United States Department of the Interior

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In Reply Refer To:
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January 31, 2006

Memorandum

To: Field Manager, Bureau of Land Management, Tucson, Arizona

From: Field Supervisor, Fish and Wildlife Service, Phoenix, Arizona

Subject: Biological Opinion for Proposed Empire Gulch Chiricahua Leopard Frog Head-Start Facility

Thank you for your request for formal consultation with the U.S. Fish and Wildlife Service (FWS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (Act). Your request was dated August 29, 2005, and received by us on September 6, 2005. At issue are impacts that may result from a proposed Chiricahua leopard frog (*Rana chiricahuensis*) head-start facility and related activities on Empire Gulch, Las Cienegas National Conservation Area (LCNCA), Pima County, Arizona. The proposed action may affect the threatened Chiricahua leopard frog and the endangered Gila topminnow (*Poeciliopsis o. occidentalis*).

This draft biological opinion is based on information provided in your letter, an August 2005 biological evaluation for the project (U.S. BLM 2005), field investigations, our files, and other sources of information. References cited in this opinion are not a complete bibliography of all literature available on the listed species evaluated, effects of head-start facility construction or operation, or on other subjects considered in this opinion. A complete administrative record of this consultation is on file at this office.

CONSULTATION HISTORY

- September 6, 2005. We received your request for consultation and the biological evaluation for the project.

- November 3, 2005. We sent you a draft biological opinion.

- December 29, 2005. We received your comments on the draft biological opinion.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Head-start Facility

The Bureau of Land Management (BLM), Tucson Field Office, in coordination with the U.S. Fish and Wildlife Service (FWS) and Arizona Game and Fish Department (AGFD), propose to establish a population of Chiricahua leopard frogs in Empire Gulch, Pima County (Empire Ranch Field Station T 19S, R. 17E, Sec.18 NE,NE) located approximately 985 feet upstream from Empire Spring, which is currently occupied by Chiricahua leopard frogs. The project area is located north of Sonoita at an elevation of 4,600 feet within the LCNCA. The proposed facility will act as a refuge and head-start site for the last population of Chiricahua leopard frogs at LCNCA, now found only in the upper portion of Empire Gulch. The purpose of the facility is to produce metamorph frogs for augmentation of the Empire Spring population, and also to populate several more developed aquatic habitats in the future, subject to approvals, to further improve the status of this lineage of Chiricahua leopard frog.

The project consists of constructing a frog enclosure, 15' x 30' (450 sq feet) that will contain two 6' diameter, 26" deep polyethylene tubs buried nearly flush with the ground surface to serve as rearing ponds. The ponds will have a 30" tall fence constructed out of hardware cloth (¼" or 1/8" mesh) supported by metal posts. A screen door entrance will be built into both hardware cloth fences. The enclosure (15 x 30' footprint) will be in a superstructure 7' tall covered with "predator netting" (2-4" mesh) comprised of either nylon or metal hardware cloth. A screen door entrance will be attached to the wooden frame of the superstructure. The site will have an additional fence placed around it to make a small (200 sq feet) livestock exclosure inside of the larger livestock-free pasture.

The water supply for the project will be well water from a spigot on an adjoining building (Empire Field Station), carried by crush-proof tubing on or below the ground surface (total distance ca. 50 yards). A float valve will control water levels. Electricity will be supplied by cable along the same path as the water supply. The electricity will be used to pump and circulate water through a biological filter system inside the enclosure. Native plants and rocks will be used inside the enclosure and ponds to improve habitat conditions for rearing frogs. Limited supplemental water will be provided to the terrestrial plants in the enclosure.

BLM, AGFD, and FWS will be responsible for collecting frogs, eggs, and tadpoles. Collection activities will be covered by a 10(a)(1)(A) Scientific Collection Permit. The project proposal consists of collecting eggs and newly hatched tadpoles from Empire Gulch Spring in quantities that do not exceed 20 percent of the current available egg or tadpole segment of the frog population. The precise number of Chiricahua leopard frog eggs and tadpoles collected will depend on what is available and will not exceed a total of 300 eggs or tadpoles over three years. Eggs and tadpoles will be collected by experienced biologists with the appropriate State and Federal permits and moved to the frog enclosure. Standard precautions will be utilized to prevent the introduction of chytridiomycosis to leopard frog populations at Empire Gulch Spring

and to newly created populations at the project site through routine sterilization of collecting equipment, handling equipment and boots, as described at the Chiricahua Leopard Frog Certification Workshop given by the AGFD and FWS.

After the eggs and tadpoles have been reared in the two ponds to a juvenile (metamorph) size class, they will be allowed to emigrate down to Empire Spring or will be translocated to other refuge sites as they are developed on the LCNCA to create new populations of this lineage of Chiricahua leopard frog. These new sites are planned to be developed over the next two years.

The ponds and related facilities will be monitored on a regular basis (twice weekly) by BLM (on-site ranger and biologists) and University of Arizona (Dr. Phillip Rosen) personnel for the three-year duration of the project. Monthly monitoring of the frog and tadpole populations will be conducted by BLM biologists and University personnel to evaluate the success of the project and to adjust habitat parameters and improve rearing conditions. Standard precautions will be used to prevent the introduction of chytridiomycosis to the newly created leopard frog populations through the sterilization of handling equipment and boots.

Conservation Measures

The proposed action is designed to contribute to the recovery of this species. However, capture, sorting, and handling stress and related (often delayed) mortality to the donor and transfer populations of Chiricahua leopard frogs can be limited to a great extent by using the following precautions [most of which apply to the 10(a)(1)(A) permit]:

1) Tadpoles and eggs will be held for less than one hour and released after temperature acclimation at the new location in order to reduce mortality from handling and transportation stress.

2) Tadpoles and eggs with apparent disease or parasites will be culled from the stock to be translocated.

3) Tadpoles collected by seine would not be “beached” but rather “bagged” and left in the water and dipped out as necessary.

4) FWS-recommended leopard frog egg mass and tadpole collection and transportation protocols will be followed.

5) The exclosure will be monitored by BLM staff for trespass livestock and livestock will be promptly removed by the permittee.

6) No more than 20 percent of available eggs or tadpoles (not to exceed a total of 300 eggs or tadpoles over three years) will be collected from Empire Spring to populate the head-starting facility.

STATUS OF THE SPECIES
Chiricahua leopard frog

The Chiricahua leopard frog was listed as a threatened species without critical habitat in a Federal Register notice dated June 13, 2002 (USFWS 2002a). Included was a special rule to exempt operation and maintenance of livestock tanks on non-Federal lands from the section 9 take prohibitions of the Act. The frog is distinguished from other members of the *Rana pipiens* complex by a combination of characters, including a distinctive pattern on the rear of the thigh consisting of small, raised, cream-colored spots or tubercles on a dark background; dorsolateral folds that are interrupted and deflected medially; stocky body proportions; relatively rough skin on the back and sides; and often green coloration on the head and back (Platz and Mecham 1979). The species also has a distinctive call consisting of a relatively long snore of 1 to 2 seconds in duration (Davidson 1996, Platz and Mecham 1979). Snout-vent lengths of adults range from approximately 2.1 to 5.4 inches (Stebbins 2003, Platz and Mecham 1979). Populations of Chiricahua leopard frogs on the Mogollon Rim differ genetically from those in southeastern Arizona, but it is unclear whether the differences are great enough to recognize them as distinct species (Platz and Grudzien 1999, Goldberg *et al.* 2004, Hillis and Wilcox 2005). The Ramsey Canyon leopard frog (*Rana subaquavocalis*) is similar in appearance to the Chiricahua leopard frog, but it reportedly grows to a larger size and has a distinct call that is typically given under water (Platz 1993). Recent genetic work suggests *R. subaquavocalis* and *R. chiricahuensis* may be conspecific (Goldberg *et al.* 2004).

The Chiricahua leopard frog is an inhabitant of cienegas, pools, livestock tanks, lakes, reservoirs, streams, and rivers at elevations of 3,281 to 8,890 feet in central and southeastern Arizona; west-central and southwestern New Mexico; and in Mexico, northern Sonora, and the Sierra Madre Occidental of northern and central Chihuahua (Platz and Mecham 1984, Degenhardt *et al.* 1996, Sredl *et al.* 1997, Sredl and Jennings 2005). Reports of the species from the State of Aguascalientes (Diaz and Diaz 1997) are questionable. The distribution of the species in Mexico is unclear due to limited survey work and the presence of closely related taxa (especially *Rana montezumae* and *R. leomosespinali*) in the southern part of the range of the Chiricahua leopard frog. In New Mexico, of sites occupied by Chiricahua leopard frogs from 1994-1999, 67 percent were creeks or rivers, 17 percent were springs or spring runs, and 12 percent were stock tanks (Painter 2000). In Arizona, slightly more than half of all known historical localities are natural lotic systems, a little less than half are stock tanks, and the remainder are lakes and reservoirs (Sredl *et al.* 1997). Sixty-three percent of populations extant in Arizona from 1993 to1996 were found in stock tanks (Sredl and Saylor 1998).

Die-offs of Chiricahua leopard frogs were first noted in former habitats of the Tarahumara frog (*Rana tarahumarae*) in Arizona at Sycamore Canyon in the Pajarito Mountains (1974) and Gardner Canyon in the Santa Rita Mountains (1977-78)(Hale and May 1983). From 1983 to 1987, Clarkson and Rorabaugh (1989) found Chiricahua leopard frogs at only two of 36 Arizona localities that had supported the species in the 1960s and 1970s. Two new populations were reported. During subsequent extensive surveys from 1994 to 2001, the Chiricahua leopard frog was found at 87 sites in Arizona, including 21 northern localities and 66 southern localities. (Sredl *et al.* 1997, Rosen *et al.* 1996, USFWS files). In New Mexico, the species was found at 41 sites from 1994 to 1999; 31 of those were verified extant during 1998 to 1999 (Painter 2000).

During May to August 2000, the Chiricahua leopard frog was found extant at only eight of 34 sites where the species occurred in New Mexico during 1994 to 1999 (C. Painter, pers. comm. 2000). The species has been extirpated from about 75 percent of its historical localities in Arizona and New Mexico. The status of the species in Mexico is unknown.

Based on Painter (2000) and the latest information for Arizona, the species is still extant in most major drainages in Arizona and New Mexico where it occurred historically; with the exception of the Little Colorado River drainage in Arizona and possibly the Yaqui drainage in New Mexico. It has also not been found recently in many rivers, valleys, and mountains ranges, including the following in Arizona: White River, West Clear Creek, Tonto Creek, Verde River mainstem, San Francisco River, San Carlos River, upper San Pedro River mainstem, Santa Cruz River mainstem, Aravaipa Creek, Babocomari River mainstem, and Sonoita Creek mainstem. In southeastern Arizona, no recent records (1995 to the present) exist for the following mountain ranges or valleys: Pinaleno Mountains, Peloncillo Mountains, Sulphur Springs Valley, and Huachuca Mountains. Moreover, the species is now absent from all but one of the southeastern Arizona valley bottom cienega complexes. In many of these regions Chiricahua leopard frogs were not found for a decade or more despite repeated surveys. Recent surveys suggest the species may have recently disappeared from some major drainages in New Mexico (C. Painter and R. Jennings, pers. comm. 2004).

Threats to this species include predation by nonnative organisms, especially bullfrogs, fish, and crayfish; disease; drought; floods; degradation and loss of habitat as a result of water diversions and groundwater pumping, poor livestock management, altered fire regimes due to fire suppression and livestock grazing, mining, development, and other human activities; disruption of metapopulation dynamics; increased chance of extirpation or extinction resulting from small numbers of populations and individuals; and environmental contamination. Loss of Chiricahua leopard frog populations is part of a pattern of global amphibian decline, suggesting other regional or global causes of decline may be important as well (Carey *et al*. 2001). Numerous studies indicate that declines and extirpations of Chiricahua leopard frogs are at least in part caused by predation and possibly competition by nonnative organisms, including fish in the family Centrarchidae (*Micropterus* spp., *Lepomis* spp.), bullfrogs (*Rana catesbeiana*), tiger salamanders (*Ambystoma tigrinum mavortium*), crayfish (*Orconectes virilis* and possibly others), and several other species of fish (Clarkson and Rorabaugh 1989; Sredl and Howland 1994; Fernandez and Bagnara 1995; Snyder *et al.* 1996; Rosen *et al.* 1994, 1996; Fernandez and Rosen 1996, 1998). For instance, in the Chiricahua region of southeastern Arizona, Rosen *et al.* (1996) found that almost all perennial waters investigated that lacked introduced predatory vertebrates supported Chiricahua leopard frogs. All waters except three that supported introduced vertebrate predators lacked Chiricahua leopard frogs. Sredl and Howland (1994) noted that Chiricahua leopard frogs were nearly always absent from sites supporting bullfrogs and nonnative predatory fish. Rosen *et al.* (1996) suggested further study was needed to evaluate the effects of mosquitofish, trout, and catfish on frog presence.

Recent evidence suggests a chytridiomycete skin fungi, *Batrachochytrium dendrobatidis*, is responsible for global declines of frogs, toads, and salamanders (Speare and Berger 2000, Longcore *et al.* 1999, Berger *et al.* 1998, Hale 2001). Although the cause of death is uncertain, a thickening of the skin on the feet, hind legs and ventral pelvic region is thought to interfere with

water and gas exchange, leading to death of the host (Nichols *et al.* 2001). The proximal cause of extinctions of two species of Australian gastric brooding frogs and the golden toad (*Bufo periglenes*) in Costa Rica was likely chytridiomycosis. Another species in Australia for which individuals were diagnosed with the disease may be extinct (Daszak 2000). In Arizona, chytrid infections have been reported from four populations of Chiricahua leopard frogs (M. Sredl, pers. comm. 2000), as well as populations of several other frogs and toads (Morell 1999, Davidson *et al.* 2000, Sredl and Caldwell 2000, Hale 2001, Bradley *et al.* 2002). In New Mexico, chytridiomycosis was identified in a declining population near Hurley, and patterns of decline at three other populations are consistent with chytridiomycosis (R. Jennings, pers. comm. 2000). Die-offs occur during the cooler months from October-February. High temperatures during the summer may slow reproduction of chytrids to a point at which the organism cannot cause disease (Bradley *et al.* 2002). Rollins-Smith *et al.* (2002) also showed that chytrid spores are sensitive to antimicrobial peptides produced in ranid frog skin. The effectiveness of these peptides is temperature dependent and other environmental factors probably affect their production and release (Matutte *et al.* 2000).

The role of the fungi in the population dynamics of the Chiricahua leopard frog is as yet undefined; however, there is increasing evidence for amphibian population declines correlated with chytrid infections (Carey *et al.* 2003). It is clear that Chiricahua leopard frog populations can exist with the disease for extended periods. The frog has coexisted with chytridiomycosis in Sycamore Canyon, Arizona since at least 1972. However, at a minimum, it is an additional stressor, resulting in periodic die-offs that increase the likelihood of extirpation and extinction. It may well prove to be an important contributing factor in observed population decline, and because of the interchange of individuals among subpopulations, metapopulations of frogs may be particularly susceptible. Rapid death of all or most frogs in stock tank populations in a metapopulation of Chiricahua leopard frogs in Grant County, New Mexico was attributed to post-metamorphic death syndrome (Declining Amphibian Populations Task Force 1993). Hale and May (1983) and Hale and Jarchow (1988) believed toxic airborne emissions from copper smelters killed Tarahumara frogs and Chiricahua leopard frogs in Arizona and Sonora. However in both cases, symptoms of moribund frogs matched those of chytridiomycosis. The disease has now been documented to have been associated with Tarahumara frog die-offs since 1974 (Hale 2001). The earliest record for chytridiomycosis in Arizona (1972) roughly corresponds to the first observed mass die-offs of ranid frogs in Arizona.

Epizootiological data from Central America and Australia (high mortality rates, wave-like spread of declines, wide host range) suggest introduction of the disease into naive populations and the disease subsequently becoming enzootic in some areas. Alternatively, the fungus may be a widespread organism that has emerged as a pathogen because of either higher virulence or an increased host susceptibility caused by other factors such as environmental changes (Berger *et al.* 1998), including changes in climate or microclimate, contaminant loads, increased UV-B radiation, or other factors that cause stress (Carey *et al.* 1999, 2001; Daszak 2000; Pounds and Crump 1994). Morehouse *et al.* (2003) found low genetic variability among 35 fungal strains from North America, Africa, and Australia, suggesting that the first hypothesis – that it is a recently emerged pathogen that has dispersed widely – is the correct hypothesis. If this is the case, its rapid colonization could be attributable to humans. The fungus does not have an airborne spore, so it must spread via other means. Amphibians in the international pet trade

(Europe and USA), outdoor pond supplies (USA), zoo trade (Europe and USA), laboratory supply houses (USA), and species recently introduced (*Bufo marinus* in Australia and American bullfrog in the USA and Uruguay) have been found infected with chytrids, suggesting human-induced spread of the disease (Daszak 2000, Mazzoni *et al.* 2003). Recently, retrospective analysis revealed presence of chytridiomycosis in African clawed frogs (*Xenopus laevis*) dating to 1938 (Weldon *et al.* 2004). Further evidence showed the disease was a stable endemic in southern Africa for at least 23 years before any chytrid-positive amphibian specimen was found outside of Africa. African clawed frogs were exported from Africa for use in human pregnancy testing beginning in the 1930s. Weldon *et al.* (2004) suggest that Africa is the origin of the disease and that international trade in African clawed frogs was the means of disease dissemination. Once introduced to the Southwest via escaped or released clawed frogs, the disease may have spread across the landscape by human introductions or natural movements of secondarily-infected American bullfrogs, tiger salamanders, leopard frogs.

Free-ranging healthy bullfrogs with low-level chytriodiomycosis infections have been found in southern Arizona (Bradley *et al.* 2002). Tiger salamanders and bullfrogs can carry the disease without exhibiting clinically significant or lethal infections. When these animals move, or are moved by people, among aquatic sites, chytridiomycosis may be carried with them (Collins *et al.* 2003). Other native or nonnative frogs may serve as disease vectors or reservoirs of infection, as well (Bradley *et al.* 2002). Chytrids could also be spread by tourists or fieldworkers sampling aquatic habitats (Halliday 1998). The fungus can exist in water or mud and thus could be spread by wet or muddy boots, vehicles, cattle, and other animals moving among aquatic sites, or during scientific sampling of fish, amphibians, or other aquatic organisms. The Service and Arizona Game and Fish Department are employing preventative measures to ensure the disease is not spread by aquatic sampling.

An understanding of the dispersal abilities of Chiricahua leopard frogs is key to determining the likelihood that suitable habitats will be colonized from a nearby extant population of frogs. As a group, leopard frogs are surprisingly good at dispersal. In Michigan, young northern leopard frogs (*Rana pipiens*) commonly move up to 0.5 mile from their place of metamorphosis, and three young males established residency up to 8.4 miles from their place of metamorphosis (Dole 1971). Both adults and juveniles wander widely during wet weather (Dole 1971). In the Cypress Hills, southern Alberta, young-of-the year northern leopard frogs successfully dispersed to downstream ponds 3.4 miles from the source pond, upstream 0.6 mile, and overland 0.6 mile. At Cypress Hills, a young-of-the-year northern leopard frog moved 13 miles in one year (Seburn *et al.* 1997). The Rio Grande leopard frog (*Rana berlandieri*) in southwestern Arizona has been observed to disperse at least one mile from any known water source during the summer rainy season (Rorabaugh 2005). After the first rains in the Yucatan Peninsula, leopard frogs have been collected a few miles from water (Campbell 1998). In New Mexico, Jennings (1987) noted collections of Rio Grande leopard frogs from intermittent water sources and suggested these were frogs that had dispersed from permanent water during wet periods.

Dispersal of leopard frogs away from water in the arid Southwest may occur less commonly than in mesic environments in Alberta, Michigan, or the Yucatan Peninsula during the wet season. However, there is evidence of substantial movements even in Arizona. Movement may occur via movement of frogs or passive movement of tadpoles along streamcourses. The maximum

distance moved by a radio-telemetered Chiricahua leopard frog in New Mexico was 2.2 miles in one direction (R. Jennings, C. Painter, pers. comm. 2004). In 1974, Frost and Bagnara (1977) noted passive or active movement of Chiricahua and Plains (*Rana blairi*) leopard frogs for 5 miles or more along East Turkey Creek in the Chiricahua Mountains. In August, 1996, Rosen and Schwalbe (1998) found up to 25 young adult and subadult Chiricahua leopard frogs at a roadside puddle in the San Bernardino Valley, Arizona. They believed that the only possible origin of these frogs was a stock tank located 3.4 miles away. Rosen *et al.* (1996) found small numbers of Chiricahua leopard frogs at two locations in Arizona that supported large populations of nonnative predators. The authors suggested these frogs could not have originated at these locations because successful reproduction would have been precluded by predation. They found that the likely source of these animals were populations 1.2 to 4.3 miles distant. In the Dragoon Mountains, Arizona, Chiricahua leopard frogs breed at Halfmoon Tank, but frogs occasionally turn up at Cochise Spring (0.8 mile down canyon in an ephemeral drainage from Halfmoon Tank) and in Stronghold Canyon (1.1 mile down canyon from Halfmoon Tank). There is no breeding habitat for Chiricahua leopard frogs at Cochise Spring or Stronghold Canyon, thus it appears that observations of frogs at these sites represent immigrants from Halfmoon Tank. In the Chiricahua Mountains, a population of Chiricahua leopard frogs disappeared from Silver Creek stock tank after the tank dried up; but frogs then began to appear in Cave Creek, which is about 0.6 mile away, again, suggesting immigration. Movements away from water do not appear to be random. Streams are important dispersal corridors for young northern leopard frogs (Seburn *et al.* 1997). Displaced northern leopard frogs will home, and apparently use olfactory and auditory cues, and possibly celestial orientation, as guides (Dole 1968, 1972). Rainfall or humidity may be an important factor in dispersal because odors carry well in moist air, making it easier for frogs to find other wetland sites (Sinsch 1991).

Additional information about the Chiricahua leopard frog can be found in Platz and Mecham (1979, 1984), Sredl and Howland (1994), Jennings (1995), Rosen *et al.* (1994, 1996), Degenhardt *et al.* (1996), Sredl *et al.* (1997), Painter (2000), and Sredl and Jennings (2005).

Gila topminnow

The Gila topminnow was listed as endangered in 1967 without critical habitat (USFWS 1967). The reasons for decline of this fish include past dewatering of rivers, springs, and marshlands, impoundment, channelization, diversion, regulation of flow, land management practices that promote erosion and arroyo formation, and the introduction of predacious and competing nonindigenous fishes (Miller 1961, Minckley 1985). Life history information can be found in the 1984 recovery plan (USFWS 1984), the draft revised Gila topminnow recovery plan (Weedman 1999), and references cited in the plans.

Gila topminnow are highly vulnerable to adverse effects from nonindigenous aquatic species (Johnson and Hubbs 1989). The introduction of many predatory and competitive nonindigenous fish, frogs, crayfish, and other species, made it difficult for Gila topminnow to survive in many of their former habitats, or the small pieces of those habitats that had not been lost to human alteration. Historically, the Gila topminnow was abundant in the Gila River drainage and was one of the most common fishes of the Colorado River basin, particularly in the Santa Cruz system (Hubbs and Miller 1941).

ENVIRONMENTAL BASELINE

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

The action area is that area in which effects of the action will occur. In this case, the action area includes the proposed facility site near Empire Spring at LCNCA, as well as areas to which the frogs, once released from the facility, may move to. Reasonable dispersal distance is considered to be about five miles (see review in Status of the Species); therefore, the action area also includes a five-mile radius around the facility.

Most land in the area is owned by the Arizona State Land Department and the BLM. Several BLM actions at Las Cienegas NCA have undergone section 7 consultation. The Cienega Creek diversion flood damage emergency (2-21-90-F-196) underwent formal consultation in 1990. The
Cienega Creek permanent canal control structure was consulted on in 1991 (2-21-91-F-160). The Cienega Creek headcut repair and fencing project completed consultation in 1994 (2-21-93-F-430). Cienega Creek interim grazing plan was consulted on in 1994 (2-21-95-F-177). The Cienega Creek stream restoration project was formally consulted on in 1998 (2-21-98-F-430). The Gila topminnow reestablishment in Empire Gulch was consulted on in 2001 (2-21-02-F-014)(USFWS 2001). Finally, the Las Cienegas Resource Management Plan was consulted on in 2002 (02-21-02-F-0162)(USFWS 2002b). Several of the formal consultations have been reinitiated and there have also been several informal consultations.

The BLM holds the grazing lease for State Trust Lands in the area. Grazing on the State Trust Land and BLM land is managed as one grazing allotment. There are no non-Federal actions that are likely to occur that would impact the proposed project or the immediate action area.

A. Status of the species within the action area

Rosen and Caldwell (2004) documented the past and present distribution of Chiricahua leopard frogs at LCNCA. They found that both the lowland (*Rana yavapaiensis*) and Chiricahua leopard frogs have declined precipitously since the 1990's with the lowland leopard frog completely eliminated from the creek and the Chiricahua leopard frog now rare. Currently, the distribution of this frog is limited to upper Empire Gulch near the historic Empire Ranch and in the reach from the head waters of Cienega Creek downstream to its confluence with Empire Gulch (Rosen and Caldwell 2004).

Cienega Creek is one of the last places in Arizona supporting an intact native fish fauna which is uncontaminated by nonindigenous fish, though bullfrogs are now present (Jeff Simms, and Dennis Caldwell, pers. comm., 2001). Cienega Creek provides habitat essential for the survival

of the Gila topminnow (Weedman 1999). It is one of nine extant natural topminnow sites (Voeltz and Bettaso 2003), and one of only three natural sites not contaminated by mosquitofish.

In addition, Cienega Creek supports by far the largest population of topminnow in the U.S. A fall population estimate for Cienega Creek was about 2.5 million topminnow, conservatively, for 6.5 miles of perennial habitat sampled. Another 1.1 mile of topminnow habitat in Mattie Canyon and 0.9 mile in Empire Gulch, tributaries to Cienega Creek, were not included in this estimate. Some areas of warmer groundwater discharge held extremely high densities of topminnow (Simms and Simms 1992). Gila topminnow were released into Empire Gulch in 2001 (USFWS 2001). Additional releases have been completed and others are planned. Gila topminnow are currently rare in Empire Gulch.

B. Factors affecting species environment within the action area

A general listing of threats that have contributed to the declining status of the Chiricahua leopard frog and that ultimately triggered the listing of the species as threatened is presented in the section entitled "Status of the Species". These threats are primarily human-caused factors.

Rosen and Caldwell (2004) suggest the decline of the Chiricahua leopard frog at LCNCA is likely the result of chytridiomycosis and bullfrog predation. This is one of very few sites where Chiricahua leopard frogs coexist with bullfrogs. Generally, where bullfrogs occur, they have eliminated native leopard frogs through predation, competition, or disease transmission. However, in rare instances, in complex habitats with dense cover, the two can coexist, particularly where bullfrogs densities are low, which is the case at Cienega Creek/Empire Gulch. The action area is also one of a few sites where Chiricahua leopard frogs coexist with chytridiomycosis. Sites where such coexistence occurs are typically warm springs or lower and warmer sites. Die-offs typically occur during the winter months (Bradley *et al.* 2002), thus cold temperatures are likely somehow linked to susceptibility to the disease. In these areas where frogs can persist with the disease, selection may be occurring in frog populations and/or chytrid populations to allow persistence of both the frog and chytrid (see Rettalick *et al.* 2004). If disease resistance is developing, these frog populations could be especially valuable for recovery.

Populations of Gila topminnow have waxed and waned in Cienega Creek since it was acquired by the BLM. Currently, topminnow populations occur in a smaller portion of the creek than formerly. Several factors contribute to this reduced distribution (Jeff Simms, pers. comm., 2005; Service files; pers. obs.). Removal of most livestock use of the creek has resulted in greater amounts of riparian and aquatic vegetation. When this additional vegetation dies and falls into the water, it creates an additional demand on the dissolved oxygen required for fish respiration. In addition, drier conditions that occurred during the last several years have reduced the amount and extent of surface flow. The surface flow and groundwater subflow, in combination with greater amounts of decaying vegetation, have created areas where oxygen in the water cannot sustain fish. The headwaters area and other areas are now fishless because of the anoxic conditions.

Cattle grazing and recreation also occur in the action area and have some potential to affect both the frog and topminnow and their habitat. The effects of these activities were described in U.S. Fish and Wildlife Service (2002b).

EFFECTS OF THE PROPOSED ACTION

"Effects of the action" refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

If successful, the proposed frog head-start facility will benefit the Chiricahua leopard frog population in the LCNCA because it will 1) increase survivorship from the egg to metamorph, 2) provide metamorph frogs for augmenting the Empire Spring population and for translocation projects and new populations of frogs within the LCNCA, and 3) create an off-channel rearing site that would not be subject to flooding, fire or other potential natural events that may adversely affect frogs in Empire Gulch and Cienega Creek. During a Population and Habitat Viability Workshop in December 2004, participants estimated that each breeding female frog probably produces on average about 10 offspring per year that survive to metamorphosis. Females probably produce about one egg mass per year, each of which contains 300 to 1,485 eggs (Sredl and Jennings 2005); hence, survivorship from egg to metamorph is about 0.6 to 3.0 percent in the wild. Based on experience with headstarted ranid egg masses at the Phoenix Zoo and other facilities, survivorship to metamorphosis can be 50 percent or more, so that headstarting is a very efficient means to increase productivity of frogs. The LCNCA facility will not likely have the success of the Phoenix Zoo, which is highly controlled, where tadpoles are fed nutritious diets, and where predators are absent. The LCNA facility will exclude larger predators, but giant water bugs (*Lethocerus* sp.) and other invertebrate predators, garter snakes, and perhaps other predators will reduce survivorship. However, in a similar facility that contained invertebrate predators at Buenos Aires National Refuge, about 40 percent of Tarahumara frog (*Rana tarahumarae*) tadpoles survived to become late stage tadpoles or metamorph frogs. Metamorphs produced at the facility would either be allowed to move back to Empire Spring or could be moved (subject to approvals by us, Arizona Game and Fish Department, and others where appropriate) to other suitable habitats at LCNCA.

Up to 300 eggs or tadpoles will be "taken" from Empire Spring over a three-year period and moved to the facility, and some animals could die or be injured in the process, or during rearing. In addition, this would represent a loss of frogs from the wild population, although the BLM proposes that no more than 20 percent of available eggs or tadpoles would be collected. The BLM has received a section 10(a)(1)(A) recovery permit from us for this activity. The permit contains conditions to minimize adverse effects to the species. The BLM states that they will follow our leopard frog egg mass and tadpole collection and transportation protocols during operations. These protocols were developed by Dr. Kevin Wright, formerly at the Phoenix Zoo, and have been used extensively in leopard frog projects in Arizona. Typically little or no mortality occurs if the protocols are followed.

Some small number of eggs or tadpoles may be killed or injured during monitoring and occasional maintenance of the facility, including cleaning out excess vegetation or algae, replumbing water systems, and other maintenance. As with capture of tadpoles and egg masses, stress associated with monitoring or maintenance may result in some mortality. The BLM (2005) anticipates some mortality of reared animals from recreational and grazing activities, but they are taking steps to minimize such effects and make the case that such effects are unlikely. The facility will be in close proximity to the Empire Field Station and will be largely hidden from view, so opportunities for vandalism are few. The facility will be in a livestock exclosure and, if livestock enter the facility, they should be quickly detected by staff and the problem corrected. As a result, we anticipate little mortality from these causes.

The BLM proposes to allow metamorph frogs to move from the head-start facility back to Empire Spring, which is a distance of 985 feet. This is quite a distance for a metamorph frog to move and many will likely be eaten, desiccate before reaching water, or move in a direction away from Empire Spring and never reach suitable habitat. A policy of physically moving the metamorphs to Empire Spring or other sites targeted to receive frogs would eliminate this loss. Chytridiomycosis is known from the Cienega Creek area. Although the BLM has proposed measures to reduce the likelihood of disease moving into the facility, we believe chytridiomycosis will probably show up there. It is likely that tadpoles, which contract the disease, transferred from Empire Spring to the facility will be infected and will infect the facility. Invertebrates moving between the spring or Empire Gulch and the facility could also carry chytrids. Even if chytrids can be excluded from the facility, when metamorphosed frogs move back to Empire Spring/Gulch, they will be exposed to it. Although tadpoles contract the disease, they apparently do not die from it. Metamorphosed frogs are more susceptible to the disease because of their keratinized skin, which the fungus attacks. Although some metamorphosed frogs are likely to die from the disease, particularly during winter or early spring, we expect a large number will survive. BLM is having frogs tested at Arizona State University to determine the presence or absence of chytrid fungus infection in the Empire Gulch leopard frog population. As mentioned, selection may be occurring in this population which may result in more disease-resistant Chiricahua leopard frogs.

The effects of the proposed action on Gila topminnow are uncertain. Adult Chiricahua leopard frogs eat invertebrates. However, since Gila topminnow are small, it is possible that the frogs may rarely prey on topminnow. How much predation may occur may be dependent on how many frogs are present. If the frog population is near carrying capacity, predation on fish may be more likely, especially if the frog's normal prey items are reduced. It is not likely that invertebrate prey items will be reduced, except in extraordinary circumstances. The proposed action may serve to increase the frog population in Empire Gulch. It is unknown what the carrying capacity for frogs at Empire Gulch is, or how near the current population is to carrying capacity.

Cumulative Effects

Cumulative effects are those impacts of future non-Federal (State, local government, and private) actions that are reasonably certain to occur in the project area. Future Federal actions will be

subject to the consultation and conferencing requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed project.

Because the action area is Federal land, most activities that could affect the frog will be Federal actions subject to section 7. The primary cumulative effects in the action area are due to passage of illegal immigrants and smugglers, but these are relatively few and are not expected to impact the facility.

The pumping of groundwater in the Sonoita area could affect the quality of the riparian habitat in the project area. This activity can result in lower stream flows or complete drying of the stream course for all or part of the year. The result could be reduced survival of cottonwood and willow, species requiring water available to their root zones throughout the year. Salt cedar may gain a competitive advantage and dominate the plant community if water-use trends continue.

The loss of native fish may occur from the presence of nonnative fish and amphibians. These nonnative species find their way into the system through accidental introduction, and humans may transport them. Flooding can also move nonnative fish and frogs from reservoirs or ponds in the watershed to downstream habitats occupied by native fishes. This contamination of native fish habitat with nonnative fish and frogs often results in the loss of entire populations through predation or competition (Miller 1961, Minckley and Deacon 1991).

CONCLUSION

After reviewing the current status of the Chiricahua leopard frog, the environmental baseline for the action area, the effects of the proposed Chiricahua leopard frog head-starting facility, and the cumulative effects, it is our biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of the Chiricahua leopard frog. No critical habitat has been designated for the species, thus none will be affected. Our rationale for this conclusion is summarized here:

1) Although some incidental mortality or injury of eggs or tadpoles is likely to occur, survivorship from egg to metamorph is expected to substantially increase over what would occur in the wild. The metamorphs produced at the facility will be used to augment the frog population at Empire Spring or to create new populations elsewhere at LCNCA. These activities will help ensure the persistence of the frog at LCNCA, and hence contribute to recovery.

2) The BLM proposes to use our protocols for capture and transport of egg masses and tadpoles, which have a high rate of success and low mortality.

3) The location of the facility within a livestock exclosure, near the Empire Field Station, and out of sight, reduces the likelihood of damage or vandalism from livestock or recreationists, respectively.

After reviewing the current status of the Gila topminnow, the environmental baseline for the action area, the effects of the proposed Chiricahua leopard frog head-starting facility, and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to

jeopardize the continued existence of the endangered Gila topminnow. No critical habitat has been designated; thus, none would be affected. We base this conclusion on the following:

1) The proposed conservation measures will minimize effects to the species and its habitat.

2) Chiricahua leopard frog predation on topminnow is likely to be rare, and may not be increased at all at Empire Gulch by the proposed action.

3) Gila topminnow are currently rare in Empire Gulch, though efforts to increase the population are planned.

4) A very small portion of habitat in Las Cienegas will be affected by the project.

5) Gila topminnow are highly fecund, and any impacts from rare predation by leopard frogs will have little to no impact.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined (50 CFR 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined (50 CFR 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the BLM so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The BLM has a continuing duty to regulate the activity covered by this incidental take statement. If the BLM (1) fails to assume and implement the terms and conditions or (2) fails to require the (applicant) to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the BLM must report the progress of the action and its impact on the species to the FWS as specified in the incidental take statement. [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

We anticipate Chiricahua leopard frogs will be taken incidental to the operation of the head-starting facility in the following forms:

1) Twenty eggs or tadpoles as a result of handling stress during movement of animals from Empire Spring to the facility, monitoring, and during maintenance on the facility.

2) Thirty percent of metamorphs produced at the facility due to predation, desiccation, and other factors involved with moving from the facility to Empire Spring, a distance of 985 feet.

If more than 20 dead or injured tadpoles or eggs are encountered, and their death or injury is attributable to the proposed action, incidental take will have been exceeded. Mortality as described in # 2 above is not likely to be detected, because small frogs will be difficult to detect, will be eaten, or will be rapidly scavenged.

We anticipate that incidental take of the Gila topminnnow will be difficult to detect because dead fish will be difficult to find if they are eaten by leopard frogs. However, the authorized level of take will be considered exceeded if: More than 5 dead Gila topminnow are found at the project site during activities in the active channel.

EFFECT OF THE TAKE

In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to the species.

REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the BLM must comply with the following reasonable and prudent measures and their implementing terms and conditions. These measures and terms and conditions are non-discretionary.

The BLM will ensure that mortality and injury due to handling stress and maintenance activities is minimized.

1) The BLM shall not disturb egg masses once translocated to the facility, and minimize netting or other capture of tadpoles at the facility during monitoring.

2) When cleaning the ponds or doing other maintenance at the facility, workers shall take all reasonable precaution to prevent disturbing eggs masses and tadpoles. If excess vegetation is removed, it shall be carefully checked to make sure tadpoles are not trapped, and such tadpoles shall be quickly returned to the ponds.

The BLM shall ensure that mortality of metamorphs is minimized during their return to Empire Spring.

1) Rather than allowing the metamorphs to move on their own from the facility to Empire Spring, when deemed appropriate by BLM biologists, Arizona Game and Fish Department or we

will be contacted to physically move the frogs to Empire Spring. Alternatively, the BLM could obtain permits from us and Arizona Game and Fish Department to accomplish this task.

Disposition of Dead or Injured Listed Species

Upon locating a dead, injured, or sick listed species initial notification must be made to the FWS's Law Enforcement Office, 2450 W. Broadway Rd, Suite 113, Mesa, Arizona, 85202, telephone: 480/967-7900) within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a photograph if possible, and any other pertinent information. The notification shall be sent to the Law Enforcement Office with a copy to this office. Care must be taken in handling sick or injured animals to ensure effective treatment and care, and in handling dead specimens to preserve the biological material in the best possible state.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. We recommend you implement the following conservation recommendations for the Chiricahua leopard frog.

1) When the recovery plan is completed for the Chiricahua leopard frog, assist us in implementing it.

2) Work with us and the Arizona Game and Fish Department to identify and approve sites at LCNCA suitable for establishing populations of Chiricahua leopard frogs with progeny from the head-start facility.

REINITIATION NOTICE

This concludes formal consultation for the proposed Empire Gulch Chiricahua leopard frog head-start facility at the LCNCA. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

We appreciate your efforts to conserve and recover the Chiricahua leopard frog and other listed species in your jurisdiction. For further information please contact Doug Duncan (520) 670-

6150, Jim Rorabaugh (602) 242-0210 (x238), or Sherry Barrett (520) 670-6150. Please refer to the consultation number, 02-21-05-F-0835, in future correspondence concerning this project.

Sincerely,

/s/ Steven L. Spangle
Field Supervisor

cc: Assistant Field Supervisor, Fish and Wildlife Service, Tucson, AZ
BLM, Arizona State Office, Phoenix, AZ

Branch Chief, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ
Regional Supervisor, Arizona Game and Fish Department, Tucson, AZ

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REFERENCES CITED

Berger L., R. Speare, P. Daszak, D.E. Green, A.A. Cunningham, C.L. Goggins, R. Slocombe, M.A. Ragan, A.D. Hyatt, K.R. McDonald, H.B. Hines, K.R. Lips, G. Marantelli, and H. Parkes. 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. Proceedings of the National Academy of Science, USA 95:9031-9036.

Bradley, G.A., P.C. Rosen, M.J. Sredl, T.R. Jones, and J.E. Longcore. 2002. Chytridomycosis in native Arizona frogs. Journal of Wildlife Diseases 38(1):206-212.

Campbell, J.A. 1998. Amphibians and Reptiles of northern Guatemala, the Yucatan, and Belize. University of Oklahoma Press, Norman, Oklahoma.

Carey, C., D.F. Bradford, J.L. Brunner, J.P. Collins, E.W. Davidson, J.E. Longcore, M. Ouellet, A.P. Pessier, and D.M. Schock. 2003. Biotic factors in amphibian population declines. *In* G. Linder, D.W. Sparling, and S.K. Krest, eds., Multiple Stressors and Declining Amphibian Populations: Evaluating Cause and Effect. Society of Environmental Toxicology and Chemistry (SETAC). Pensacola, Florida.

Carey, C., N. Cohen, and L. Rollins-Smith. 1999. Amphibian declines: an immunological perspective, Development and Comparative Immunology 23:459-472.

Carey, C., W.R. Heyer, J. Wilkinson, R.A. Alford, J.W. Arntzen, T. Halliday, L. Hungerford, K.R. Lips, E.M. Middleton, S.A. Orchard, and A.S. Rand. 2001. Amphibian declines and environmental change: use of remote sensing data to identify environmental correlates. Conservation Biology 15(4):903-913.

Collins, J.P., J.L. Brunner, V. Miera, M.J. Parris, D.M. Schock, and A. Storfer. 2003. Ecology and evolution of infectious disease. Pages 137-151 *in* R.D. Semlitsch, Amphibian Conservation. Smithsonian Books, Washington D.C.

Clarkson, R.W., and J.C. Rorabaugh. 1989. Status of leopard frogs (*Rana pipiens* Complex) in Arizona and southeastern California. Southwestern Naturalist 34(4):531-538.

Daszak, P. 2000. Frog decline and epidemic disease. International Society for Infectious Diseases. Http://www.promedmail.org.

Davidson, C. 1996. Frog and toad calls of the Rocky Mountains. Library of Natural Sounds, Cornell Laboratory of Ornithology, Ithaca, NY.

Davidson, D., Pessier, A.P., J.E. Longcore, M. Parris, J. Jancovich, J. Brunner, D. Schock, and J.P. Collins. 2000. Chytridiomycosis in Arizona (USA) tiger salamanders. Page 23 *in* Conference and Workshop Compendium: Getting the Jump! On Amphibian Disease. Cairns, Australia, August 2000.

Declining Amphibian Populations Task Force. 1993. Post-metamorphic death syndrome. Froglog 7:1-2.

Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and reptiles of New Mexico. University of New Mexico Press, Albuquerque.

Diaz, J.V., and G.E.Q. Diaz. 1997. Anfibios y reptiles de Aguascalientes. Grupo Impressor Mexico, Aguascalientes, Aguascalientes, MX.

Dole, J.W. 1968. Homing in leopard frogs, *Rana pipiens*. Ecology 49:386-399.

_____. 1971. Dispersal of recently metamorphosed leopard frogs, *Rana pipiens.* Copeia 1971:221-228.

_____. 1972. Evidence of celestial orientation in newly-metamorphosed *Rana pipiens*. Herpetologica 28:273-276.

Fernandez, P.J., and J.T. Bagnara. 1995. Recent changes in leopard frog distribution in the White Mountains of east central Arizona. Page 4 *in* Abstracts of the First Annual Meeting of the Southwestern Working Group of the Declining Amphibian Populations Task Force, Phoenix, AZ.

Fernandez, P.J., and P.C. Rosen. 1996. Effects of the introduced crayfish *Oronectes virilis* on the native aquatic herpetofauna in Arizona. Report to the Arizona Game and Fish Department, Heritage Program, IIPAM Project No. I94054.

_____, and _____. 1998. Effects of introduced crayfish on the Chiricahua leopard frog and its stream habitat in the White Mountains, Arizona. Page 5 *in* Abstracts of the Fourth Annual Meeting of the Declining Amphibian Populations Task Force, Phoenix, AZ.

Frost, J.S., and J.T. Bagnara. 1977. Sympatry between *Rana blairi* and the southern form of leopard frog in southeastern Arizona (Anura: Ranidae). SW Naturalist 22(4):443-453.

Goldberg, C.S., K.J. Field, and M.J. Sredl. 2004. Ramsey Canyon leopard frogs' (*Rana subaquavocalis*) identity crisis: mitochondrial sequences support designation as Chiricahua leopard frogs (*Rana chiricahuensis*). Journal of Herpetology 38(3):313-319.

Hale, S.F. 2001. The status of the Tarahumara frog in Sonora, Mexico based on a re-survey of selected localities, and search for additional populations. Rep. to USFWS, Phoenix.

_____, and J.L. Jarchow. 1988. The status of the Tarahumara frog (*Rana tarahumarae*) in the United States and Mexico: part II. Report to the Arizona Game and Fish Department, Phoenix, and the Office of Endangered Species, USFWS, Albuquerque, New Mexico.

_____, and C.J. May. 1983. Status report for *Rana tarahumarae* Boulenger. Arizona Natural Heritage Program, Tucson. Rep. to Off. of Endangered Species, USFWS, Albuquerque.

Halliday, T.R. 1998. A declining amphibian conundrum. Nature 394:418-419.

Hillis, D.M., and T.P. Wilcox. 2005. Phylogeny of New World true frogs (*Rana*). Molecular Phylogenetics and Evolution 34:299-314.

Hubbs, C. L., and R. R. Miller. 1941. Studies of the fishes of the order Cyprinodonts. XVII: Genera and species of the Colorado River system. Occas. Papers Mus. Zool., Univ. Mich. 433:1-9.

Jennings, R.D. 1987. The status of *Rana berlandieri*, the Rio Grande leopard frog, and *Rana yavapaiensis*, the lowland leopard frog, in New Mexico. Report to New Mexico Department of Game and Fish, Santa Fe, New Mexico.

_____. 1995. Investigations of recently viable leopard frog populations in New Mexico: *Rana chiricahuensis* and *Rana yavapaiensis*. New Mexico Game & Fish Dept., Santa Fe.

Johnson, J.E., and C. Hubbs. 1989. Status and conservation of poeciliid fishes. Pages 301-331 *in* G.K. Meffe, and F.F. Snelson, eds., Ecology and Evolution of Livebearing Fishes (Poeciliidae). Prentice Hall, Englewood Cliffs, New Jersey. 453pp.

Longcore, J.E., A.P. Pessier, and D.K. Nichols. 1999. *Batracytrium dendrobatidis* gen. Et sp. Nov., a chytrid pathogenic to amphibians. Mycologia 91(2):219-227.

Matutte, B., K.B. Storey, F.C. Knoop, and J.M. Conlon. 2000. Induction of synthesis of an anti-microbial peptide in the skin of the freeze-tolerant frog, *Rana sylvatica*, in response to environmental stimuli. FEBS Lett. 483:135-138.

Mazzoni, R., A.A. Cunninghan, P. Daszak, A. Apolo, E. Perdomo, and G. Speranza. 2003. Emerging pathogen of wild amphibians in frogs (*Rana catesbeiana*) farmed for international trade. Emerging Infectious Diseases 9(8):3-30.

Miller, R.R. 1961. Man and the changing fish fauna of the American Southwest. Pap. Michigan Acad. Sci., Arts, Lett. 46:365-404.

Minckley, W.L. 1985. Native fishes and natural aquatic habitats in U.S. Fish and Wildlife Region II west of the Continental Divide. Rept. to U.S. Fish and Wildlife Service, Albuquerque, New Mexico. Dept. of Zoology, Ariz. State Univ., Tempe. 158pp.

___, and J.E. Deacon. 1991. Battle against extinction: native fish management in the American West. University of Arizona Press, Tucson.

Morehouse, E.A., T.Y. James, A.R.D. Ganley, R. Vilgalys, L. Berger, P.J. Murphys, and J.E. Longcore. 2003. Multilocus sequence typing suggests the chytrid pathogen of amphibians is a recently emerged clone. Molecular Ecology 12:395-403.

Morell, V. 1999. Are pathogens felling frogs? Science 284:728-731.

Nichols, D.K., E.W. Lamirande, A.P. Pessier, and J.E. Longcore. 2001. Experimental transmission of cutaneous chytridiomycosis in dendrobatid frogs. Journal of Wildlife Diseases 37:1-11.

Painter, C.W. 2000. Status of listed and category herpetofauna. Report to US Fish and Wildlife Service, Albuquerque, NM. Completion report for E-31/1-5.

Platz, J.E. 1993. *Rana subaquavocalis*, a remarkable new species of leopard frog (*Rana pipiens* Complex) from southeastern Arizona that calls under water. J. Herpetology 27(2):154-162.

_____, and T. Grudzien. 1999. The taxonomic status of leopard frogs from the Mogollon Rim country of central Arizona: evidence for recognition of a new species. Proceedings of Nebraska Academy of Sciences 109:51.

_____, and J.S. Mecham. 1979. *Rana chiricahuensis*, a new species of leopard frog (*Rana pipiens* Complex) from Arizona. Copeia 1979(3):383-390.

_____, and _____. 1984. *Rana chiricahuensis*. Catalogue of American Amphibians and Reptiles 347.1.

Pounds, J.A., and M.L. Crump. 1994. Amphibian declines and climate disturbance: the case of the golden toad and the harlequin frog. Conservation Biology 8(1):72-85.

Retallick, R.W., H. McCallum, and R. Speare. 2004. Endemic infection of the amphibian chytrid fungus in a frog community post-decline. PLoS Biology 2(11):1965-1971.

Rollins-Smith, L.A., C. Carey, J.E. Longcore, J.K. Doersam, A. Boutte, J.E. Bruzgal, and J.M. Conlon. 2002. Activity of antimicrobial skin peptides from ranid frogs against *Batracytrium dendrobatidis*, the chytrid fungus associated with global amphibian declines. Devel. Comp. Immunol. 26:471-479.

Rorabaugh, J.C. 2005. *Rana berlandieri* Baird, 1854(a), Rio Grande leopard frog. Pages 530-532 *in* M.J. Lannoo, ed., Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

Rosen, P.C., and D.J. Caldwell. 2004. Aquatic and riparian herpetofauna of Las Cienegas National Conservation Area, Empire Cienega Ranch, Pima County, Arizona. Final report to the BLM, Tucson, AZ.

_____, and C.R. Schwalbe. 1998. Using managed waters for conservation of threatened frogs. Pages 180-202 *in* Proc. of Symposium on Environmental, Economic, and Legal Issues Related to Rangeland Water Developments. November 13-15, 1997, Tempe, AZ.

_____, _____, D.A. Parizek, P.A. Holm, and C.H. Lowe. 1994. Introduced aquatic vertebrates in the Chiricahua region: effects on declining native ranid frogs. Pages 251-261 *in* L.F. DeBano, G.J. Gottfried, R.H. Hamre, C.B. Edminster, P.F. Ffolliott, and A. Ortega-Rubio, tech. coords., Biodiversity and Management of the Madrean Archipelago. USDA Forest Service, General Technical Report RM-GTR-264.

_____, _____, and S.S. Sartorius. 1996. Decline of the Chiricahua leopard frog in Arizona mediated by introduced species. Report to Heritage program, Arizona Game and Fish Department, Phoenix, AZ. IIPAM Project No. I92052.

Seburn, C.N.L., D.C. Seburn, and C.A. Paszkowski. 1997. Northern leopard frog (*Rana pipiens*) dispersal in relation to habitat. Herpetological Conservation 1:64-72.

Simms, J.R., and K.M. Simms. 1992. What constitutes high quality habitat for Gila topminnow (POECILIOPSIS OCCIDENTALIS OCCIDENTALIS)? An overview of habitat parameters supporting a robust population at Cienega Creek, Pima Co., AZ. Abstract. Proc. Desert Fish. Council 22-23:82.

Sinsch, U. 1991. Mini-review: the orientation behaviour of amphibians. Herpetological J. 1:541-544.

Snyder, J., T. Maret, and J.P. Collins. 1996. Exotic species and the distribution of native amphibians in the San Rafael Valley, AZ. Page 6 *in* Abstracts of the Second Annual Meeting of the Southwestern United States Working Group of the Declining Amphibian Populations Task Force, Tucson, AZ.

Speare, R., and L. Berger. 2000. Global distribution of chytridiomycosis in amphibians. Http://www.jcu.edu.au/school/phtm/PHTM/frogs/chyglob.htm.11 November 2000.

Sredl, M.J., and D. Caldwell. 2000. Wintertime populations surveys - call for volunteers. Sonoran Herpetologist 13:1.

_____, and J.M. Howland. 1994. Conservation and management of Madrean populations of the Chiricahua leopard frog, *Rana chiricahuensis*. Arizona Game and Fish Department, Nongame Branch, Phoenix, AZ.

_____, _____, J.E. Wallace, and L.S. Saylor. 1997. Status and distribution of Arizona's native ranid frogs. Pages 45-101 *in* M.J. Sredl, ed., Ranid Frog Conservation and Management Ariz. Game & Fish Department, Nongame & Endangered Wildlife Program, Tech. Report 121.

_____, and R.D. Jennings. 2005. *Rana chiricahuensis*: Platz and Mecham, 1979, Chiricahua leopard frogs. Pages 546-549 *in* M.J. Lanoo, ed., Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

_____, and L.S. Saylor. 1998. Conservation and management zones and the role of earthern cattle tanks in conserving Arizona leopard frogs on large landscapes. Pages 211-225 *in* Proceedings of Symposium on Environmental, Economic, and Legal Issues Related to Rangeland Water Developments. November 13-15, 1997, Tempe, AZ.

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Company, Boston, MA.

U.S. BLM. 2005. Biological evaluation for the proposed Empire Gulch Chiricahua leopard frog refugium project, Pima County, Arizona. BLM, Tucson, AZ.

U.S. Fish and Wildlife Service. 1967. Native Fish and Wildlife. Endangered Species. Federal Register 32(48):4001.

___. 1984. Sonoran topminnow recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 56pp.

___. 2001. Biological opinion for Gila topminnow reestablishment in Empire Gulch. Fish and Wildlife Service, Phoenix. 23pp.

___. 2002a. Endangered and threatened wildlife and plants; listing of the Chiricahua leopard frog (*Rana chiricahuensis*); final rule. Federal Register 67(114):40790-4-811.

___. 2002b. Biological and conference opinion for the Las Cienegas National Conservation Area management Plan. Fish and Wildlife Service, Phoenix.

Voeltz, J. B., and R.H. Bettaso. 2003. 2003 status of the Gila topminnow and desert pupfish in Arizona. Ariz. Game and Fish Dept., Nongame and Endangered Wildl. Prog. Tech. Rept. 226, Phoenix. 124pp.

Weedman, D.A. 1999. Gila topminnow, *Poeciliopsis occidentalis occidentalis*, revised recovery plan. Draft. August 1999. Fish and Wildlife Service, Phoenix.

Weldon, C., L.H. du Preez, A.D. Hyatt, R. Muller, and R. Speare. 2004. Origin of the amphibian chytrid fungus. Emerging Infectious Diseases 10(12):3-8.