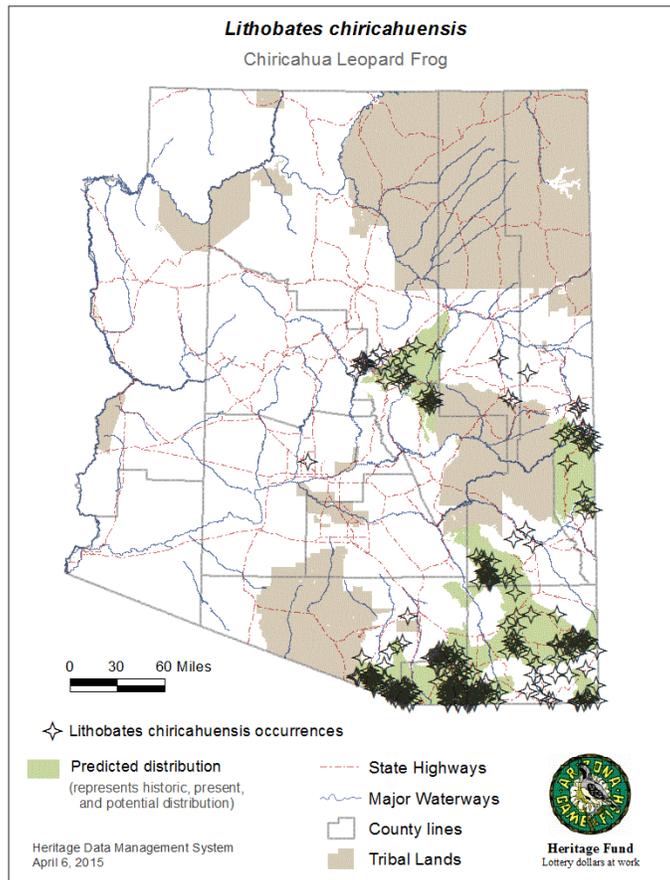


CHIRICAHUA LEOPARD FROG CONSERVATION GUIDELINES

INTRODUCTION

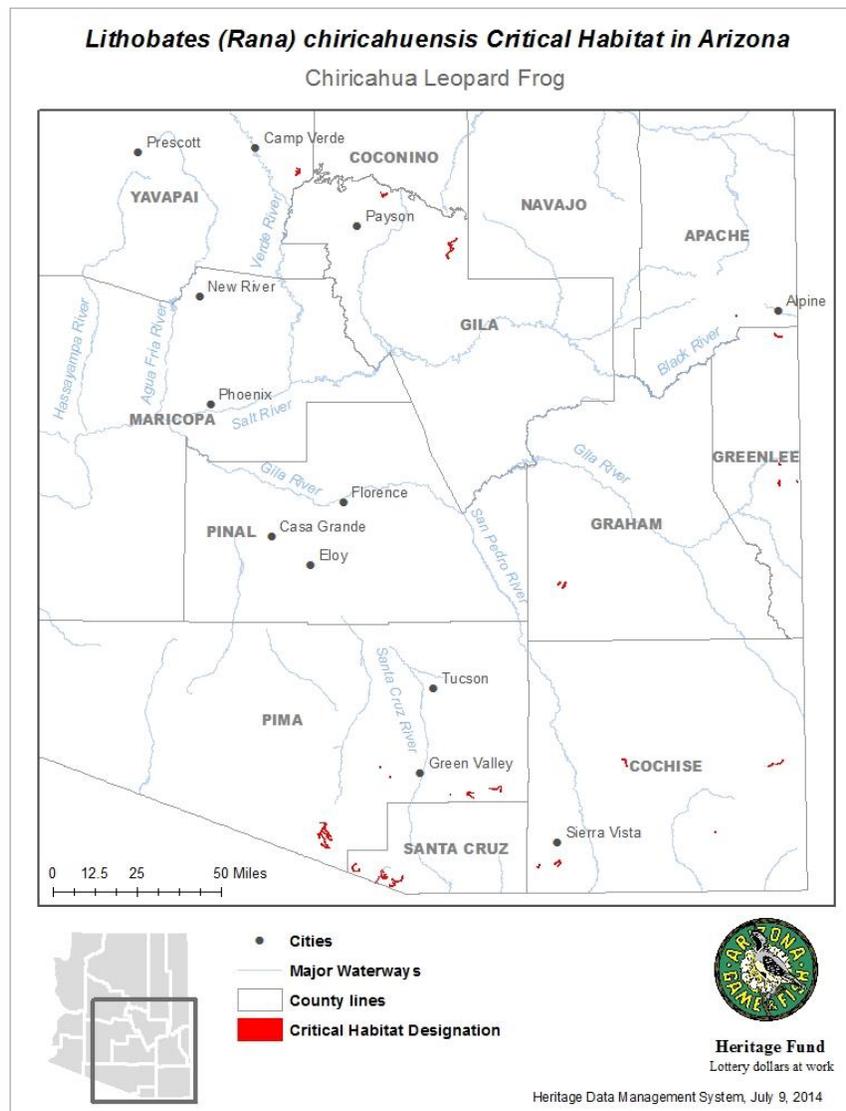
The Chiricahua leopard frog (*Lithobates [Rana] chiricahuensis*) occurs in limited distribution in Arizona with a range that is divided into two areas of the state (Fig 1). The northern portion occurs in the montane areas of central Arizona, extending east and south along the Mogollon Rim, while the second portion is located in the mountains and valleys of southeastern Arizona. The Chiricahua leopard frog occupies variety of permanent and semi-permanent aquatic systems in oak, mixed oak, and pine woodlands as well as in chaparral, grassland and desert habitats (Mecham 1968; Zweifel 1968; Frost and Bagnara 1977; Scott and Jennings 1985; Stebbins 1985; Sredl and Saylor 1998). Vegetation associated with egg masses includes: pondweed (*Potamogeton* sp.), yellowcress (*Rorippa* sp.), and barnyard grass (*Echinochloa* sp.) (Sredl and Jennings in Lannoo 2005). Management of suitable habitat varies and includes lands owned or managed by U.S. Forest Service (USFS), U.S. Fish and Wildlife Service refuges (USFWS), Bureau of Land Management, State Land Department, Arizona Game and Fish Department (AGFD), Department of Defense (Fort Huachuca), Tribal Lands, and private parties.

Figure 1: Distribution of Chiricahua leopard frog in Arizona.



Except as authorized by special license or permit, collection and possession of Chiricahua leopard frogs is prohibited by state and federal law. Beginning in 1993 and continuing to the present, there has been no open season for Chiricahua leopard frogs under AGFD Commission Order 41, making collection and possession illegal except as authorized by special licenses (AGFD 2015). Similarly, upon its federal listing under the Endangered Species Act in 2002, special federal permit was required to “take” and possess Chiricahua leopard frogs (USFWS 2002). A Final Recovery Plan was released in April 2007 (USFWS 2007) and in 2012, USFWS designated 10,346 acres of critical habitat for Chiricahua leopard frogs throughout much of their range in Arizona and New Mexico. In Arizona (Fig 2), this critical habitat occurs in Apache, Cochise, Gila, Graham, Greenlee, Pima, Santa Cruz, and Yavapai counties (USFWS 2012).

Figure 2: Chiricahua leopard frog critical habitat in Arizona.



Since the time of listing, the Chiricahua leopard frog has made modest population gains in Arizona as a result of cooperative head-starting (rearing frogs in captivity from eggs through metamorphosis), campaigns and active partnerships and cooperation in management of occupied habitat (USFWS 2012).

GENERAL BIOLOGY

The Chiricahua leopard frog has a stocky body ranging from 2.1-5.4 inches in length with a distinctive color pattern on the thigh consisting of small, raised, cream-colored spots or tubercles on a dark background. These dorsal spots are generally smaller and more numerous than in other leopard frogs. The dorsolateral folds, paired raised glandular ridges running down the sides of the back, are broken and inset toward the rear of the body. Chiricahua leopard frogs are often green on the head and back with eyes that are positioned relatively high on the head. Their distinct call which further separates them from other leopard frog species is a “snore” of unusually high pulse rate lasting 1-3 seconds (depending on temperature), which is intermittently repeated and terminated by a “tail” produced by slight change in pitch (Frost and Platz 1983; Platz and Mecham 1984; USFWS 2014).

Chiricahua leopard frogs are highly aquatic habitat generalists with complex life cycles consisting of aquatic eggs, aquatic larvae (tadpoles) which go through metamorphosis changing into primarily aquatic (sometimes terrestrial) frogs (USFWS 2012). Post-metamorphic Chiricahua leopard frogs are generally inactive from November through February, likely over-wintering near breeding sites; however, a detailed study of wintertime activity, microsites for hibernacula, and habitat use have not been well studied (Sredl and Jennings *in* Lannoo 2005). Adults become active in February (Jennings 1988, 1990), and eggs are laid in spring and sporadically through the summer and fall. Adult frogs are active more at night than juveniles. It is presumed that very high mortality occurs in the egg and early tadpole stages, high mortality when the tadpole turns into a juvenile frog, and relatively low mortality occurs when the frogs are adults (USFWS 2012). Life span and age at first reproduction are currently unknown, although preliminarily research indicates that they can live up to 6 years (Durkin 1996, cited by Sredl and Jennings *in* Lannoo 2005).

Reproduction

At high elevation, the Chiricahua leopard frog breeds in late May through August (Zweifel 1968; Frost and Platz 1983). At lower, warmer localities, breeding occurs from mid-February through June and sporadically until September (Frost and Bagnara 1977; Frost and Platz 1983) and October. Egg masses have been reported in all months, but reports of oviposition in June are uncommon (Sredl and Jennings *in* Lannoo 2005). This may be due to lower water levels and higher temperatures before the summer rainy season begins. Scott and Jennings (1985) did not note a difference in the time of breeding at different elevations, but did find a relationship between the time of breeding and water temperatures at sites in New Mexico (Jennings 1988, 1990). Proximate cues that stimulate mating are not well studied, but oviposition has been correlated with rainstorms (Fernandez 1996) and changes in water temperature (Platz 1993).

Females deposit 300-1485 eggs in spherical masses attached to submerged vegetation, suspended within 5 cm of the surface (Jennings and Scott 1991). Zweifel (1968b cited by Sredl and Jennings *in* Lannoo 2005) noted the water temperature range for Chiricahua leopard frog embryos was 12.0-31.5 °C, while in New Mexico Jennings (personal observations, cited by Sredl and Jennings *in* Lannoo 2005) noted water temperatures ranged from 12.6 °C at a stock tank to 29.5 °C recorded at a warm spring. Eggs take approximately 14 days to hatch (Platz 1993) (range between 8-14 days depending on water temperature), and larvae metamorphose in 3-9 months (Jennings 1988, 1990) with growth rates being faster in warmer conditions, tadpoles are known to over-winter (Frost and Platz 1983).

Movement

The home range for male Chiricahua leopard frogs (dry season mean = 161.0 m²; wet season mean = 375.7 m²) tends to be larger than that of females (dry season mean = 57.1 m²; wet season mean = 92.2 m²). Individual frogs may shift their home range due to reasons such as competition, predation, or unfavorable environmental conditions, leading to the formation of metapopulations between nearby habitats that fall within a 5 mile range. Adults will move between these sites via connecting waters or overland during seasonal rainfall events. Adults and juveniles may also wander extensively during wet weather while tadpoles can be washed into new habitats by increased streamflow after rainfall events (USFWS 2007, 2014).

HABITAT REQUIREMENTS

The Chiricahua leopard frog is a habitat generalist that can be found in a variety of natural or manmade aquatic habitats including cienegas, springs, pools, beaver ponds, livestock tanks, lakes, reservoirs, streams, and rivers at elevations of 3,281 to 8,890 feet (1,000 to 2,710 meters). They are also occasionally found in livestock drinkers, irrigation sloughs and acequias, wells, abandoned swimming pools, back yard ponds, and mine adits. Although these frogs are capable of occupying such a wide variety of aquatic habitats, they may often be restricted to springs, livestock tanks, and streams in the upper portions of watersheds where non-native predators either have yet to invade or where habitats are marginal (USFWS 2007, 2012a, 2012b). Chiricahua leopard frogs require permanent or nearly permanent waters characterized by low levels of contaminants, the absence of non-native predators (or occurring at low levels in a complex habitat) and disease, and the existence of corridors for dispersal. Land and water uses that occur within a one-mile radius of a site may have either negative or positive consequences to frog populations and habitat (USFWS 2007).

The aquatic habitat is essential for providing the space, food, and cover necessary to sustain all life stages of Chiricahua leopard frogs. Water quality and persistence is essential for breeding, tadpole development to metamorphosis, overwintering, and the prevention of desiccation. Complex aquatic habitats with a variety of depths, substrates, vegetation, undercut banks, and other cover sites are important for reproduction, foraging, hibernation, and retreat from predation. The adjacent and surrounding upland

habitat and riparian areas provide further opportunities for foraging and basking (USFWS 2007, 2011, 2012b).

Aquatic component

High quality Chiricahua leopard frog habitat often consists of pools of fresh water at least 20 in (0.5 m) deep or greater. These pools need to be permanent enough to support breeding, tadpole development to metamorphosis, survival of frogs, and overwintering. Water bodies can be natural or manmade (e.g., stock ponds), slow-moving streams or pools within streams, off-channel pools, and other ephemeral or permanent water bodies that typically hold water or rarely dry for more than a month. Sites that dry out for one month or more will not provide essential breeding or overwintering habitat. Although they are primarily aquatic, adult frogs may persist in semi-permanent water; however, reproduction is not likely to be successful due to the entirely aquatic nature of eggs and larvae. During periods of drought, or less than average rainfall, these sites may not hold water long enough for individuals to complete metamorphosis, however, they would still be considered essential breeding habitat in wet years (as long as water was present for at least 3 months to allow for metamorphosis) or as a stepping stone for dispersing frogs. Furthermore, occasional drying for short periods (less than one month) may be beneficial in that the adult frogs may survive, while nonnative predators, particularly fish and in some cases, American bullfrogs and populations of aquatic forms of tiger salamanders, will be eliminated during the dry period (USFWS 2007, 2011, 2012b).

The structure and complexity of the aquatic habitat is important. Water bodies should contain a variety of depths, bankline vegetation, emergent and submerged vegetation, root masses, undercut banks, fractured rock and other substrates, or some combination thereof, however, emergent vegetation must not completely cover the surface of water bodies (USFWS 2012b). Shallow waters with emergent vegetation provide egg deposition, tadpole and adult thermoregulation or basking sites, and foraging sites. Deeper water, root masses, and undercut banks provide refuge from predators and potential hibernacula. Aquatic sites should have substrate (some mud and not just bare rock) that will allow for the growth of algae and diatoms to serve as food for developing tadpoles and to allow for overwintering sites. Overwintering sites of Chiricahua leopard frogs have not been investigated; however, hibernacula (shelter occupied during winter by non-active animals) of similar species include sites at the bottom of well-oxygenated ponds, burial in mud, or inside moist caves (USFWS 2007).

Water quality is another important aspect of the frog's habitat. Chiricahua leopard frogs require fresh water characterized by salinities less than 5 parts per thousand, pH greater than or equal to 5.6, and pollutants absent or minimally present. This includes, but is not limited to, heavy metals, pesticides, mine runoff, fire retardants, or any other pollutants occurring from livestock, agricultural fields, roadside use of salts, or aerial overspray. Frogs are fairly tolerant of variations in water quality but will not likely persist in waters severely polluted with cattle feces or runoff from mine tailings or leach ponds. Table F1 of the Recovery Plan (USFWS 2007) further lists the following water quality parameters suitable for Arizona leopard frogs: Temperatures between 68°-74° Fahrenheit; pH range 7.8-9.0; ammonia not to exceed 0.2 parts per million; nitrite not to exceed 0.1 parts per

million; nitrate not to exceed 10 parts per million; total hardness not to drop below 350 parts per million; calcium hardness not to be less than total hardness; alkalinity between 50-100 parts per million; iron not to exceed 2 parts per million.

Stock ponds often provide great opportunities for implementation of the recovery plan as well as opportunities for ranchers and land managers to participate in recovery. Something as small as a 6.0 ft (1.8 m) diameter steel trough can serve as an important breeding site, especially if that population is part of a metapopulation that can be recolonized from adjacent sites in the event of extirpation. Some of the most robust extant breeding populations are in dirt livestock tanks (USFWS 2011). According to the Chiricahua Leopard Frog Recovery Plan (USFWS 2007 Appendix A), livestock tank management should occur within the context of creating metapopulations, isolated but robust populations, and captive or actively-managed refugia. Primary sites (a permanent water source of ¼ acre size or more with a reliable water source) must contain terrestrial travel corridors or connectivity to secondary sites (smaller source that occasionally goes dry) that will facilitate movement of frogs between sites. Primary sites will facilitate natural emigration to other sites as well as provide translocation stock, while secondary sites provide additional habitat that may be occupied via natural migration during wet years. In order to enhance vegetation, prevent trampling, decrease water degradation, and minimize the spread of chytridiomycosis, it is sometimes recommended that managers consider partial fencing of occupied stock tanks, complete fencing of occupied stock tanks with a supplemental drinker, or the gradual replacement of occupied single tanks with “trick-tanks” or double tanks, one of which could be fenced, while the other left open for livestock access. This type of management, however, should be implemented on a case-by-case basis with stakeholder inclusion. Further enhancement of underwater cover and substrates for egg mass deposition can be achieved by placing logs and branches in water tanks. Careful consideration of placement of tanks as well as regulating public access may be necessary to ensure the tanks do not become reservoirs or stepping stones for non-native species, facilitating their movement across the landscape.

Maintenance of stock tanks prevents earthen tanks from filling-in with sediments and is thus beneficial to both the land manager and leopard frogs. Constructing double tank systems, a small refugia site, or a fence will allow for maintenance that maintains a portion of the tank as escape cover for resident frogs during maintenance, thus is encouraged where feasible. Appendix A of the Recovery Plan has further details on stock tank descriptions, management, and recommendations (USFWS 2007).

Terrestrial Component

Chiricahua leopard frogs are most often encountered in or very near water, generally at breeding locations. Only rarely are they found far from water. They can be found basking or foraging in riparian vegetation and on open banklines out to the edge of riparian vegetation. These upland areas provide essential foraging and basking sites. A combination of open ground and vegetation cover is desirable for basking and foraging, respectively. Vegetation in these areas provide habitat for prey species and protection from terrestrial predators. In particular, Chiricahua leopard frogs use these upland areas during the summer rainy season. They are also known to use corridors between aquatic

sites. Maintaining connections that allow for these movements are crucial for conserving metapopulations (a set of local populations that interact via individuals moving between the local populations). Metapopulation dynamics and dispersal allows for the repopulation of sites where local populations are extirpated through drought, disease or other factors (USFWS 2012).

Dispersal capabilities of Chiricahua leopard frogs indicate they will likely disperse 1.0 mile (1.6 kilometers) overland, 3.0 miles (4.8 kilometers) along ephemeral or intermittent drainages, 5.0 miles (8.0 kilometers) along perennial drainages, or some combination thereof not to exceed 5.0 miles (8.0 kilometers) (USFWS 2007). Areas with ephemeral, intermittent, or perennial water that are generally not suitable for breeding, and associated upland or riparian habitat provide corridors for frogs among breeding sites in a metapopulation. Chiricahua leopard frogs will disperse via overland and nonwetted corridors, where some vegetation cover or structural features (e.g., boulders, rocks, organic debris such as downed trees or logs, small mammal burrows, or leaf litter) provides for shelter, forage, and protection from predators. Corridors should be free of barriers that block movement by Chiricahua leopard frogs, including, but not limited to, cliff faces; urban, industrial, or agricultural development; reservoirs that are 50 acres (20 hectares) or more in size and contain nonnative predatory fish, bullfrogs, or crayfish; highways that do not include frog fencing and culverts; walls; major dams; or other structures that physically block movement (USFWS 2012).

Food Component

Adult Chiricahua leopard frogs eat arthropods and other invertebrates such as beetles, true bugs, and flies as well as fish and snails (Stebbins 1985; Degenhardt et al. 1996). Stomach analyses of other members of the leopard frog complex from the western United States show a wide variety of prey items, including many types of aquatic and terrestrial invertebrates (e.g., snails, spiders, and insects) and vertebrates (e.g., fish, other anurans [including conspecifics], small birds; Stebbins 1951). Riparian vegetation along water bodies as well as emergent and submerged vegetation within water bodies not only provide habitat for frogs but also provide habitat for prey species and are therefore important foraging sites for adult and juvenile frogs. Tadpoles are herbivorous and likely eat available food items including algae, organic debris, plant tissue, and minute organisms in the water (Marti and Fisher 1998). A mix of mud and rock substrates in aquatic sites allows for the growth of algae and diatoms which serve as an important food source for developing tadpoles (USFWS 2007).

Non-Native Predators and Disease

Chiricahua leopard frogs survive best and maintain highest abundances at sites where non-native predators have yet to invade and where chytridiomycosis, an infectious amphibian disease caused by the chytrid fungus *Batrachochytrium dendrobatidis* (Bd) is in low prevalence or has not arrived. Nonnative predators such as crayfish, bullfrogs, and nonnative fish should be absent or occurring at levels that do not preclude the presence of the Chiricahua leopard frog. In a suitable site where Chiricahua leopard frogs have been extirpated, active removal of crayfish, bullfrogs, and nonnative fish alone may be sufficient enough to allow repopulation of a site by Chiricahua leopard frogs. For

example, eliminating bullfrogs in a 5-mile radius of an occupied or potential site can protect a population or allow for recolonization, while occasional drying episodes of short duration may also eliminate bullfrogs and predatory fish (USFWS 2007, 2012b). If these predators are present in essential Chiricahua leopard frog breeding habitat, they should occur only as rare dispersing individuals that do not breed, or are at low enough densities in habitats that are complex (as opposed to simple) and with abundant escape cover so that frogs can persist with the nonnative species (USFWS 2011).

It is also important to avoid introduction of Bd to the aquatic system, or if present, then environmental, physiological, and genetic conditions are such that allow persistence of Chiricahua leopard frogs. Following the guidelines found in Field Work Disease Prevention Protocol (Appendix G of the Recovery Plan (2007)), will help to prevent or reduce the spread of amphibian and other aquatic borne disease through human activity. If chytridiomycosis is present, frogs may be able to survive with the disease or clear it from their systems at warm sites. The precise temperature at which frogs can coexist in the wild with the disease is unknown and may depend on a variety of factors; however, one study (Christman 2006) indicates that winter water temperatures must not drop below about 20°C (68° F). Therefore warmer, southern exposures, lower elevations, and especially warm springs, may be critical for the persistence of Chiricahua leopard frogs as the effects of this disease continue to emerge. A pH of greater than 8 during at least part of the year may also limit the ability of the disease to be an effective pathogen (USFWS 2007, 2011, 2012b).

MONITORING

Individuals must be permitted by both the USFWS and the AGFD in order to conduct scientific research, surveys, and recovery activities for Chiricahua leopard frogs. In order to obtain a permit, surveyors are required to complete a Chiricahua leopard frog survey training workshop. For information contact Christina Akins at cakins@azgfd.gov.

Habitat

Aquatic and riparian ecosystems are influenced by the surrounding uplands and assessment of watershed conditions is an important component of riparian management. There are several guidance documents available pertaining to assessment of bottomland ecosystems and while each governmental agency has their preferred methods, there is no one superior method. The Recovery Plan (USFWS 2007) recommends that any assessment method should “consider criteria (indicators) that can be used to prioritize riparian habitat management, recognizing four major categories of criteria that influence riparian/fluviat ecosystem management: hydrology (including geochemistry and geomorphology), ecological health, cultural resources, and socio-economic variables.” Further details of watershed and channel processes that support aquatic and riparian ecosystems and frog habitat as well as a list and brief description of some of the published stream and riparian assessment and classification protocols can be found in Appendix H of the Recovery Plan, while suitable habitat factors are described in Appendix D (USFWS 2007).

Populations

The Chiricahua leopard frog may occur in a variety of permanent or semi-permanent waters at elevations of 3,281 to 8,890 feet. It is not recommended to survey below the lower elevation limits where frogs are not expected to be found. However, any suitable habitat at or above those limits, including cienegas, pools, beaver ponds, livestock tanks, lakes, reservoirs, streams, rivers, livestock drinkers, irrigation sloughs and acequias, wells, abandoned swimming pools, back yard ponds, and mine adits may potentially be occupied (USFWS 2007).

The following survey and preliminary monitoring protocols (taken from Appendix E of the Recovery Plan) have been adopted by the USFWS and AGFD and are recommended in order to detect Chiricahua leopard frogs where they occur or confirm absence:

Surveys shall include a night visit to all suitable habitats in the project's action area (the area affected directly and indirectly by the action). This will typically involve walking stream and river banks, along the edges of wet meadows, and around the perimeters of stock tanks and lakes in the action area. Surveys shall be carried out with flashlights/headlamps, and a dip net shall be used to sample for tadpoles and frogs concealed in undercut banks or at the base of emergent vegetation. Watch for frogs on banklines, but also floating in the water or visible on the bottom, and in areas away from water - particularly during or after rains. Surveyors shall also listen for the distinctive call of the Chiricahua leopard frog and watch for egg masses. Audible plops may indicate frogs are present, but their identity to species must be confirmed. Plops preceded by an escape call ("eeep") indicate American bullfrog presence. In order to survey when frogs are most active, surveys shall be carried out from April through September, and when water temperatures are at least 14°C at elevations below 5,500 feet and at least 12°C at 5,500 feet and above, and winds are light or absent. A diurnal survey can substitute for a nocturnal survey, but if frogs are not detected, surveyors should return at night. In simple habitats, such as typical livestock tanks with little or no bankline and emergent cover, 2 diurnal surveys carried out at least 3 hours after sunrise can substitute for a nocturnal survey. If surveyors have valid State and Federal permits for collecting, and populations appear large enough to sustain collection, a sample of up to 3 tadpoles should be collected as vouchers. Such a population is defined here as one in which 20 or more adult frogs are visible within 100 meters of shoreline or stock tank perimeter and tadpoles are visibly abundant. If possible, surveyors should note observations of fishes to species, American bullfrogs, crayfish, salamanders, and gartersnakes to species, and other native frogs as well.

Additional information on how to survey sites is contained in Appendix E, Attachment 1, of the Final Recovery Plan which includes the general visual encounter survey (VES) method for both lentic and lotic system. Attachments 2 and 3 of Appendix E include the survey form upon which data should be recorded and instructions for the form (USFWS 2007, Appendix E).

It is vital that surveyors avoid the inadvertent movement of disease or parasitic organisms among sites and are therefore encouraged to follow the *Field Work Disease Prevention Protocol* for working in wetland habitats contained in Appendix G of the Recovery Plan (USFWS 2007).

I. KEY THREATS

- The introduced fungal skin disease, chytridiomycosis.
- Predation by non-native species, especially bullfrogs, fishes (e.g. sport fish) and crayfish.

- Degradation and destruction of habitat, including events such as drought, floods, wildfires, water diversions and groundwater pumping.
 - Livestock grazing, ungulate grazing, dams and reservoirs, mining, agriculture, altered fire regimes,
- Disruption of metapopulation dynamics (relationships among populations of frogs).
- An increased chance of extirpation resulting from small numbers of populations and individuals, and environmental contamination.

STANDARD MITIGATION MEASURES

Maximizing the positive benefits while eliminating, minimizing, or mitigating threats to the frog, requires appropriate watershed use and management guidelines. Habitat management must involve preservation and/or improvement of habitats including maintaining habitat complexity, balancing the hydrological regime, maintaining dispersal corridors and buffer zones, preventing or mitigating the introduction and spread of non-native predators and disease, and minimizing or mitigating the introduction of contaminants harmful to the frog (USFWS 2007).

The *Recommended Conservation Measures for Projects Affecting Frogs* can be found in Appendix I of the Recovery Plan (USFWS 2007). Conservation measures should, to the extent practicable and in order of importance, avoid, minimize, rectify, reduce, and/or compensate for the impacts of a project on the Chiricahua leopard frog and its habitat. The conservation measures in Appendix I should be incorporated into all projects that may affect suitable frog habitats, sites selected for habitat restoration or creation, and movement corridors among sites within management areas. These recommendations cover livestock grazing and management, fire suppression and prescribed fire, flood control, surface-disturbing construction projects (with additional measures for road construction, reconstruction or maintenance, mining, and logging/thinning), hazardous materials including pesticides, recreational developments and activities, monitoring and research activities, projects with long-term effects, groundwater pumping, impoundments, and surface water diversions, habitat buffers, and restoration of disturbed areas.

The *Watershed and Channel Processes that Support Aquatic and Riparian Ecosystems and Chiricahua Leopard Frog Habitat* can be found in Appendix H of the Recovery Plan (USFWS 2007). The information provided in this appendix can be used to help guide management of healthy aquatic systems and watersheds and can help develop watershed use and maintenance plans for watersheds containing extant populations.

- **Maintain standing bodies of fresh water**
 - Salinities less than 5 parts per thousand; Temperatures between 68°-74° Fahrenheit; pH range 7.8-9.0; ammonia not to exceed 0.2 parts per million; nitrite not to exceed 0.1 parts per million; nitrate not to exceed 10 parts per million; total hardness not to drop below 350 parts per million; calcium hardness not to be less than total hardness; alkalinity between 50-100 parts per million; iron not to exceed 2 parts per million.

- Chemical pollutants are absent or minimally present
 - Includes, but is not limited to, heavy metals, pesticides, mine runoff, fire retardants, or any other pollutants occurring from livestock, agricultural fields, roadside use of salts, or aerial overspray
(For specific pesticide use guidelines for minimizing impact, including information on recommended measures, species information, buffer zones and pesticide areas for listed species consult White, 2007.)
- Water must be available in sufficient quality and quantity long enough (> 3 months) for metamorphosis of tadpoles
- Small patches of suitable aquatic habitat must be within the dispersal range of metamorphs (USFWS 2007, pg 47-48)
- Stock tanks/ponds
 - Criteria for a primary site are the amount, reliability, relative permanence of water, and the extent to which frogs can move from a primary site to neighboring sites (see **Habitat Requirements**, stock ponds/tanks above)
 - Stock tanks requiring maintenance should be thoroughly surveyed for frogs by a permitted individual(s) prior to maintenance and, if found, protocols for captive care, transportation, release as well as conservation protocols should be considered and implemented after coordinating with AGFD's Ranid Frogs Project and Scientific Collecting Permit program (see Recovery Plan, 2007, A-8).
 1. To avoid disturbing over-wintering frogs, maintenance activities should be conducted during the period when leopard frogs are most active (April 1 to October 31) unless otherwise recommended by qualified technical advisors.
 2. The Department's Ranid Frogs Project often uses techniques outlined in Tom Biebighauser's *Wetland Restoration and Construction: A Technical Guide* when implementing projects to create more water permanency in suitable frog habitat.
- **Cover – Maintain shore side vegetation and rooted aquatic vegetation as well as root masses, undercut banks, fractured rock substrates, or a combination thereof sufficient to provide refuge from predators and desiccation as well as breeding and foraging habitat.**
 - Emergent vegetation must not completely cover water body surface.
- **Upland Habitat - Provide opportunities for foraging and basking that are immediately adjacent to or surrounding breeding aquatic and riparian habitat with a combination of both riparian vegetation and open bankline.**
- **Food – Maintain vegetation cover and substrate that will allow for the growth of algae and diatoms.**
 - Adults are invertebrate generalists thus increased vegetation cover tends to influence the relative abundance of prey for leopard frogs and provides foraging sites.

- Aquatic sites should have substrate (some mud as well as rock) that will allow for the growth of algae and diatoms to serve as food for developing tadpoles.
- **Avoid the introduction of Bd to the aquatic system, or if present, then environmental, physiological, and genetic conditions are such that allow persistence of Chiricahua leopard frogs.**
 - Minimize exposure to Bd from human activity (adapted from Appendix G of the Recovery Plan (USFWS 2007))
 - If possible, use site dedicated equipment, including footwear, to be cleaned and stored separately.
 - All equipment, including footwear, used for field/survey work or stock tank maintenance, must be disinfected between visits to any other body of water in the following manner:
 1. Rinse and remove all debris
 2. Disinfect with ONE of the following solutions
 - a. Rinsing with household bleach
 - b. 20-second exposure to 70% ethanol or 1 mg/ml benzalkonium chloride
 - c. Desiccation and exposure to 50-60° C heat for 30 minutes
 - d. 0.012% Path-X™ or 0.008% quaternary ammonium compound 128 (both containing DDAC, didecyl dimethyl ammonium chloride as active ingredient)
 3. Following disinfection, rinse copiously with tap water and allow to dry completely
 4. Footwear must be completely cleaned before and between visiting sites; avoid use of felt-bottomed waders.
 5. Equipment should be cleaned at a lab, base camp, or storage facility. If disinfecting in the field is necessary, sanitize all items before arriving at the next location.
 - a. Do not use solutions in the immediate vicinity of the water or in other habitats; dispose of cleaning materials and liquids properly and safely.
 - American bullfrogs and tiger salamanders are often unaffected by chytridiomycosis but can serve as carriers, spreading the disease among sites (Recovery Plan 2007, A-7).
 - Conditions in which chytridiomycosis may coexist or not adversely affect CLF population:
 - Frogs may be able to survive with the disease or clear it from their systems in warm sites. Warmer, southern exposures, lower elevations, and warm springs are critical for the persistence of native leopard frogs as the disease continues to emerge.
- **Non-natives**

- Water bodies should be free from non-native predators including crayfish, fishes, and American bullfrogs, or occurring at levels that do not preclude presence of the Chiricahua leopard frog.
 - Active removal of non-native crayfish, American bullfrogs, and fish, especially in simple systems such as stock tanks, and within a 5-mile radius.
 - Although not optimal, coexistence can occur in habitats that are complex (providing refugia) with low densities of non-native predators
- **Fire suppression and prescribed fire**
 - Properly managed low-severity fire can reduce the likelihood of catastrophic fires and improve habitat conditions in the long term. The following measures are taken directly from the Recovery Plan 2007, Appendix I:
 - An objective of fire suppression should be protection of Chiricahua leopard frogs and their habitats
 - All personnel on the fire should be briefed about protecting the Chiricahua leopard frog and its habitat.
 - On wildfires, Resource Advisors should be designated to coordinate listed species and other resource concerns and serve as an advisor to the Incident Commander. Resource Advisors should monitor fire suppression activities to ensure that protective measures endorsed by the Incident Commander are implemented. The Resource Advisor should also perform other duties as necessary to ensure adverse effects to the Chiricahua leopard frog and its habitat are minimized. Resource Advisors should be on call 24 hours during the fire season.
 - Off-road vehicle activity should be kept to a minimum. Vehicles should be parked as close to roads as possible, and vehicles should use wide spots in roads to turn around. Whenever possible, local fire-fighting units should go off-road first because of their prior knowledge of the area.
 - To the degree possible, crew camps, equipment staging areas, and aircraft landing and refueling areas should be located away from Chiricahua leopard frog populations and sites selected for habitat restoration or creation. Whenever possible, these activities should be located in previously disturbed areas. Any temporary solid and sanitary waste facilities should be located well away from frog habitats. If such activities are located in Chiricahua leopard frog habitats, measures should be taken to limit habitat disturbance and to locate sites in areas with minimal effects to the frog and its habitat (see measures for surface-disturbing construction projects, below).
 - Use of tracked vehicles should be restricted to activities that, in the judgment of the Incident Commander and in consultation with the

Resource Advisor, might save a large area or important resources from fire.

- Fire crews should, to the extent possible, obliterate vehicle tracks made during the fire where presence of tracks is likely to encourage off-road travel by recreationists.
- No fire retardants or suppressants toxic to fish or amphibians should be used over habitats occupied by Chiricahua leopard frogs, tributary drainages, or on the watershed where these chemicals are likely to enter occupied frog habitats.
- Water should not be drafted from stock tanks or other aquatic habitats if Chiricahua leopard frogs are present or likely to be present, or if the site is known to be chytrid-positive. If stock tanks are refilled after a fire, only sources of water known to be free of non-native predators and chytrids (such as well water) should be used as a source. Avoid water drops on Chiricahua leopard frog habitats unless the water is known to be free of non-natives and chytrids.
- If fire burns in the watershed of an extant population of frogs and in the judgment of the Resource Advisor will result in significant ash or sediment flow into that habitat, measures such as construction of waterbars in firelines, etc. should be implemented to direct flow away from frog habitats. If ash and/or sediment flow is likely to occur despite these measures, frogs and tadpoles should be salvaged and held at a holding facility until toxic conditions abate or habitat can be restored. If possible, at least 20 frogs and/or 100 tadpoles should be salvaged. Salvage can often wait until the fire is controlled in the area of the habitat. Ash and sediment flow will not be a problem until significant rainfall occurs. Appendices C, E, and I provide guidance on establishing refugia, and care and transport of frogs. It is imperative that unwanted genetic mixing not occur, that the frogs are not brought into contact with exotic diseases during salvage or at the holding facility, and that any repatriations are done carefully to avoiding moving anything except the frogs (ie., unwanted snails, algae, fish, etc.) back to re-release sites.
- Rehabilitation of the burned areas should be undertaken, including seeding, planting of native perennial species, etc. Watersheds of occupied habitat and sites selected for habitat restoration/creation should be rested from grazing for the first two summer growing seasons (July, August, and September) following the fire.
- Recovery of vegetation should be monitored.
- The effectiveness of suppression activities and these measures should be evaluated after a fire. Procedures should be revised as needed.
- Only light burns should occur in the watersheds of occupied Chiricahua leopard frog habitats and sites selected for habitat

restoration/creation. However, if higher intensity burns occur and biologists predict that ash or sediment may flow into frog habitats, measure 10 for fire suppression, above, should be implemented.

- **Groundwater pumping impoundment and surface water diversions.**
 - Such activity should not be authorized where it would adversely affect occupied CFL sites or project sites selected for restoration or creation. If unavoidable, conservation measures will need to be tailored for individual projects but should include:
 - Relocating the project to a site where effects are minimized.
 - Minimizing the amount or duration of water pumped, diverted or impounded.
 - Providing replacement water to frog habitats to offset impacts.
 - Temporarily relocating frogs if disturbance to hydrology is temporary.
 - Replanting riparian and wetland vegetation if temporary impacts desiccate these plants.
- **Corridors – Maintain suitable aquatic habitat within the dispersal range of metamorphs.**
 - Dispersal corridors should be without barriers and maintained in order to recolonize vacated sites and maintain connections among extant populations.
 - Corridors not more than 1.0 mile (1.6 kilometers) overland, 3.0 miles (4.8 kilometers) along ephemeral or intermittent drainages, 5.0 miles (8.0 kilometers) along perennial drainages, or some combination thereof not to exceed 5.0 miles (8.0 kilometers).
 - Mitigation of barriers where necessary such as providing fencing and culverts under highways.
 - Roads within 0.3 mile of occupied frog habitat or habitats selected for habitat restoration or creation should include a frog barrier fence on each side of the road that is exposed to frog habitat. In cases where such barriers could isolate populations, culverts should be installed to facilitate movement of frogs under the road.
 1. Barrier fencing should consist of flashing or other solid barrier material at least 12 inches high and buried sufficiently to ensure gaps do not form under the barrier.
 2. Hardware cloth with a 0.25-inch mesh may also be used if the top is folded over and out, away from the project site, to prevent frogs from climbing over the barrier.
- **Metapopulations – Manage populations in the form of metapopulations.**
 - A metapopulation should consist of at least four local populations that exhibit regular recruitment, three of which are continually in existence, and geographically arranged in such a way that no local population will be greater than 5.0 mi (8.0 km) from at least one other local population unless facilitated dispersal is planned (refer to #7 regarding corridor component).
 - Metapopulations should include at least one large, healthy subpopulation of at least 100 adults; may be smaller if aquatic habitat can be managed for

persistence through drought periods by supply water via a pipeline or well, or by lining a pond.

- In order to create a buffer against disease spreading rapidly through all populations, isolated but robust breeding populations should also exist and be located at a distance farther than 5 miles (8km) from other Chiricahua leopard frogs, contain at least 60 adults (40-50 if in a drought-resistant habitat), and exhibit a diverse age class distribution that is relatively stable over time.
- Buffer areas between sites with non-natives (see Non-natives above).

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