effectiveness of conservation actions.
Step 7. Analyze and evaluate monitoring and research results to determine progress towards attainment of conservation objectives.
Step 8. Return to Step 3.

Conservation Goal

Ensure the persistence of relict leopard frog populations and groups of populations in a diversity of habitats and localities that reflect the PMZ (Figure 3) for the species for the duration of this Agreement.

Conservation Objectives, Strategies, and Actions

The following conservation objectives, strategies, and actions must be implemented to achieve the conservation goal for the relict leopard frog. Conservation objectives and strategies are listed in a step-down format in which the objectives are stepped down to strategies. In the Implementation Schedule (Table 3), the objectives and strategies are stepped down to specific actions, which are linked to the status of those actions and responsible parties.

Objective 1. Identify, remove, or substantially minimize threats to relict leopard frog populations.

Strategy 1. Determine the level, timing, scope, and severity of threats at occupied sites.
Strategy 2. Remove or minimize threats where feasible.

Objective 2. Enhance or create relict leopard frog habitat.

Strategy 1. Identify sites where the quality of the habitat might limit the conservation potential for relict leopard frogs.

Strategy 2. Identify areas where creation of relict leopard frog habitat would provide substantial conservation benefits.

Objective 3. Establish additional populations and augment existing populations of relict leopard frogs as necessary.

Strategy 1. Identify new sites where populations of relict leopard frogs could be established through translocation.
Strategy 2. Identify sites that need augmentation.
Strategy 3. Translocate relict leopard frogs to establish new sites or augment existing sites.
Strategy 4. Evaluate the outcome of translocations and augmentations over a 5-year period.

Objective 4. Maintain an adaptive monitoring program to assess the status of relict leopard frog populations and report progress on meeting the goal and objectives of this Agreement.

Strategy 1. Monitor established populations of relict leopard frogs following a standardized protocol.
Strategy 2. Maintain and revise process for collecting and maintaining data and information for distribution to stakeholders and decision makers.

Objective 5. Investigate the conservation biology of the relict leopard frog, and use the results of such investigations to better meet the overall conservation goal and objectives.

Strategy 1. Identify and prioritize research needs.
Strategy 2. Evaluate research and monitoring on a regular basis.

Objective 6. Increase public awareness and appreciation of relict leopard frogs and their habitat by making information available to interested parties and decision makers.

Strategy 1. Encourage citizen and landowner participation in implementation of the Agreement and Strategy as appropriate.

Table 3. Conservation strategy and 10-year implementation schedule for the relict leopard frog. Specified are objectives, strategies, actions, and lead parties. All actions enumerated in this Implementation Schedule have been initiated in some manner under the prior Agreement and Strategy (Conservation Team 2005).

Objectives, Strategies, and Actions	Action Status Initiation – Expected Completion	Lead Parties
Objective 1. Identify, remove, or substantially minimize threats to relict leopard frog populations.		
Strategy 1. Determine the level, timing, scope, and severity of threats at occupied sites.		
Action 1. Assess the level, timing, scope and severity of known threats at each occupied site during routine site visits and update determinations from prior threats assessments.	2016–2026	All
Action 2. Identify the level, timing, scope and severity of new potential threats at each occupied site during routine site visits and update threats assessments.	2016–2026	All
Strategy 2. Remove or minimize threats where feasible.		
Action 1. Develop and implement site-specific plans to remove or minimize important threats where feasible as part of the annual work planning process.	2016–2026	All
Objective 2. Enhance or create relict leopard frog habitat.		
Strategy 1. Identify sites where the quality of the habitat might limit the conservation potential for relict leopard frogs.		
Action 1. Develop and implement site-specific plans to enhance habitat as part of the annual work planning process.	2016–2026	All
Strategy 2. Identify areas where creation of relict leopard frog habitat would provide substantial conservation benefits.		
Action 1. Develop and implement site-specific plans to create habitat or habitat features as part of the annual work planning process.	2016–2026	All
Objective 3. Establish additional populations and augment existing populations of relict leopard frogs as necessary.		
Strategy 1. Identify new sites where populations of relict leopard frogs could be established through translocation.		
Action 1. Revise site selection criteria.	2016–2017	All
Action 2. Maintain site selection criteria, as necessary.	2017–2026	All
Action 3. Identify potential release sites during the development of annual work plans.	2016–2026	All
Action 4. Assess the suitability of potential release sites.	2016–2026	All

Action 5. Complete compliance required to translocate relict leopard frogs.	2016–2026	All
Action 6. Prepare site as necessary.	2016–2026	All
Strategy 2. Identify sites that need augmentation.		
Action 1. Revise criteria to consider prior to augmentation, as necessary.	2016–2017	AGFD, NDOW, UNLV, USFWS
Action 2. Maintain criteria to consider prior to augmentation, as necessary.	2017–2026	AGFD, NDOW, UNLV, USFWS
Action 3. Assess whether sites require augmentation and incorporate into annual work plans.	2016–2026	AGFD, NDOW, UNLV, USFWS
Strategy 3. Translocate relict leopard frogs to establish new sites or augment existing sites.		
Action 1. Revise animal husbandry, health screening, transport, and translocation protocols.	2016–2017	AGFD, NDOW, UNLV, USFWS
Action 2. Maintain animal husbandry, health screening, transport, and translocation protocols, as necessary.	2017–2026	AGFD, NDOW, UNLV, USFWS
Action 3. Maintain a headstarting facility as necessary.	2016–2026	UNLV, NDOW, NPS
Action 4. Determine headstart and translocation priorities annually, and incorporate into work plans by identifying appropriate source populations.	2016–2026	All
Action 5. Collect individuals from appropriate source populations.	2016–2026	NDOW, NPS, UNLV
Action 6. Translocate frogs to new sites or augment existing sites.	2016–2026	AGFD, NDOW, UNLV, NPS, BLM, USFWS
Action 7. Review headstart and translocation efforts annually and amend work plans and protocols as necessary.	2016–2026	All
Strategy 4. Evaluate the outcome of translocations and augmentations over a 5-year period.		
Action 1. Revise post-release monitoring protocol.	2016–2017	AGFD, NDOW, UNLV, USFWS
Action 2. Maintain post-release monitoring protocol, as necessary.	2017–2026	AGFD, NDOW, UNLV, USFWS
Action 3. Monitor populations at release sites and incorporate findings into future translocation efforts.	2016–2026	AGFD, NDOW, UNLV, USFWS
Objective 4. Maintain an adaptive monitoring program to assess the status of relict leopard frog populations and report progress on meeting the goal and objectives of this Agreement.		
Strategy 1. Monitor established populations of relict leopard frogs following a standardized protocol.		
Action 1. Monitor all relict leopard frog populations using a standardized monitoring protocol.	2016–2026	All
Action 2. Maintain a standardized monitoring protocol for relict leopard frog populations, and amend as necessary.	2017–2026	AGFD, NDOW, UNLV, USFWS

Strategy 2. Maintain and revise the process for collecting and maintaining data and reports for distribution to stakeholders and decision makers.		
Action 1. Maintain a repository for storage of data from inventory and monitoring efforts.	2016–2026	UNLV
Action 2. Ensure data and information developed through actions of the Agreement are available to involved parties.	2016–2026	UNLV
Objective 5. Investigate the conservation biology of the relict leopard frog, and use the results of such investigations to better meet the overall conservation goal and objectives.		
Strategy 1. Identify and prioritize research needs.		
Action 1. Propose research to analyze and alleviate potential threats to relict leopard frogs and their habitats, and other important questions that can inform species conservation.	2016–2026	All
Action 2. Assess research needs on an ongoing basis and modify and prioritize research needs as necessary.	2016–2026	All
Action 3. Implement proposed research projects as approved by the Conservation Team and incorporate new and ongoing actions into annual work plans.	2016–2026	All
Strategy 2. Evaluate research and monitoring on a regular basis.		
Action 1. Write and distribute reports to involved parties, and publish research in peer-review journals.	2016–2026	All
Action 2. Incorporate research findings that improve management, as appropriate, to ensure that the goal and objectives of this Agreement are ultimately met.	2016–2026	All
Objective 6. Increase public awareness and appreciation of relict leopard frogs and their habitat by making information available to interested parties and decision makers.		
Strategy 1. Encourage citizen and landowner participation in implementation of the Agreement and Strategy as appropriate.		
Action 1. Develop and distribute informational and educational materials on the relict leopard frog and its management needs for dissemination to public and media.	2016–2026	All
Action 2. Develop and distribute informational materials to recreational users, private landowners, stakeholders, decision makers, and the scientific community who may be involved in actions affecting relict leopard frogs or their habitat.	2016–2026	All

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