CHIRICAHUA LEOPARD FROG
(*Lithobates [Rana] chiricahuensis)*

Chiricahua Leopard Frog from Sycamore Canyon, Coronado National Forest, Arizona
Photograph by Jim Rorabaugh, USFWS

CONSIDERATIONS FOR MAKING EFFECTS DETERMINATIONS AND RECOMMENDATIONS FOR REDUCING AND AVOIDING ADVERSE EFFECTS

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INTRODUCTION

The general goals of this document, "Considerations for Making Effects Determinations"[1] (CMED) for the Chiricahua leopard frog (*Lithobates [Rana] chiricahuensis*), are to focus the effects analysis of proposed Federal activities on critical elements, reduce uncertainty in determining effects, and improve and facilitate section 7 consultations that may be required under the Endangered Species Act. The CMED should be used as a guide in assessing potential effects of a proposed action to the species, but consideration must be given to site-specific information in making the final determination of effects.

The CMED provides considerations in determining if the species may be in the action area of the proposed activity and, if so, possible ways in which Federal activities may affect various aspects of the species and its habitat. Examples are provided of representative activities and ways in which those activities may affect Chiricahua leopard frogs. The purpose of this is to "jump-start" the thought process during the effects analysis of similar activities. Finally, the CMED provides various examples of conservation measures that may be incorporated into proposed actions to reduce adverse effects and take, and in doing so facilitate section 7 consultations. These examples should be used as a guide and not as a "cook-book" when designing projects and evaluating their effects. The document should be used in conjunction with informal consultation between the Federal action agency and the U.S. Fish and Wildlife Service (USFWS).

Information and concepts in this document are consistent with the Chiricahua Leopard Frog (*Rana chiricahuensis*) Final Recovery Plan (USFWS 2007). It is important that the practitioner using this CMED document also become very familiar with the recovery plan for the frog and is able to incorporate conservation measures from the plan into proposed activities where the frog is likely to be present or where future recovery actions for the species are likely to occur. Whenever possible, incorporating recovery actions into projects may prove essential to the timely conservation of Chiricahua leopard frogs.

Thus, this CMED document is an important component of a comprehensive, long-term strategy for streamlining consultations. To be most effective, a comprehensive strategy must also emphasize the species' recovery under section 7(a)(1) of the Endangered Species Act through affirmative conservation programs by Federal agencies (50 CFR 402.1(a)) so that protection under the Act and its requirements for section 7 consultations are no longer needed.

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[1] Formerly "Guidance Criteria" as described in the *Long-term Strategy for Streamlining Consultations under the Endangered Species Act in Arizona and New Mexico* (Southwest Strategy, November 1999).

I. BACKGROUND

A. Status of the Chiricahua leopard frog

The Chiricahua leopard frog (*Lithobates [Rana] chiricahuensis*) was listed as threatened without critical habitat on June 13, 2002 (USFWS 2002). A special rule to exempt operation and maintenance of livestock tanks on non-Federal lands from the Section 9 take prohibitions was included in the listing (USFWS 2002).

A recovery plan for the species was finalized in 2007 (USFWS 2007). Copies of the recovery plan, final rule to list the species, and current information on the legal status of the species may be obtained on-line at http://www.fws.gov/endangered/, http://www.fws.gov/southwest/es/arizona/, and http://www.fws.gov/southwest/es/NewMexico/; or from the Arizona Ecological Services Field Office, 2321 West Royal Palm Road, Suite 103, Phoenix, Arizona 85303; or the New Mexico Ecological Services Field Office, 2105 Osuna NE, Albuquerque, New Mexico 87113. Information about the recovery program, such as ongoing recovery projects, safe harbor agreements, local recovery groups, and meeting notes of steering committees, is available at http://www.fws.gov/southwest/es/arizona/CLF_Recovery_Home.htm.

The recovery plan provides an abundance of current information and management recommendations relevant to making effects determinations. The document is also necessary during project planning to insure that Federal activities incorporate elements to not only reduce or avoid adverse effects (including take), but also elements that will assist in the recovery of the species. In addition to the recovery plan, new information will continue to become available that will assist in project planning and analyses of effects. New information relevant to project planning and making effects determinations for the Chiricahua leopard frog is disseminated through recovery team meetings and a list-serve. However, to reduce the likelihood that pertinent new information is missed, contact a member of the Technical Subgroup of the Chiricahua leopard frog Recovery Team, identified by name in the recovery plan, at the beginning of project planning and during the analysis of effects. In addition, use the informal consultation process, by which species leads in the Ecological Services office may be contacted directly, to review the current legal status and availability of new biological information pertaining to the frog. Reviewing recent biological opinions also provides valuable insights into project design considerations (i.e., conservation measures) to reduce adverse effects, and into considerations for making effects determinations. The Arizona Ecological Services Field Office and the New Mexico Ecological Services Field Office maintain excellent web sites (see above) where biological opinions may be viewed and printed, and should be reviewed.

B. Habitats and life history

To effectively consider how a proposed activity may impact the Chiricahua leopard frog, an understanding of the species' life history, habitat use, and associated vulnerabilities is necessary. In general, many aspects of the frogs' life history are not well studied (USFWS 2007: 12-19). Because of this, basic life history information is often considered from what is known of other frog species and extrapolated to Chiricahua leopard frogs, if reasonable to do so. The information presented below is largely derived from the recovery plan but is augmented with additional information. It is not a complete account of the species, but attempts to highlight elements of the frogs' ecological relationships that are likely to be susceptible to impacts from anthropogenic activities, especially those with a federal nexus (see Section II of this document). The historical range of the Chiricahua leopard frog included portions of west-central and southwestern New Mexico, and central and southeastern Arizona (in addition to portions of Mexico) (Figure 1). Presently, the known distribution of the species still includes most of the larger watersheds from which the species historically occurred. However, the number of populations in much of the species' range has declined drastically. The species is likely, but not certainly, extirpated from the Little Colorado River drainage system.

Within the species' range, aquatic habitats historically and/or currently used by the frogs include a variety of natural and human-constructed waters between elevations of 3,281 and 8,890 feet (1,000 and 2,710 meters), including rivers, permanent streams and permanent pools in intermittent streams, beaver ponds, cienegas (i.e., wetlands), springs, and earthen livestock tanks. They are occasionally found in livestock drinkers, irrigation sloughs or acequias, wells, abandoned swimming pools, ornamental ponds, and mine adits (USFWS 2007: 17).

Chiricahua leopard frogs have a complex life cycle consisting of eggs and larvae that are entirely aquatic and adults that are primarily aquatic (USFWS 2007: 11). Each stage of the frogs' life history has its own set of environmental or habitat requirements that influence its susceptibility to changes in its habitat, but in general Chiricahua leopard frogs need permanent to semi-permanent water that is free, or nearly so, of non-native aquatic predators (USFWS 2007: 18, 50). However, frogs are known to move among aquatic sites and can be found in upland sites, roadside puddles, and habitats that only hold water briefly during these movements. This emphasizes the importance of considering the broad spectrum of suitable habitats during project design and effects analyses.

To accommodate the various habitat requirements at each stage in the species' life history the following habitat features are likely important to maintain a reproducing population of Chiricahua leopard frogs (USFWS 2007: 18-19, 49-50, E-5):

- Permanent or nearly permanent water that is free or relatively free from non-native predators;
- Within-site habitat diversity, including:
  - Shallow water with emergent and perimeter vegetation that provide egg deposition, tadpole and adult thermoregulation sites, and foraging sites;
  - Deeper water, root masses, undercut banks that provide refuge from predators and potential hibernacula during the winter;
  - Substrate that includes some mud that allows for the growth of alga and diatoms (food for tadpoles) and to allow for hibernacula;
- Relatively clean water not overly polluted by livestock excrement or chemical pollutants.
- A diversity or complex of nearby aquatic sites including a variety of lotic and lentic aquatic habitats, to provide habitat for breeding, post-breeding, and dispersing individuals. In these situations, a metapopulation[2] may be established, enhancing the likelihood of the frogs' continued existence.

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[2] Metapopulation (USFWS:K-2): "A system of local populations connected by dispersing individuals, or a set of local populations that interact *via* individuals moving among local populations."

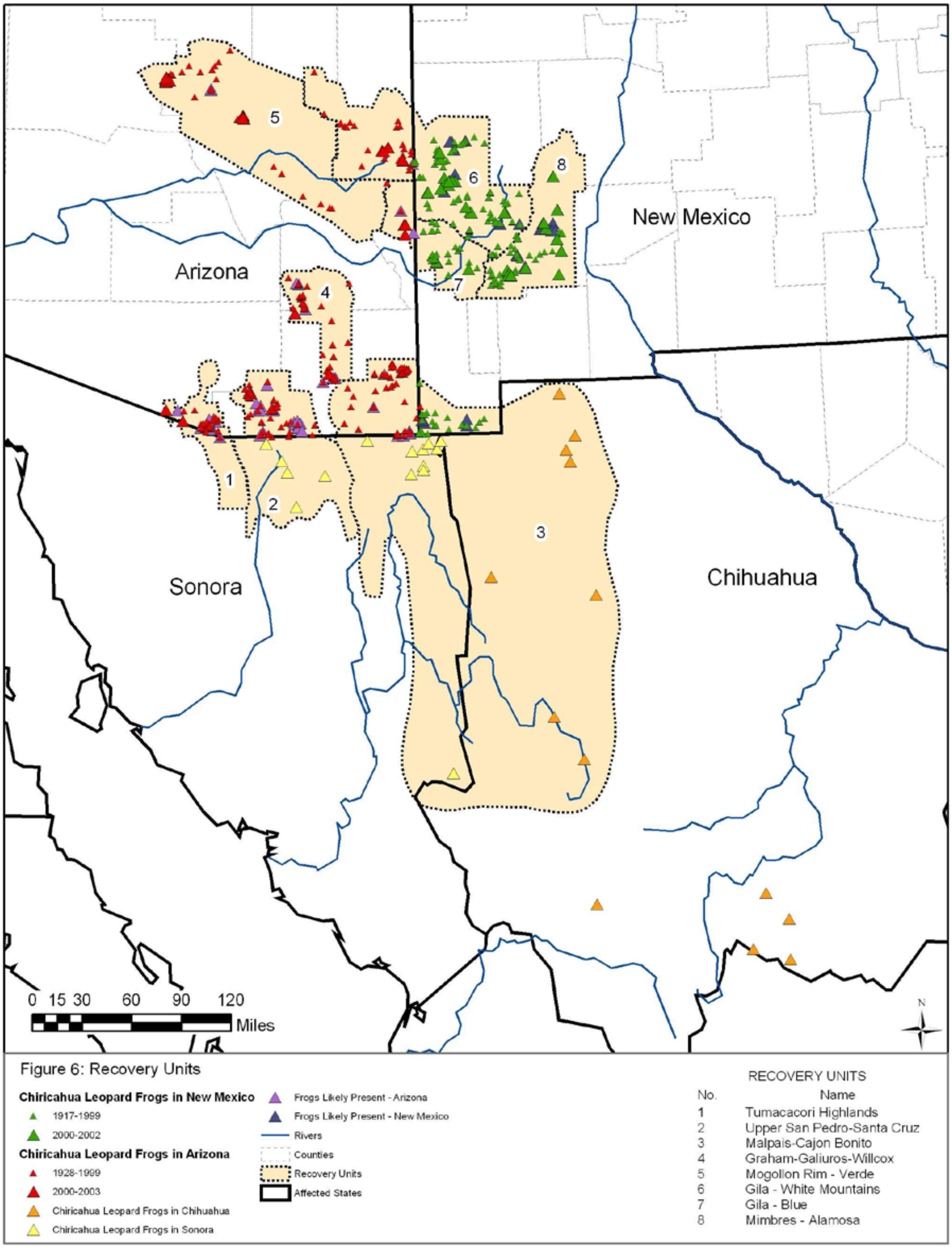

Figure 1. Historical range of Chiricahua leopard frogs as delineated by recovery units (from Figure 6 in USFWS 2007). This map is not intended for use in determining whether your action area intersects the potential distribution of this species. Contact the local land manager and species experts for distribution information.

The following is a brief discussion of the various life stages of the Chiricahua leopard frog and the different environmental needs and vulnerabilities at each stage. More specific habitat needs and associations are discussed in relation to more specific aspects of the species' life history. The discussion is not comprehensive, but tries to provide a framework of information typically relevant when considering how a proposed activity may affect Chiricahua leopard frogs.

1. Breeding – male vocalization, egg-laying, egg development

Advertisement calls by male ranids are assumed to serve as conspecific mate attractants that facilitate successful mating (Frost and Platz 1983). Male Chiricahua leopard frogs typically call above water while floating in the water, but may also advertise underwater (Sredl and Jennings 2005). Davidson (1996) reported calls of Chiricahua leopard frogs are given primarily at night.

The breeding season of Chiricahua leopard frogs, as represented by observations of egg masses, varies with elevation and may be a reflection of temperature regimes (Frost and Platz 1983, Zweifel 1968). Frost and Platz (1983) reported egg-laying activity in Arizona and New Mexico from March through August. Egg laying in the Ramsey Canyon leopard frog (*Lithobates[Rana] subaquavocalis*), which was recently subsumed into the Chiricahua leopard frog (Crother 2008, Goldberg *et al*. 2004), has been documented from February through November (meeting notes of the Ramsey Canyon leopard frog Conservation Team). Scott and Jennings (1985) reported that in New Mexico the species bred from February through September with reduced oviposition in May and June. Frost and Platz (1983) further noted that at elevations below about 5,900 feet (1,800 meters), Chiricahua leopard frogs tended to deposit eggs from spring through late summer, but mostly prior to June; whereas, above 5,900 feet, the species bred in June, July, and August. However, egg masses have been found at one high elevation site (about 8,200 feet or 2,500 meters) as early as February. There are indications that springs feeding this particular site are at least somewhat thermally influenced. Scott and Jennings (1985) noted the importance of springs where, "The relatively warm winter water temperatures permit year-round adult activity and winter breeding." Elliott et al. (2009) find that the species breeds whenever the water temperature exceeds about 57^{0} F (14°C). The timing of breeding activities as indicated by egg-laying often shows year-to-year and site-specific variation (USFWS 2007: 12).

Eggs are deposited as spherical masses encased in a gelatinous matrix and are attached to submerged vegetation (or the submerged portion of emergent vegetation such as pondweed (*Potamogeton* sp.), watercress (*Rorippa* sp.) in slack waters of aquatic habitats (Sredl and Jennings 2005). Egg masses are typically suspended within 2 inches (5 centimeters) of the water surface (Sredl and Jennings 2005). Eggs (embryos) cannot survive desiccation and must remain in aquatic habitats throughout their development.

The developmental rate of embryos in the eggs to larvae (tadpoles) is influenced by water temperature, generally taking about 14 days, but as short as 8 days under warmer conditions (USFWS 2007: 12). Water temperatures at which eggs have been found in the wild and at which embryos develop generally range from about 55°F to 85°F (about 13°C to 30°C) (Zweifel 1968, USFWS 2007: 20).

Because of the permeability of eggs, various aspects of water quality may influence the developing Chiricahua leopard frog embryos. The egg "jelly" surrounding the embryos of aquatic amphibian eggs, including the northern leopard frog (*Lithobates [Rana] pipiens*), is permeable to and important in the transport of gases (e.g., oxygen), water, and various other ions between the aquatic environment and the embryo (Morrill *et al*.1966, Pinder and Friet 1994).

Fernandez and Rosen (1996) found crayfish (*Orconectes virilis*) did not feed on egg masses or single eggs unless the gelatinous coat was removed. However, Saenz *et al*. (2003) determined that crayfish (*Procambarus nigrocinctus*) significantly reduced the hatching success of southern leopard frog (*Lithobates sphenocephalus [Rana sphenocephala]*) eggs by eating them. Werschkul and Christensen (1977) found bluegill (*Lepomis macrochirus*) readily fed on the eggs of ranid frogs. However, Vredenburg (2004) found that (introduced) rainbow trout (*Oncorhynchus mykiss*) did not attack or feed on the eggs of southern mountain yellow-legged frogs (*Rana muscosa*) in enclosures. Leeches (e.g., *Haemopis sanguisuga*) are known predators of some ranid eggs (Laurila *et al*. 2002). Bull (2005) noted that leeches consumed all the embryos of Columbia spotted frog (*Rana luteiventris*) at one breeding pond for three consecutive years.

2. Larvae – tadpoles and their metamorphosis to frogs
After hatching, tadpoles remain in the water, where they feed and metamorphose to juvenile frogs (metamorphs). The tadpole is fully aquatic requiring an aquatic environment for breathing, feeding, and to prevent desiccation. Thus, water must be available in sufficient quantity and quality long enough for the completion of metamorphosis (USFWS 2007: 50). Tadpoles metamorphose in 3 to 9 months (sooner in warmer water) and may live through a winter before completing their metamorphosis (USFWS 2007: 12, E-5). In New Mexico, leopard frog tadpoles were found in any fresh water relatively free of vertebrate predators (e.g., fish, salamander larvae) or having refuge areas for tadpoles to avoid predation (e.g., shallow water with flooded vegetation) (Scott and Jennings 1985). Tadpoles in warm springs appear to grow continuously, while growth of those in cold-water sites appeared to be arrested or retarded during the winter, however tadpoles can remain active under ice in water at 41°F (5°C) (USFWS 2007: 12). Dispersal by tadpoles apparently occurs primarily as passive displacement in drainages or watercourses, often during high-flow events (Frost and Bagnara 1977; USFWS 2007: 15).

Larval Chiricahua leopard frogs are primarily herbivorous. Food items may include bacteria, diatoms, phytoplankton, periphyton, filamentous green algae, watermilfoil (*Myriophyllum* sp.), duckweed (*Lemna minor*), and detritus (USFWS 2007: 13). Aquatic sites should have unconsolidated substrate such as mud, and not just bare rock, that will allow for the growth of these types of foods for tadpoles (USFWS 2007: 18).

Specific water quality limitations for Chiricahua leopard frogs are not known, but all life stages presumably require, "reasonable water quality" (USFWS 2007: 50). Dissolved oxygen concentrations influence growth rates of tadpoles (Alford 1999). Tadpoles are sensitive to a variety of organic and inorganic chemicals (USFWS 2007: 44-46). In addition, water quality that might influence food production or predator survivorship would indirectly affect tadpoles.

Tadpoles are likely preyed upon by aquatic insects, and vertebrates such as native and non-native fishes, gartersnakes (*Thamnophis* spp.), great blue herons (*Ardea herodias*), and other water birds (USFWS 2007: 13). In closed-systems (i.e., aquaria), Fernandez and Rosen (1996) documented that crayfish (*Orconectes virilis*) killed and consumed newly hatched embryos and tadpoles of Chiricahua leopard frogs, in addition to uprooting and consuming aquatic macrophytes. Adult and, especially, larvae of dyticid beetles are known to readily consume ranid tadpoles (Ideker 1979) and are likely to prey on Chiricahua leopard frog tadpoles. Shallow water with an abundance of aquatic vegetation or coarse woody debris is important in providing refuge for tadpoles from vertebrate predators (Scott and Jennings 1985, Bull 2005). Bull (2005) noted that tadpoles of Columbia spotted frogs were particularly vulnerable to predation when they remained in shallow, warmer water or at the water surface, being fed upon by gartersnakes, giant water bugs (Belostomatidae), and kingfishers (*Ceryle alcyon*). Vredenburg (2004) demonstrated (in enclosures) intense predation by rainbow trout on the tadpoles of mountain yellow-legged frogs.

The presence of overwintering American bullfrog (*Lithobates catesbeianus [Rana catesbeiana]*) tadpoles results in reduced mass at metamorphosis of southern leopard frogs perhaps by reducing food resources such as algae available to the leopard frog tadpoles (Boone *et al*. 2004). Introduced crayfish (*Orconectes* sp.) significantly reduce macrophyte species richness and abundance (Rosenthal *et al*. 2006), thus potentially reducing foraging habitat and cover for tadpoles.

Chelgren *et al*. (2006) reported that larger tadpoles and quicker metamorphosis of the larvae increase the probability of survival among metamorphs and their ability to move out of the aquatic environment into terrestrial habitats. However, slower larval growth rates are often associated with larger size at metamorphosis (Beebee 1996), and that larger size may impart greater protection from terrestrial predators (John-Alder and Morin 1990) and reduced developmental time to maturity. If conditions in the pond are poor for larval survival, due to predation or drying of a pond, survivorship from egg to breeding adult may be higher if time in the pond is minimized (Newman 1988a,b), even though size at metamorphosis is reduced. Thus, carryover effects of aquatic stressors that alter growth rates and time to metamorphosis of tadpoles may have population-level impacts, some of which may not be expressed until post-metamorphic stages.

3. Frogs – feeding, predators, dispersal, hibernation, and vulnerabilities

Post-metamorphic (i.e., metamorphs, subadults, adults) Chiricahua leopard frogs are primarily aquatic and need permanent to semi-permanent water for survival. Frogs are rarely found far from water bodies except during transient, overland movements during wet periods, and even then must remain moist (USFWS 2007: 14-15, 50). Frogs do inhabit intermittent bodies of water, however. In these habitats, frogs may be able to survive the loss of surface water by moving to more permanent sites (if ambient conditions are moist enough to permit overland movement) or by burrowing into muddy cracks and holes around drying water sources (USFWS 2007: 17, 50). Under these conditions, shoreline vegetation may create moist microhabitats important for the survival of frogs during drying conditions.

Frogs are sensitive to pollutants in their aquatic environments (USFWS 2007: 18) and require "reasonable water quality" that is not overly polluted (USFWS 2007: 50). The recovery plan (USFWS 2007: Table F-1) lists various water quality conditions that are recommended for captive frogs, but acceptable or limiting water quality conditions in the wild are apparently not known. It is known that frogs are sensitive to a variety of organic and inorganic chemicals that may contaminate their aquatic environments (USFWS 2007: 44-46). Rotenone, commonly used in fisheries renovation projects, was found to be toxic within the range of concentrations expected to occur after application; whereas Actimycin-A (Fintrol formulation), another piscicide, tested with several optional carrier solvents (acetone, deionized water, and surfactants) was non-toxic to embryonic and larval (Stage 25 and older) Chiricahua leopard frogs at expected application concentrations (Little *et al.* 2007, Little and Calfee 2008). The same authors found copper to be acutely toxic at concentrations lower than maximum concentrations observed in Chiricahua leopard frog habitats. Water with pH less than 6.0 may inhibit reproduction, and acidic waters with a pH of less than 5.5 are likely fatal to most Chiricahua leopard frogs (USFWS 2007: 25), whereas pH above 10 is likely detrimental. In addition, water quality that might influence food production, the survival of predators, or the viability of disease would also indirectly affect frogs.

Neither the feeding behavior nor diet of Chiricahua leopard frogs has been rigorously studied. However, it is likely the frogs feed on a wide variety of aquatic and terrestrial invertebrates including snails, insects, and other arthropods and some vertebrates (fish, frogs and toads, and even small birds) (USFWS 2007: 13). Submergent and emergent aquatic vegetation and terrestrial vegetation peripheral to the aquatic site provide important habitat for macroinvertebrates (McGaha 1952, Krull 1970) on which the frogs may feed. Christman and Cummer (2005) reported on items found in the stomachs of 56 museum specimens of Chiricahua leopard frog. They observed a total of 314 food items; 10 were unidentifiable; 1 was a vertebrate (possible Anuran frog); 1 cypriniform fish; and 302 invertebrates. The invertebrates belonged to 13 orders and 45 families, but three orders (Coleoptera, Hemiptera, and Diptera) comprised 75% of the items observed. The authors grouped prey items into aquatic or terrestrial (a prey item was considered aquatic if any life stage occurred in the water). Terrestrial prey accounted for 44.6% of prey, and aquatic prey accounted for 37.3%.

Predators of frogs likely include native and non-native fishes, American bullfrogs, gartersnakes, great blue herons, ravens (*Corvus corax*) and a variety of mammals (USFWS 2007: 14, Bull 2005). Frogs avoid terrestrial predators by hopping to water. Shoreline habitats may be important for basking (thermoregulation) and foraging and frogs may be exposed to predation at these times. Shoreline vegetation likely provides important cover especially from predators that rely on visual cues to detect prey, such as ravens (Liebezeit and George 2002). However, dense shoreline vegetation may favor other predators such as gartersnakes. Deep water, aquatic vegetation, undercut banks, root masses, and other cover sites may be important to the frogs in avoiding predation (USFWS 2007).

Information on overwintering habitat of Chiricahua leopard frogs has not been studied. Post-metamorphic Chiricahua leopard frogs are generally inactive when water temperatures drop below 52°F (14^{0} C), and from November through February, although year round activity has been observed in warm springs (USFWS 2007: 13, Sredl and Jennings 2005). During this time, Chiricahua leopard frogs likely overwinter underwater near breeding sites, although their hibernation behavior has not been studied (Sredl and Jennings 2005). Other leopard frogs typically overwinter at the bottom of well-oxygenated streams, rivers, ponds or lakes, and may bury themselves in the mud (Smith 2003, USFWS 2007: 18). High oxygen saturation at aquatic sites used for overwintering northern leopard frogs may be critical in their selection of overwintering sites and for their survival (Smith 2003).

Movement patterns by Chiricahua leopard frogs are not well understood. Frogs inhabit sites not suitable for reproduction and have appeared at previously unoccupied sites after the drying of formerly inhabited sites, indicating that frogs actively move among aquatic habitats, using mesic or aquatic corridors and overland habitats during their travel (Frost and Bagnara 1977, USFWS 2007: 15; R. Jennings, pers. comm. 2006).

Active movement of adult frogs up-and-down a drainage, or directional dispersal of metamorph and subadult frogs may be in response to deteriorating habitat (i.e., drying of breeding pond), predators (e.g., conspecifics and gartersnakes), or intraspecific competition (USFWS 2007: 14). Historically, it is likely that perennial corridors were important for dispersing individual frogs. In the absence of perennial corridors, movement by frogs is likely facilitated by the presence of seasonal surface waters (lotic and lentic) and otherwise wet conditions during the summer rainy season that permit overland movement in typically dry environments (USFWS 2007: 14-15; R. Jennings, pers. comm. 2006). Based on observations of various ranids in Arizona and New Mexico (USFWS 2007: 14-15), reasonable dispersal distances for the species are (1) one mile overland, (2) three miles along intermittent drainages, and (3) five miles along permanent water courses (USFWS 2007: D-2,3), or some combination thereof.

4. Disease - chytridiomycosis

The recovery plan (USFWS 2007: 24-32) identifies numerous diseases and parasites that are components of the Chiricahua leopard frogs' habitat and life history. Presently, one of the most serious of these is chytridiomycosis, a highly virulent pathogen caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*). Chytridiomycosis has been implicated in the deaths of frogs and the decline and extinction of frog populations (Daszak *et al*. 1999) including Chiricahua leopard frogs. Although the fungus appears in larval Chiricahua leopard frogs (typically on the mouthparts), mortality from the infection seem to be confined to adults (Bradley *et al*. 2002). However, Blaustein *et al*. (2005) have cautioned that oral deformities from chytridiomycosis may impair grazing by the tadpoles, leading to reduced growth and slower development. In turn, this may lead to poor condition at metamorphosis and ultimately may increase mortality in postmetamorphic life stages.

Some frogs are capable of acquiring chytridiomycosis as adults and of clearing their infections entirely (Kriger and Hero 2006a). Apparently, some populations of Chiricahua leopard frogs, especially those in warmer waters, are able to coexist with the disease (USFWS 2007: 27). *Bd* growth is maximal at 63°F to 77°F (17°-25°C) at pH 6 to pH 7. At temperatures above 82°F (28°C) or below 43°F (6°C) *Bd* does not grow or grows slowly; infections at these temperatures may not be fatal because growth of the fungus is not favored (Piotrowski *et al*. 2004). The organism dies and is eliminated in water held at 32^{0} C for 96 hours (Johnson *et al.* 2003). Johnson and Speare (2005) found growth of the fungi ceased in pH 3 or pH 4 media. In

Australia, increased prevalence of chytridiomycosis and resulting mortality rates are related to lower air and water temperatures (Berger *et al*. 2004, Kriger and Hero 2006b). In Arizona, die-offs of ranids are correlated with cooler months (Bradley *et al*. 2002).

Chytrid fungus may be transmitted to Chiricahua leopard frogs in various ways. Rachowicz and Vredenburg (2004) demonstrated experimentally that tadpoles infected by the fungal zoospores can then transmit the infection to other conspecific tadpoles and to postmetamorphic frogs.

Alternative host species may also be important in maintaining the disease in a water body in the absence of Chiricahua leopard frogs and also in transmitting the disease to frogs. Alternative hosts likely include bullfrogs (Bradley *et al.* 2002, Daszak *et al*. 2004, Hanselmann *et al*. 2004), Tiger salamanders (*Ambystoma mavortium*) (Davidson *et al*. 2003), other amphibians that contract *Bd*, including Chiricahua leopard frogs, and freshwater shrimp (Rowley *et al*. 2006). The chitinous exoskeleton of freshwater shrimp is likely similar in composition to that of crayfish, but the role of crayfish as an alternative host for *Bd* is not known. *Bd* can be moved with stocks of warm water fishes from hatcheries, either in the water or on tadpoles or salamanders that are commonly moved with sport fish (Green and Dodd 2007).

Bd is able to survive in the absence of any host species for at least 12 weeks in sterile, moist river sand, where pH was not limiting (Johnson and Speare 2005). Johnson and Speare (2003) found *Bd* capable of surviving in tap water for 3 weeks, deionized water for 4 weeks, and lake water for up to 7 weeks. Longer survival in lake water may have resulted from higher nutrient levels and the presence of nonliving organic substrate such as algae and other microorganisms on which zoosporangia attach and grow (Johnson and Speare 2003). Whether *Bd* can persist indefinitely in the environment without a suitable amphibian host is unknown; however, anecdotal information from Arizona suggests it may be eliminated from aquatic systems over time. Johnson and Speare (2005) found that the *Bd* zoospore will attach to feathers within 1 minute of contact and survived outside of the experimental media. They authors suggested that birds are a possible means of *Bd* transport from one body of water to another.

Bd appears to be widely distributed throughout the range of the Chiricahua leopard frog. In the long-term, survival of the species in the face of this threat may depend on local adaptation by the frog or the pathogen (Retallick *et al.* 2004, Longcore *et al.* 2007), or development of a treatment that can be used in the environment, such as augmenting the microbiotic community on frog skin (Harris *et al.* 2009)

II. CONSIDERATIONS FOR MAKING EFFECTS DETERMINATIONS

For any federal action pursuant to section 7 of the Endangered Species Act, if a Chiricahua leopard frog may be present (reasonably likely to occur) in the action area[3], then potential effects to the species need to be considered. "Presence" should include any likely dispersal of frogs into the action area from occupied sites within reasonable dispersal distance during the life of the action. If an individual frog may be affected by the action, directly or indirectly, or by the effects of interrelated or interdependent actions (50 CFR 402.02), then section 7 consultation with the USFWS is required (50 CFR 402.14(a)). If suitable habitat (see page II-3, "Suitable habitat") is present and USFWS-permitted surveys are not conducted, then for the purpose of effects analysis you should 1) assume the habitat is occupied, or 2) build a case for absence based on previous USFWS-permitted surveys, proximity to historical localities, presence of non-native species, chytridiomycosis, or other factors that may preclude the species; elevation regimes (see Table E-1, USFWS 2007), or other considerations. See USFWS (2007: E6) for further information regarding drawing conclusions about presence or absence from USFWS-permitted survey data and other information. If, for the life of the action[4], habitat is not present within the action area for any part of the life cycle (e.g., temporary ponds, travel corridors) then further evaluation is not necessary. Any possible effects trigger consultation. However, if during informal consultation with the USFWS, all effects to the species are determined to be insignificant, discountable, or wholly beneficial and the USFWS concurs in writing, then formal consultation is not necessary.

Accurately identifying whether or not the species is reasonably likely to occur within the action area is crucial. Inquiries should be made to document known past and current occurrences of Chiricahua leopard frogs within and in the vicinity of the project area. Discussions with USFWS, Ecological Services personnel to ascertain this information are encouraged through the informal consultation process (50 CFR 402.13) or more formally with a written request for a species list (50 CFR 402.12).

In Arizona, the Arizona Game and Fish Department (AGFD) now features a helpful on-line program called HGIS (http://www.azgfd.gov/hgis/) to assist in environmental reviews. The AGFD Heritage Data Management System (HDMS) and Project Evaluation Program work together to provide current, reliable, objective information on Arizona's plant and wildlife species location and status to aid in the environmental decision making process. This information can be used to guide preliminary decisions and assessments of proposed land and water development, management, and conservation projects statewide, while incorporating fish and wildlife resource needs or features. The HDMS documents positive USFWS-permitted survey information. Negative survey information and areas where surveys have not been conducted are not accessible to the public or are not in the HDMS. Therefore, HDMS can only be used to verify where species occur, not as evidence of where they do not occur. HDMS is updated periodically, but may not have the very latest information on localities. In addition to consulting HDMS, we suggest you contact USFWS-Ecological Services or the AGFD Ranid

[3] Action Area means all areas to b affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (USFWS 1986).

[4] "Life of the action" refers to the entire time span that covers all activities associated with a proposed action that the action agency maintains discretion over; including pre-construction activities, operation, maintenance, mitigation (e.g. reclamation) and post-mitigation monitoring.

Frog Program, Nongame Branch, in Phoenix. In conjunction with Department of Homeland Security, USFWS is developing a database for the Arizona borderlands for which project proponents can log in their project location and type and receive data on species' presence and suggested best management practices for their project types. This system, called IPaC, should be online in 2009 or 2010. New Mexico also provides information to assist in project planning through Natural Heritage New Mexico (NHNM) http://nhnm.unm.edu/ . The Biological Conservation Database maintained by NHNM provides reliable information on sensitive plants, animals, and plant communities for New Mexico. Examples of products that can be obtained from the database include GIS data, maps, location data on sensitive species and specialized databases. The Information Management Division of NHNM (http://nhnm.unm.edu/im/index.php) provides data on the biology, status and taxonomy of New Mexico species; provides data on the location and distribution of these species for conservation, management and scientific purposes. Cooperative agreements between NHNM and USFWS, U. S. Forest Service (USFS), and U. S. Bureau of Land Management (BLM) permit these agencies to utilize their services without charge. Web access is available at USFS, BLM, and USFWS offices to the NHNM databases. For others, however, NHNM may charge a fee for information other than a species list. For these situations or with other questions, contact the Information Manager at 505-277-3822 or nmnhp@unm.edu.

The recovery plan for the Chiricahua leopard frog identifies 8 Recovery Units for the species, each of which is necessary for the survival and recovery of the species (USFWS 2007: 51). When an action appreciably impairs or precludes the capability of a recovery unit from providing both the survival and recovery function assigned it, that action may represent jeopardy to the species (USFWS and National Marine Fisheries Service 1998). Thus, for any project the importance of accurately identifying potential effects to frogs and implementing actions to minimize adverse effects is particularly important.

A. Concepts of Chiricahua leopard frog habitats

Accurately identifying (1) the action area of a proposed project and (2) whether habitats occur within the action area where the species is reasonably likely to occur are critical steps in the process of analyzing if and how a particular action may affect Chiricahua leopard frogs. This subsection briefly presents some considerations to assist in accurately assessing these issues.

For Chiricahua leopard frogs, defining the action area of a proposed project must consider the reasonable dispersal capabilities of the species, and the likelihood/extent of any downstream or upstream effects that might arise from the proposed action. Reasonable dispersal distances for the frog from occupied habitats to sites being evaluated for occupancy include: a) within 1 mile overland, b) within 3 miles along an ephemeral or intermittent drainage, or c) within 5 miles along a perennial stream, or some combination thereof. Downstream effects of proposed actions, however, may result in even small effects (such as sediment flow or other altered hydrologic characteristics) much farther than 5 miles downstream from the project area. If this is determined likely to occur, then the action area of the proposed project will increase in size accordingly, and consideration of habitats where the frog may be present (and affected) could extend much farther than 5 miles from the project area.

Within the action area of a proposed project, identifying habitats where the frogs may be present is also needed to enable an evaluation of whether or not the proposed project may affect the frog.

Several concepts are used to focus attention on what constitutes Chiricahua leopard frog habitat. Understanding these various kinds of Chiricahua leopard frog habitat is necessary to determine whether the species is reasonably likely to occur in the action area. Regardless of the labels involved in the classification of Chiricahua leopard frog habitat, for the purpose of section 7 consultation compliance the objective of assessing habitats in the action area is to determine whether or not the species may be present or reasonably likely to occur during the life of the project. If the assessment determines the species may be present in the action area, then additional analysis is needed to identify potential effects from the proposed action to the frog. Understanding what types of habitats may be used by the frog is also important in identifying possible effects from a proposed action. In this way, projects may be more readily modified to minimize of eliminate adverse effects.

Suitable habitat. As seen in Section I, Chiricahua leopard frogs are able to use, and have been found in a wide variety of aquatic and some terrestrial habitats. Because of this, the concept of *suitable habitat*[5] for the species is very broad, including aquatic habitats as varied as rivers and lakes to abandoned swimming pools and ephemeral puddles (USFWS 2007: E-5) and terrestrial or riparian habitats that may be used temporarily during dispersal. Habitats suitable for one life stage or activity of the frog may not be suitable for others. During an analysis of effects, it is recommended that the discussion of suitable habitat presented in Appendix E of the recovery plan should be used when evaluating the presence of suitable habitat within an action area. The basis for determining whether a species may be affected is the potential presence of one individual of that species, even temporarily, in the action area. Suitable habitat may include marginal habitats and also those sites that are occupied, likely to be occupied and unoccupied habitats.

Marginal habitat. Some habitat that is suitable (i.e., within the range of habitat variation where the species has been found) may provide only marginal conditions for some stages of the frog. Marginal habitats can be semi-perennial stock tanks, in which breeding is supported in some years but not others. Small habitats, such as small springs or small stock tanks, may also be marginal because they can only support a small population, which may not be viable in the long term. However, often the largest and most stable populations in a management area or recovery unit are in stock tanks, thus their value cannot be disregarded. The presence of non-native predators in an aquatic habitat may also marginalize its suitability, yet as seen in the recovery plan (USFWS 2007: E-5), these habitats are at least sometimes occupied by frogs and therefore are suitable habitats, by definition.

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[5] Suitable habitat (USFWS 2006:K-5): Habitat that is suitable for Chiricahua leopard frogs if it falls within the range of habitat variation where the frog has been found. This range is described in the "Habitat Characteristics/Ecosystems" in part 1 and in Appendix E of the recovery plan.
The recovery plan suggests that suitable habitat must support a *population* (by definition, a *breeding population*, USFWS 2006:K-3) of Chiricahua leopard frogs. At first glance, the requirement for suitable habitat to support a breeding population seems incongruent with the transient use (and, by definition, suitability) of ephemeral aquatic sites and non-aquatic uplands by dispersing frogs. However, the importance of dispersal habitat is emphasized in the recovery plan (USFWS 2006:14-15, 33, 40, 81, A-3, D-2) as crucial in facilitating the maintenance of Chiricahua leopard frog populations.

Occupied, Likely to be occupied, and Unoccupied habitats. At least two Federal agencies, the USFS and BLM, presently use the concepts of *Occupied habitat*[6] and *Likely to be occupied habitat*[7] as important considerations when evaluating the effects of livestock grazing activities on Chiricahua leopard frogs (USFS 2005, USBLM 2006). Both of these habitats include suitable habitats and, in the context of section 7 analysis, impacts to either type of habitat may affect the frog. "*Unoccupied Habitat*", another type of suitable habitat, is defined in the recovery plan (USFWS 2007: K-5) as including, "Sites that support all of the constituent elements necessary for Chiricahua leopard frogs, but where surveys have determined the species is not currently present. The lack of individuals or populations in the habitat is assumed to be the result of reduced numbers or distribution of the species such that some habitat areas are unused. It is expected that these areas would be used if species numbers or distribution were greater."

Site occupancy can also change due to immigration and colonization, which may occur anytime during the warmer months (and is most likely to occur during the summer monsoons). If extant populations occur within reasonable dispersal distance of a site under assessment supporting suitable habitat, colonization is likely to occur and surveys more than once a year as part of project planning or effects analysis may be warranted to assess presence/absence. Surveys conducted in May or June, and then repeated after the monsoon season in September, can detect occupancy in both the permanently wet habitats and the seasonally colonized habitats. For long-term projects, such as 10-year grazing permits, you should assume frogs will colonize suitable habitats within reasonable dispersal distance during the life of the project. For short-term projects, surveys immediately prior to and possibly during construction or project implementation may be needed in habitats within reasonable dispersal distance of occupied sites to evaluate if frogs will be directly affected. "Reasonable dispersal distance" includes the following distances from occupied habitat to sites being evaluated for occupancy: a) within one mile overland, b) within three miles along an ephemeral or intermittent drainage, or c) within five miles along a perennial stream.

The recovery plan also identifies a broader consideration of Chiricahua leopard frog habitat to include *occupied watersheds* and *unoccupied watersheds with suitable habitat* (USFWS 2007: 76, Appendix H, Appendix I). Occupied watersheds are those within which a population(s) of Chiricahua leopard frogs is likely to be present (USFWS 2007: H-11).

Potential habitat. For Chiricahua leopard frogs the concept of *potential habitat* is used in various documents, but may be somewhat confusing. As defined in the recovery plan, potential habitats[8] are not suitable habitats. In this context, the USFS (2005) and USBLM (2006) also use the concept of potential habitats as being,

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[6] Occupied habitat includes sites where the frog is known to occur or where it was present within the last 10 years but no follow-up surveys have been conducted confirming its absence and suitable habitat is present.
[7] Likely to be occupied habitat includes: 1) currently suitable habitat where the frog has been documented within the last 10 years, but is apparently now absent, or (2) suitable habitat that is (a) within 1 mile overland of occupied habitat, (b) within 3 miles along an ephemeral or intermittent drainage from occupied habitat, or (c) within 5 miles along a perennial stream from occupied habitat.
[8]Potential habitat (USFWS 2006: K-3): Habitat that is lacking one or more of habitat elements necessary to support a Chiricahua leopard frog population, but with proper management could develop into suitable habitat.

> "…those aquatic systems (within the historical range of the frog) that are damaged or degraded from natural perturbations or chronic stressors...but have the appropriate hydrological and ecological components, which are capable of being restored to suitable habitat. Aquatic habitats may become unsuitable for Chiricahua leopard frogs, due to increased amounts of sediments, longer or more frequent periods of intermittency, reduced flows, dewatering of ponds or bank chiseling."

As with the concept of suitable habitat, the concept of potential habitat is particularly meaningful if applied to specific life-stage requirements. Thus, an aquatic site may be "potential", and thus unsuitable, for breeding frogs because, at present, it does not hold water for a sufficient length of time for egg and larval development, or the water is present at times when breeding does not occur. That same aquatic site, however, may be important suitable habitat for dispersing frogs, providing a "stepping-stone" to a permanent breeding site.

In summary, regardless of habitat terminology, if a Chiricahua leopard frog may be present in the action area, then potential effects to the species must be evaluated.

B. How alterations to habitat may affect Chiricahua leopard frogs

The following discussion describes how changes in various elements of Chiricahua leopard frog habitat may affect the species. It assumes the presence of occupied or likely to be occupied habitats. Largely because of the lack of quantitative information regarding Chiricahua leopard frog habitat use and various life-history requirements (e.g., USFWS 2007: 18), cause-and-effect relationships are necessarily general and subjective. In addition, the qualitative and variable relationship between habitat parameters and the complex life history of the species require generalizations in relating changes to the habitat with likely effects to the species. However, this should not lessen the ability to determine if a proposed action may affect the species because *any possible effect, whether beneficial, benign, adverse, or of an undetermined character requires a "may affect" determination* (USFWS 1986).

For any activity taking place where Chiricahua leopard frogs may occur, consideration should be given to the timing of the action in relation to the frog's life cycle. This may be important especially for actions of brief duration where there is little likelihood of carryover effects extending beyond the time it takes to implement the project. For example, if a project is implemented during the non-breeding period, then eggs will not be affected. Actions during the winter may not affect eggs, but tadpoles and hibernating/aestivating adults may be impacted. Actions during warm, moist periods may be more likely to impact dispersing frogs than during hot, dry times or during winter aestivation.

Many components of leopard frog habitat are susceptible to alterations, the results of which may affect growth, survival, and behavior of frogs during the various life stages. Direct or indirect modification or alteration of frog habitats may be beneficial or detrimental to the Chiricahua leopard frog depending on the resulting conditions (Bull 2005) and might arise as the result of landscape-wide and/or localized impacts. Freshwater ecosystems are greatly influenced by terrestrial processes, including many human uses or modifications of land and water that may alter moisture and flow regimes (Baron *et al*. 2002). Thus, activities within an occupied watershed may influence various aquatic parameters including flow regimes and water permanence, and erosion capabilities and sediment transport (USFWS 2007: Appendix H) that themselves affect other habitat features important to frog feeding, breeding, protection, and survival. During the planning of a project and the associated analysis of effects, consideration should be given to how the project may alter elements of frog habitat. Some of these habitat features include (but are not limited to):

(1) Water permanence and flow regimes,
(2) Water quality (temperature, sediment, contaminants, piscicides),
(3) Aquatic, semi-aquatic, and peripheral vegetation,
(4) Presence of non-native predators and competitors,
(5) Exposure to *Bd*, and
(6) Dispersal habitats.

These habitat components are not independent. For instance, alterations affecting water quality (e.g., increase in sediment input) may affect water permanence (e.g., filling in pools or stock tanks) and vegetation (e.g., increasing turbidity and reducing macrophytes). Altering these habitat components may affect such basic frog resources as food, cover, breeding success. The alterations may result in brief impacts to frog behavior or may ultimately affect the survivorship of eggs, tadpoles, or adults. This complexity of interactions should be recognized when evaluating how a proposed action may affect Chiricahua leopard frogs. Again the lack of quantitative relationships between habitat parameters and frog responses will likely prevent quantitative conclusions during effects analyses. It will not, however, preclude determining whether a proposed activity may affect the species.

1. Water permanence and flow regimes

Regardless of the existing moisture or flow regime (e.g., permanent, semi-permanent, or seasonal lentic waters; perennial, intermittent, ephemeral lotic waters) of an aquatic site, a change (reduction or increase) in the length of time that water is present may affect some stage of the frog's life cycle. For example, reducing the length of time a site holds water may eliminate its capability to sustain a breeding population if the site becomes dry prior to the complete metamorphosis of tadpoles (3 to 9 months, depending on water temperature). Frogs may respond to drying by dispersing (if ambient conditions permit) or burying themselves in mud, but this would likely expose them to increased mortality from predation, desiccation, or some physiological stress. If eggs or tadpoles are present, they too may be exposed to additional mortality from predation or desiccation. A reduction in permanency will also result in changes to other components such as aquatic vegetation and invertebrates, leading to a reduction in food resources to larval and adult frogs. A reduction in permancy will also affect frog competitors and predators. Periodic drying, even for short periods of time, will eliminate all fish and bullfrog tadpoles. Conversely, an increase in the moisture or flow regime at a site may lead to conditions that promote egg, larval and adult survivorship by reducing the risk of desiccation. Increased permanency may also increase the likelihood for invasion by non-native species.

Boone *et al*. (2004) found that longer hydroperiods[9] resulted in greater survival, greater size at metamorphosis, longer larval periods, and later time until emergence of the first metamorphs for southern leopard frogs . Increased water permanence generally promotes invertebrate and plant diversity as they might relate to food and cover for Chiricahua leopard frogs (McGaha 1952,

[9] Hydroperiod is the duration of water level at or above the substrate surface (Forman *et al*. 2003).

Krull 1970, Voigts 1976, Whiles and Goldowitz 2001), thus providing conditions for improved growth and survivorship at all life stages of the species.

Some concern has been expressed that more permanent aquatic sites may also provide conditions suitable for the invasion of some non-native predators (USFWS 2007: 16). Boone *et al*. (2004) noted that moisture regimes may mediate the impacts bullfrogs have on amphibians; temporary ponds generally cannot support bullfrogs because their larval period is relatively long compared to native frogs. In Arizona, bullfrog larval periods may exceed a year. The likelihood of such an effect might be influenced by the proximity of the site to source populations of bullfrogs.

Alterations of vegetative and edaphic characteristics in the terrestrial uplands of an occupied watershed may reduce or increase water permanence in lotic and lentic systems occupied by Chiricahua leopard frogs by altering runoff patterns, overland sediment flow, and amounts of water taken up by plants (Neary *et al*. 2005). Altering runoff patterns may result in increased or decreased base flows as water is either more rapidly transported overland, or allowed to percolate into the soil where it is released more gradually (USFWS 2007: Appendix H). The condition of vegetation in the watershed may alter the amount of water that is available for aquatic systems. For example, transpiration processes (particularly associated with deep-rooted plants) may consume water that otherwise would become perennial streamflow or enter aquifers feeding spring-fed ponds (Neary *et al*. 2005). Thus, a reduction or increase in vegetation may have different impacts to water permanency of aquatic sites depending on the vegetative characteristics. It is important that likely impacts from landscape-type activities to hydrological functions of a watershed that may alter water permanency are considered with information specific to the local watershed conditions[10].

Activities that degrade riparian zones are likely to have significant impacts to water permanency in lotic systems and their associated backwater pools. USFWS (2007: H-6) notes, "Healthy riparian areas act as giant sponges during flood events, raising water tables and maintaining a source of streamflow during dry seasons."

In addition to watershed-level effects that may alter water permanency of occupied sites, more local activities may also impact moisture and flow conditions with impacts to the permanency or stability of surface water. Groundwater pumping, diversion of water, or intentional drying of sites by other means may eliminate habitat for any frogs present, resulting in forced dispersal, increased exposure to predators, or desiccation. On the other hand, the creation of permanent or semi-permanent aquatic habitats within dispersal distance of occupied sites may increase the likelihood of survivorship among dispersing frogs and provide the opportunity for successful reproduction. Altering the distribution of permanent water sources may also, however, influence the distribution of non-native competitors or predators depending on their dispersal capabilities.

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[10] It is not in the scope of this document to explore hydrological modeling that may be needed to analyze likely impacts of landscape-wide activities to watershed and hydrologic functions affecting water permanence of aquatic habitats. Such an analysis is identified in the recovery plan as a recovery action needed for all watersheds containing extant populations of Chiricahua leopard frogs (USFWS 2006:76). In addition, Appendix H of the recovery plan provides information and suggestions that can be used to develop watershed use and maintenance plans for these watersheds. Such plans will recognize the importance of flow and moisture regimes in providing essential suitable habitat for the species.

2. Water quality (temperature, sediment, contaminants, piscicides)

Relationships between water quality and Chiricahua leopard frogs have generally not been studied (but see Little *et al.* 2007, and Little and Calfee 2008). However, the effects of pesticides, heavy metals, pH, temperature, and other water quality parameters on various aspects of amphibian biology have been studied in some detail (Diana and Beasley 1998), including ranid frogs, particularly in regard to the northern leopard frog (Rorabaugh 2005). Characteristics of water quality are likely to influence Chiricahua leopard frogs by altering survival, rates of growth, and development through direct toxicity, impacts to food and cover resources, and habitat heterogeneity, as well as disrupting predator-prey relationships, immune function, rates of malformations, parasitic loads, and disease relationships. Furthermore, there may be interactions among factors that make it very difficult to predict the outcome of changes in water quality. Not all factors affecting water quality are addressed here. Additional specific factors potentially impacting water quality may be found in the recovery plan.

a. Temperature

As noted in Section I of this document, warmer water temperature (up to a point, of course) has some advantages to Chiricahua leopard frogs, including more rapid embryo and tadpole development and perhaps greater resistance to the impacts from chytridiomycosis. In some instances, the removal of vegetative canopy shading aquatic sites may promote increased water temperature, greater primary productivity, and higher oxygen concentrations, all of which may increase the developmental rates of eggs and tadpoles (Haglund and Lovtrup 1966, Werner and Glennemeier 1999, Chelgren *et al*. 2006, USFWS 2007).

b. Sediment

Sediments may be produced from upland erosion processes, streambank/shoreline erosion, and in-stream/in-pond disturbances. These sediments may impact Chiricahua leopard frog habitat as suspended sediments or as heavier sediments that are deposited in the aquatic site (USFWS 2007: H-5,-6). Either type of sediment may alter components of the aquatic environment and affect Chiricahua leopard frogs.

The recovery plan notes that increased sediment loads can kill eggs and larval frogs and decrease the value of the aquatic habitat for the species (USFWS 2007: A-8). Sediment flows that enter lentic bodies of water may fill and eliminate deep pools otherwise used by Chiricahua leopard frogs for breeding, predator escape, and hibernacula (Parker 2006, USFWS 2007: 35). Increased sediment flows into occupied stock tanks will likely increase the need and frequency of maintenance to remove those sediments, resulting in increased likelihood of mortality of the frogs (USFWS 2007: A-6). Post-fire sediment movement can be especially dramatic, filling in pools and covering stream beds in rocks and cobble.

In lentic and lotic systems, increased turbidity caused by sediments or the deposited sediments themselves may reduce primary productivity with resulting declines in food resources for tadpoles and frogs such as algae, periphyton, and invertebrates (Castro and Reckendorf 1995). Active dispersal by frogs may be influenced by aquatic conditions experienced during the tadpole stage. Larvae of Couch’s spadefoot in ponds with abundant food supply transformed more rapidly than in ponds where food was scarce and tadpole density high (Newman 1989). Thus, carryover effects from sedimentation that might alter food production and result in reduced growth rates and delayed metamorphosis of tadpoles may have population-level impacts, some of which may not be expressed until post-metamorphic stages.

Although the typical location of egg masses may reduce their vulnerability to sediments, if egg masses do become coated with particulates, oxygen transfer to the developing embryo may be reduced or blocked, resulting in slower development, delayed hatching, or presumably death (Mills *et al*. 2001). Excessive suspended sediment may also inhibit respiration by tadpoles resulting in reduced growth and development, although this has not been reported.

Maxell (2000) noted that the impacts from sediments entering aquatic systems may be exacerbated if those sediments contain additional toxic materials; citing examples of runoff from contaminated road construction fill material and mine tailings that resulted in reduced densities and mortalities of amphibians, macroinvertebrates, and fish.

c. Contaminants and piscicides

As shown in Section I (see also pages 18-19, 35, 37-38, 44-46 in USFWS 2007), contamination of aquatic habitats with various organic and inorganic substances may result in lethal and sublethal effects to Chiricahua leopard frog eggs, tadpoles, and adults. Conversely, limited contamination of aquatic habitats with some nutrients may, at times, increase food resources available to frogs. Some of these effects are described in more detail, below, emphasizing the effects to different stages in the frog's life cycle.

Effects of contaminants to eggs

Because of the permeability of eggs, various aspects of water quality may influence the developing embryo. For example, increased, but environmentally relevant, levels of ammonium nitrate or ammonia may alter hatching success, embryo growth and development and result in embryo mortality in ranids (Jofre and Karasov 1999, de Solla *et al*. 2002, Ortiz *et al*. 2004).

Although no information was found specifically documenting effects of piscicides (e.g., antimycin, rotenone) to amphibian eggs, Berger *et al*. (1969) found antimycin toxic to fertilized fish eggs of a variety of species, at concentrations as low as 0.10ppb and at exposures as brief as 30 minutes. Marking and Bills (1976) reported salmonid eggs are sensitive to the piscicide rotenone, although the sensitivity is much less than that for juvenile or adult fish. It seems likely that the fertilized eggs of Chiricahua leopard frogs are also susceptible to some direct, adverse effects, including mortality, from antimycin and rotenone. No information was found regarding the potential effects of potassium permanganate (a chemical used to neutralize piscicides) on amphibian eggs (but see effects on tadpoles and adults, below).

Effects of contaminants to tadpoles

Little and Calfee (2008) examined the effects of several herbicides, Piscicides, and metals on survivorship of Chiricahua leopard frog tadpoles. In regard to herbicides, the 96 hr LC_{50s} of the herbicides Arsenal, Garlon 3A, 2,4-D, and picloram were considerably greater than concentrations expected to occur in the environment. As a result, the authors found that free-ranging Chiricahua leopard frog tadpoles are not likely to experience acute toxicity if exposed to these herbicides sprayed at the suggested application rate and without the use of adjuvants. The nominal 96 hour LC_{50} concentration for the piscicide antimycin A was 0.51 mg/L, which is above the maximum environmental concentrations of 0.01 mg/L expected to occur for several hours after a stream application. The nominal 96 hr LC_{50} of Prenfish (rotenone) was 0.79 mg/L for stage 25 tadpoles. Field application rates were estimated to be about 2.0 to 5.0 mg/L; therefore, acute toxicity and mortality of at least 50 percent of Chiricahua leopard frog larval stages 28-31 is likely to occur after application of Prenfish formulation of rotenone in the vicinity of breeding sites. The authors recommended that use of Prenfish should occur when larval Chiricahua leopard frogs are not present.

Exposures conducted over 60 days with stage 25 tadpoles determined lowest observed effect concentrations for copper of 0.165 mg/L for survival, 0.047 mg/L for development and length, and 0.007 mg/L for weight. These chronic data compare with 96 hour LC_{50} concentrations of 0.22 mg/L and 0.34 mg/L copper for the early and later life stage tadpoles, respectively. The authors noted copper concentrations as high as 47.5 mg/L near Chiricahua leopard frog breeding sites, which is more than two orders of magnitude greater than lethal concentrations determined during the laboratory studies. Thus, copper in the environment may be a limiting factor for Chiricahua leopard frogs, especially near mining operations. The lowest observed effect concentrations for cadmium determined during the 60-day chronic exposures of stage 25 CLF tadpoles were greater than 0.351 mg/L for survival. Exposure to 0.019 mg/L was significant in a beneficial way in that weight and Gosner (tadpole development) stage were enhanced, however in the next higher treatment, 0.11 mg/L, length, weight and Gosner stage were significantly lower than the controls. This chronic toxicity of cadmium compares with LC_{50} concentration of 13.8 mg/L (early life stage tadpoles) and >15 mg/L (later life stage tadpoles) for cadmium. The authors did not note cadmium in the environment at levels that could cause injury or death of Chiricahua leopard frog tadpoles; however, Hale and Jarchow (1988) and Hale *et al.* (1998) warned that cadmium toxicity may be a cause of ranid frog declines in the Southwest. Zinc was not found to be lethal by Little and Calfee (2008), even at the highest exposure concentration of 0.165 mg/L during the 60-day exposure. Exposure to zinc appeared to have a beneficial effect on weight and length compared to unexposed controls. Hale and Jarchow (1988) and Hale *et al.* (1998) argued that cadmium is toxic due to its propensity to substitute for zinc and/or copper in enzymes; thus absorption through the skin or ingestion of zinc by frogs may act to reduce cadmium toxicity. Thus in areas of relatively high zinc to cadmium ratios, frogs may be less affected.

A review of literature for other anurans reveals that effects of chemicals, UV radiation, disease, parasitic infestations, temperature, pH, or other environmental factors can be complex, with effects on frogs and populations that may be indirect or as a result of interactions or synergisms (see Carey *et al.* 2001). For instance, effects of chytridiomycosis may be greater when frogs are exposed to heavy metals or other environmental factors (Rollins-Smith *et al.* 2002, Parris and Baud 2004) effects of contaminants interactions and synergisms. Small levels of some herbicides such as Roundup (glyphosphate) are deadly to northern leopard frog tadpoles (Relyea 2005), whereas some insecticides (e.g., Malathion) may actually result in increased tadpole survival and biomass by eliminating predatory beetles (Relyea *et al*. 2005). The pre-emergent herbicide acetochlor interacts with thyroid hormone in northern leopard frog tadpoles, accelerating thyroid hormone induced metamorphosis and countering the beneficial effects of corticosterone (Cheek *et al.* 1999). Corticosterone is important in mediating the negative growth response of northern leopard frog tadpoles to increasing larval densities, and also affects development, morphology, and response to adrenocorticotropic hormone. There is growing evidence that the deleterious effects of UV radiation and chemicals may interact or be additive. In the laboratory, northern leopard frog tadpoles exposed to the pesticide s-methoprene exhibited a deformity rate of 2.1%, whereas those exposed to both UV and s-methoprene had a deformity rate of 8.7%. No deformities were observed in the control group (Akins and Wofford 1999). Exposure of northern leopard frog tadpoles to UV-A, simulating a fraction of summertime, midday sunlight in the northern latitudes, significantly increased the toxicity of fluoranthene (Monson *et al.* 1999). Exposure to low levels (i.e., levels acceptable in drinking water) of atrazine (the most widely used herbicide in the United States) for 30 days significantly reduced survivorship of green frog (*Lithobates[Rana] clamitans*) tadpoles (Storrs and Kiesecker 2004).

Rotenone and, somewhat equivocally, antimycin may affect aquatic invertebrate and plankton communities to some degree, and thus may indirectly affect aspects of the food base of tadpoles (Schnick 1974, Kotila and Hilsenhoff 1978, Minckley and Mihalick 1981, Mangum and Madrigal 1999, Ling 2003, Melaas *et al*. 2001, Walker 2003, Cerreto 2004). Potassium permanganate (KMnO4) is typically used to neutralize antimycin and rotenone in aquatic systems and may cause mortality among tadpoles and temporarily reduce the food base for tadpoles. Sima-Alvarez *et al*. (2001) found concentrations of KMnO4 lethal to bullfrog tadpoles at 1.4 mg/l and higher (to 3.0 mg/l), but not at 0.4 and 0.8 mg/l. Mortality was observed beginning 4 hours after exposure at the lower lethal concentration and between 1 and 2 hours at the highest lethal concentration. Hobbs *et al*. (2006), investigating the use of KMnO4 in the treatment and prevention of waterborne parasitic, bacterial and fungal disease in aquaculture settings, found zooplankton abundance was significantly reduced 24 hours after the chemical was applied, but typically recovered by 48 hours.

Mahaney (1994) reported that crankcase oil at concentrations of 100mg/l inhibited the growth of green treefrog (*Hyla cinerea*) and prevented metamorphosis. It is likely that other petroleum products adversely impact tadpoles, also. Ammonia concentrations at ecologically relevant levels decrease the survival, increase the prevalence of deformities, and slow the growth and development of leopard frog tadpoles (Jofre and Karasov 1999). Rouse *et al*. (1999) also reported lethal and sublethal effects in frog tadpoles at nitrate concentrations between 2.5 and 100mg/l. The combined exposure to ultraviolet radiation (UV-B from the sun) with elevated nitrate levels (from fertilizer) reduces tadpole mass and survival in tree frogs (*Pseudacris regilla*) (Hatch and Blaustein 2003). However, at lower levels, added nitrate and phosphate may also stimulate the production of algae on which tadpoles feed and the growth rates of tadpoles (Kiffney and Richardson 2001). Where organic pollution results in accelerated eutrophication, Johnson *et al*. (1999) suggested that resulting increases in snail abundance may create conditions whereby increased infection rates of tadpoles by trematodes carried by the snails may result in decreased tadpole survivorship and increased deformities. However, very few malformations have been found in wild Chiricahua leopard frogs, and deformities are not currently considered a threat to the species.

Effects of contaminants to juveniles and adults

Christin *et al*. (2003) found that exposure to some pesticides (atrazine, metribuzin, aldicarb, endosulfane, lindane, and dieldrin) in polluted wetlands altered the immune response of juvenile northern leopard frogs and decreased their ability to deal with parasitic infections. Atrazine disrupts endocrine function and even at very low concentrations of $\geq$ 0.1 ppb caused retarded gonadal development, hermaphroditism, and oocyte growth in male northern leopard frogs. Atrazine contamination is widespread in the U.S. and can be present in excess of 1 ppb even in precipitation and areas where it is not used (Hayes *et al*. 2002). Relyea (2005) noted high mortality among juvenile wood frogs (*Lithobates sylvaticus [Rana sylvatica]*) within 24 hours of being exposed to the herbicide Roundup (glyphosphate).

Jofre and Karasov (1999) noted that even in water bodies where ammonia levels are relatively low, hibernating frogs may be exposed to hazardous levels of the chemical during episodic releases of ammonia from pore sediment water. At some levels, nitrogen pollution may adversely impact invertebrate prey species of frogs, and also adversely impact vertebrate predators of frogs (e.g., eggs and fry of rainbow trout) (Rouse *et al*. 1999). However, at lower levels added nitrate and phosphate may improve foraging opportunities for tadpoles and frogs by stimulating the production of algae which may in turn increase aquatic invertebrates (Kiffney and Richardson 2001).

Sredl *et al*. (1997) attributed a die-off of the species at a stock tank (during June) to elevated levels of hydrogen sulfide. They surmised that an accumulation of organic detritus and cattle feces in the pond, coupled with a lowering of water level, high water temperature, and low concentrations of dissolved oxygen, combined to form an anoxic environment conducive to sulfur producing bacteria.

Although adult frogs are apparently much less sensitive to the direct effects of the piscicide rotenone than are tadpoles, Fontenot *et al*. (1994) reported LC50 concentrations at 24 hours of 0.24 and 1.46 mg/L rotenone among adult northern leopard frogs. Schnick (1974) reported four field studies and one laboratory study that indicated antimycin was not toxic to frogs, including northern leopard frogs at concentrations of about 10 ppb (Berger 1966a, Berger 1966b, Gilderhus *et al*. 1969). Based on results apparently presented in Lesser (1972), Schnick (1974) also reported that antimycin was not toxic to northern leopard frogs in fish-killing concentrations (5 ppb to 10 ppb). However, Schnick (1974) also presented LC50 concentrations from Lesser (1972) indicating that at higher concentrations or at longer exposure periods, antimycin does cause mortality among leopard frogs (e.g., LC50 at 24 hours: 32.5 to 59 ppb; at 96 hours: 3.8 to 11.7 ppb). However, at least in the short-term, rotenone and antimycin may reduce species diversity and density of aquatic invertebrate and plankton communities to some degree, and thus may impact the food base of frogs (Schnick 1974, Kotila and Hilsenhoff 1978, Minckley and Mihalick 1981, Mangum and Madrigal 1999, Ling 2003, Melaas *et al*. 2001, Walker 2003, Cerreto 2004).

Potassium permanganate ($KMnO4$) is typically used to neutralize the effects of both rotenone and antimycin during their use to kill existing fish in lotic and lentic waters at levels of 1 to 2 mg/liter (up to 5 mg/liter) (Marking and Bills 1975). The effects from $KMnO4$ to frogs and their habitat is poorly known under applied conditions. However, the chemical is capable of altering the invertebrate community and hence the food base of frogs. Moore *et al*. (2005) noted an immediate impact from KMnO4 on the larvae of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera), eliminating all of the mayflies and almost all of the stoneflies. Within 4 to 5 months, though, the aquatic insect community had recovered to pre-treatment levels (Walker 2003).

3. Aquatic, semi-aquatic, and peripheral vegetation

Aquatic vegetation functions as substrate for eggs, substrate and habitat for organisms fed upon by tadpoles and adult frogs (e.g., periphyton and macroinvertebrates), escape cover for tadpoles and adults, and moist microhabitats for frogs during declining moisture regimes. Aquatic and semi-aquatic macrophytes may influence water temperature regimes; facilitating the warming of shallow, perimeter water and surface water, while shading deeper water and keeping it cooler. Water temperature influences development rates of eggs and tadpoles, which in turn may influence the survival among metamorphs. Activities that reduce aquatic and semi-aquatic vegetation in and around the aquatic site, then may reduce the success of eggs, alter growth rates of tadpoles, reduce food for tadpoles and adults, and may increase the exposure of tadpoles and adults to vertebrate predation and desiccation.

Aquatic conditions experienced during the tadpole stage may ultimately impact active dispersal by frogs. Factors such as food and water temperature, both influenced by aquatic vegetation, may impact tadpole size and the timing of metamorphosis. Thus, alterations in vegetative characteristics (with resulting changes in food and temperature regimes) in and near occupied habitats with tadpoles may have delayed adverse effects to metamorphs and population-level impacts.

Vegetation peripheral to the aquatic habitats also retards bank erosion and filters sediments and contaminants/nutrients entering the aquatic habitat (USFWS 2007: H-6). If this vegetation (usually semi-aquatic and terrestrial) is impacted such that its filtering capacity is compromised, sedimentation entering the aquatic habitat may reduce the permanence of lentic habitats (as described, above), inhibit aquatic macrophyte development through increased turbidity (with the concomitant reduced food resources for tadpoles and frogs), and permit the input of nutrients such as ammonia and other nitrogenous substances into the aquatic habitat. Thus, alteration of peripheral vegetation may also increase the exposure of frogs to the effects of altered water quality in ways discussed above.

On the other hand, aquatic sites rank with aquatic vegetation or lined with extremely dense vegetation may (a) inhibit egg-laying by reducing open surface water, (b) reduce solar radiation entering the aquatic environment and thus reducing water temperature (potentially altering/delaying developmental rates of embryos and tadpoles), and/or (c) reduce open shoreline areas important for thermoregulation by basking frogs (Bull 2005, USFWS 2007: 18, 77). As with other habitat parameters for this species, the density of vegetation needed to attain these possible effects is not quantified. However, ponds completely taken over with cattails can lead to the extirpation of leopard frogs (J. Rorabaugh, pers. comm. 2006).

4. Presence of non-native predators and competitors

Other organisms form an important component of the frog's habitat. As discussed in section I, non-native predators such as crayfish, bullfrogs, and fish may cause mortality among frogs by eating their eggs, tadpoles, and adults. Furthermore, as previously seen, non-native species may impact frogs by:

(1) Reducing aquatic vegetation leading to:
- (a) Fewer egg laying sites;
- (b) Less food resources for tadpoles and adults;
- (c) Reduction in escape cover;
- (d) Reduced filtration and thermal functions by the vegetation.

(2) Altering substrate conditions, with resulting effects to vegetation development, and hibernacula availability (especially in lotic habitats, the elimination of aquatic macrophytes may lead to the loss of sediments during high flow events);

(3) Spreading or facilitating the spread of disease such as chytridiomycosis.

In addition, competition for food (e.g., by bullfrog tadpoles) may impede tadpole development (Boone *et al*. 2004), which in turn may reduce the survival and capabilities of metamorphs (Chelgren *et al*. 2006). Activities that promote the incidence of these predators in habitats may increase the likelihood of these adverse effects to Chiricahua leopard frogs. Conversely, activities that reduce the incidence of non-native predators may significantly improve the survival of leopard frogs (Doubledee *et al*. 2003, Vredenburg 2004).

The recovery plan suggests that deep water, aquatic vegetation, undercut banks, root masses and other cover sites may be important to frogs in avoiding predation (USFWS 2007: 18). Thus activities that alter these aspects of the aquatic habitat (i.e., reduce the structural complexity or hydrological stability) may increase the likelihood of predation. In simple habitats, such as stock tanks, non-native predators almost always eliminate breeding populations of Chiricahua leopard frogs. The species often coexists with a variety of native predators (e.g., gartersnakes, native fishes, tiger salamanders); however, these predators can also eliminate Chiricahua leopard frog populations, particularly if those populations are small and occur in simple aquatic systems.

5. Exposure to chytridiomycosis

The presence or introduction of *Bd* may be viewed as a habitat perturbation just as the presence of other biotic features, such as non-native aquatic predators. As discussed in the previous section, *Bd* may be spread through the movement among aquatic sites of wet equipment or mud on vehicle tires, water, birds, alternative hosts such as bullfrogs, salamanders, invertebrates, and even by other Chiricahua or other leopard frogs. Activities that may promote the spread of *Bd* to occupied habitats through the transport of the fungus in mud, water, or other hosts, will increase the risk of mortality to frogs in those habitats from chytridiomycosis.

Rowley *et al*. (2006) noted that the presence of alternative hosts may prevent the recolonization of target amphibians (in this case, Chiricahua leopard frog) back to systems from which they were extirpated. Although the authors were considering impacts to the active restoration of species, the introduction or maintenance of *Bd* in habitats presently unoccupied by Chiricahua leopard frogs may impact the success of natural recolonization of those sites by uninfected, dispersing frogs, or through reestablishment efforts.

As previously shown, the severity of chytridiomycosis infections is influenced by temperature. Activities that change the temperature regime of occupied habitats may influence the likelihood of mortality from chytridiomycosis amongst frogs that may be present. The expression and severity of the disease is also likely influenced by a variety of other stressors, such as contaminants, cold winters, UV-B radiation, acidic rainfall, and other changes in habitat that affect immune function (USFWS 2007: 27).

6. Dispersal habitats

Frogs may actively move along streamcourses, and tadpoles may be carried passively in flowing water. Dispersal may involve the use of more temporary aquatic habitats such as puddles and livestock tanks. Metamorphs, juveniles, and adults may traverse the upland terrain that frogs may pass through on their way to other aquatic sites. Precipitation may ultimately control the suitability of much dispersal habitat by creating temporary continuous aquatic corridors, temporarily surface waters, and by creating moist upland conditions permitting the overland movement of frogs. As mentioned, above, landscape or watershed-level activities that increase water permanence will likely improve the availability and quality of dispersal habitat. Dispersal habitat may be enhanced by actions that increase the distribution of intermittent sites (USFWS 2007: 82). However, increased opportunities for leopard frog dispersal will correlate with similar opportunities for bullfrog and in some cases other non-native predator dispersal.

Movement of dispersing leopard frogs may be impeded by disturbed soil surfaces and reduced vegetation. Chan-McLeod (2003) found that the removal of vegetation (i.e., clearcut harvesting) created a barrier to overland movement (e.g., dispersal) of red-legged frogs. The author noted that cover is likely important to reduce desiccation and to escape predation among frogs traveling overland. Working with northern green frogs (*Lithobates [Rana] clamitans melanota*) and northern leopard frogs, Mazerolle and Desrochers (2005) found that 72% of the frogs avoided disturbed surfaces (i.e., vegetative cover had been removed) when given a choice. When translocated to a disturbed surface, frogs had a lower probability of homing successfully (to a pond) than when on an undisturbed surface. The study also found that frogs lost the most water on substrates associated with disturbance and in the absence of cover. The authors concluded, in part, that upland disturbance has direct implications for connectivity and the persistence of frogs in the landscape because recruitment will be low in disturbed environments. Similarly, other natural and anthropogenic disturbances to the landscape may act as barriers to frog dispersal by physically preventing movement or by increasing the risk to mortality from traffic, predation and desiccation (Carr and Fahrig 2001, Forman *et al*. 2003, USFWS 2007: 18, I-7).

The importance of dispersal habitat for frogs is thought to be crucial in preserving populations of frogs (USFWS 2007: 14-15). Thus, factors that alter the suitability of dispersal habitat will affect the functioning of metapopulations (USFWS 2007: 40). For instance, drought may eliminate ephemeral pools and streams upon which frogs rely during their dispersal through otherwise arid landscapes. Wet periods, though, may facilitate dispersal and connections among local populations. Human activities that reduce or increase water permanency (as discussed above) may also inhibit or facilitate dispersal not only of Chiricahua leopard frogs, but of non-native predators and competitors (e.g., bullfrogs, crayfish, tiger salamanders).

C. Disruptions to the individual

Most of the effects (beneficial, benign, adverse, or of an undetermined character) that may result from a proposed activity to individual frogs will likely arise indirectly from alterations to habitat, as described above. However, individual frogs (eggs/embryos, tadpoles, juveniles, and adults) are themselves susceptible to the direct effects from some types of activities that may result in mortality or other disruption of behavior that may influence growth and survivorship. Activities may modify behavioral aspects of the frogs that then increase the risk of the frog to mortality, reduced fecundity, etc. Any activity that is reasonably likely to cause "take" (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct) triggers the formal consultation process. "Harm" is 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.

Physical contact with eggs, tadpoles, juveniles, or adults during the implementation of an activity may constitute take. Because they use both aquatic and terrestrial environments, Chiricahua leopard frogs are vulnerable to this type of effect in both settings. In terrestrial habitats, individuals may be trampled or crushed while seeking refuge in mud during drought (USFWS 2007: 35), or during cross-country dispersal (Carr and Fahrig 2001). At lower temperatures, frogs are unable to swiftly flee and may be vulnerable to being trampled while basking along shorelines (USFWS 2007: 14).

In aquatic environments, egg masses may be crushed or dislodged from aquatic vegetation and displaced to sites less suitable for successful hatching. During winter, disturbance of the benthos may crush hibernating frogs. Even during non-hibernating periods, activities in occupied waters may disrupt feeding, or cause movements that may expose them to predation.

As mentioned in section I, anthropogenic noise may disrupt male vocalizations in some manner, and thus may affect some aspect of mating and reproduction. Vocalizations by male frogs are species-specific and are assumed to serve as conspecific mate attractants that permit females to reduce the likelihood of error in mate choice where other similar ranid species are present (Frost and Bagnara 1977). Differences in mating call, along with differences in breeding season, provide effective pre-mating barriers to hybridization (Frost and Platz 1983). Sun and Narins (2005) found that airplane flyby noise and playbacks of low-frequency motorcycle sounds caused significant changes in the calling behavior of some ranids, perhaps influencing the likelihood of successful mating. Thus, anthropogenic noise, especially during the night or at dusk when Chiricahua leopard frogs primarily vocalize, may result in some type of effect to their calling behavior.

D. Representative examples to assist in the analysis process

This section provides brief analyses of effects that may result from some general types of activities, including fire management, construction, native fish restoration, and livestock management. This section is intended to suggest what types of effects might be considered during a project-specific assessment and provide a "jump-start" in the thought process during effects analyses. These analyses are not exhaustive and effects discussed here may not be applicable to any given proposed activity. Appendix I of the Recovery Plan provides additional information on how certain project types affect Chiricahua leopard frogs.

An effects analysis of a proposed action considers all direct and indirect effects of that action that are likely to occur to the species as a result of the proposed action, together with the effects of other activities that are interrelated to, or interdependent with the proposed action.

Direct and indirect effects
Direct effects from a proposed action include the immediate effects of the project on Chiricahua leopard frogs (eggs, tadpoles, adults). Examples of direct effects may include trampling of frogs or dislodging egg masses by livestock, scorching frogs during a prescribed fire, and shocking frogs during fish sampling.

Indirect effects to Chiricahua leopard frogs include effects that are caused by or result from the proposed action and are later in time, but still are reasonably certain to occur. For instance, during livestock grazing along the bank of an occupied aquatic site may trample the shoreline causing undercut banks to collapse. Frogs typically used the undercut banks to escape predators and also as hibernacula during the winter. The loss of this habitat causes the following indirect effects, which occur after the action of trampling is completed: (1) frogs are unable to escape rapidly from predators and mortality increases, (2) frogs must select suboptimal habitat in which to hibernate and may die as a result.

Interrelated and interdependent actions
An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the proposed action. The two concepts are somewhat difficult to separate, as indicated by the apparent confusion in an example presented in the Consultation Handbook (USFWS and National Marine Fisheries Service 1998). As noted in the Consultation Handbook,

> "As a practical matter, the analysis of whether other activities are interrelated to, or interdependent with the proposed action under consultation [or being analyzed] should be conducted by applying a "but for" test. The biologist should ask whether another activity in question would occur "but for" the proposed action under consultation [being analyzed]. If the answer is "no", that the activity in question would not occur but for the proposed action, then the activity is interrelated or interdependent and should be analyzed with the effects of the action. If the answer is "yes", that the activity in question would occur regardless of the proposed action under consultation [or being analyzed], then the activity in question is not interdependent or interrelated and would not be analyzed with the effects of the action under consultation [or being analyzed]." (pp. 4-26)

A single example of an activity specifically identified as an interrelated action was found among the numerous existing biological opinions for the Chiricahua leopard frog. In this case, the proposed action was the issuance of a permit under section 404 of the Clean Water Act. The permit only applied to road and golf cart crossings that were in waters of the United States, but issuance of the permit facilitated the development of a resort including lodging, residences, and a variety of other commercial, recreational, and cultural developments. A new road proposed for the development was considered an interrelated activity and its effects were considered in the analysis for issuing the 404 permit. The road would not occur but for the issuance of the 404 permit, and the road apparently depended on the permit for its justification.

Generally, a thorough description of the proposed action will identify all of the project “parts” including, although probably not labeled as, interrelated and interdependent activities. However, some actions that are likely to occur as a result of the proposed action may be less obvious. As is often the case in section 7 consultation, informal consultation with USFWS Ecological Services will help minimize the likelihood that important interrelated and interdependent actions are missed during the analysis of effects. Conversely, informal discussions between the action agency and USFWS will avoid considering and evaluating the effects of actions as interrelated or interdependent when those actions really are not.

1. Fire management activities

Fire, through smoke and ash, produces a variety of chemicals that may enter aquatic systems immediately. The large-scale modification of organic groundcover may result in continued impacts to various hydrological and biological features relevant to aquatic habitats used by Chiricahua leopard frogs. Associated actions often planned and implemented in conjunction with prescribed fire may also result in direct and indirect effects to Chiricahua leopard frogs and their occupied habitats.

In general, effects from fire to qualitative and quantitative components of frog habitat vary with fire severity, pre-fire watershed conditions, and other factors (Gresswell 1999, Minshall 2003). Prescribed fire, although generally much less intense than wildfire, may still involve actions and results that potentially affect Chiricahua leopard frogs and their occupied habitats (Pilliod *et al*. 2003, Beche *et al*. 2005). Properly applied, prescribed fires and fuels management projects should have long-term benefits to Chiricahua leopard frog populations by reducing the likelihood of catastrophic wildfire. However, any fire, regardless of severity, will likely have short-term adverse effects to any frog populations in the action area.

During a fire, effects from the fire to Chiricahua leopard frogs may occur in terrestrial and aquatic habitats. In uplands, juvenile or adult Chiricahua leopard frogs that are dispersing or moving across terrestrial uplands during a fire may be scorched or burned (Pilliod *et al*. 2003). The likelihood of this effect may be very low given that overland dispersal by Chiricahua leopard frogs may occur only during very wet conditions. As a result, such effects to dispersing frogs may not meet the reasonably likely threshold needed to anticipate incidental take, but may rise to the level of “may affect” if occupied habitats occur within the action area or within reasonable dispersal distance of the action area. Burning immediately adjacent to aquatic sites may increase the likelihood of some frogs being burned, but even here most potential effects may be through immediate and subsequent effects to the frogs’ habitat. Smoke and ash generated during a fire may contribute various chemicals (e.g., phosphorous and nitrogen compounds) to aquatic habitats (Beche *et al*. 2005; Minshall 2003), and fire near aquatic sites may cause water temperatures to increase rapidly (Pilliod *et al*. 2003). Eggs and larvae or even adults that are exposed to sudden increases in water temperature or changes in water chemistry from ash and smoke, may be killed or experience some type of sublethal physiological stress. Toxicity from ammonium diffusing into water from smoke generated during a fire was suggested as a cause for mortality among adult and larval tailed frogs (*Ascaphus montanus*) that were observed dead in the water soon after an intense wildfire (Spencer and Hauer 1991). However, in general, the immediate effects of most fires (prescribed or wildfire) on stream temperature and water chemistry are usually negligible with effects most likely to occur in small, shallow water bodies (Pilliod *et al*. 2003, Beche *et al*. 2005).

Post-fire effects, however, are probably more likely to result in impacts to Chiricahua leopard frogs through the modification of terrestrial and aquatic habitat features. These impacts may influence the quality and quantity of aquatic sites inhabited by Chiricahua leopard frogs.

a. Water permanence and flow regimes

Pilliod *et al*. (2003) noted that changes in vegetation resulting from fire, "…can alter the water holding capacity of plants and soil, the rate of snow melt, and local water tables, and these factors can lead to changes in the timing of peak and low-water events and the formation of small forest pools." Increased peak flows may create new pools in lotic systems, yet destroy elements of habitat complexity such as undercut banks by increasing channel scour (Pilliod *et al*. 2003). Sediments generated by fires may fill up pools in streams and stock tanks and small ponds, thus eliminating some habitats used by frogs.

By removing deep-rooted vegetation, fire may result in a temporary increase in ground water available to springs and streams (Neary *et al*. 2005). In this way, fire may extend the hydroperiod of some aquatic habitats by reducing loss of water to evapotranspiration from plants, or result in the creation of new aquatic habitats.

Minshall (2003) reported that alterations in benthic macroinvertebrate communities (up to 85-90% reduction in densities) following fire resulted primarily from increased runoff rates with accompanying channel alteration and sediment transport and deposition. He also noted that indirect effects to macroinvertebrates from fire-related disturbance varied considerably, but generally the effects were compounded, "… in watersheds already adversely impacted by generations of resource extraction and short-sighted management" (Minshall 2003:159).

b. Water quality (temperature, sediment, contaminants)

Post-fire debris or sediment flows are one of the most devastating effects of fires on leopard frog populations (Wallace 2006). These effects are most likely to occur in or downstream of catastrophic wildfires, but lesser effects can occur as a result of moderate or low severity fires, as well. After the Rattlesnake wildfire in the Chiricahua Mountains, Arizona, a large debris flow filled in Rucker Lake, a historical Chiricahua leopard frog locality. Leopard frogs (either Chiricahua or Ramsey Canyon leopard frogs) apparently disappeared from Miller Canyon in the Huachuca Mountains, Arizona, after a 1977 crown fire in the upper canyon and subsequent erosion and scouring of the canyon during storm events (T. Beatty, pers. comm. 2000). Leopard frogs were historically known from many localities in the Huachuca Mountains; however, natural pool and pond habitats are largely absent now, and the only breeding leopard frog populations occur in artificial tanks and ponds. Crown fires followed by scouring floods are a likely cause of this absence of natural leopard frog habitats. In Romero Canyon, Catalina

Mountains, Pima County, Arizona, lowland leopard frogs *Lithobates[Rana] yavapaiensis*) and their habitat were severely reduced or eliminated due to runoff and sedimentation immediately following the Aspen Fire in 2003, although subsequent surveys in Romero Canyon have noted a return of some pool habitat and frogs (Wallace 2006). Loss of occupied habitat also occurred in Buehman Canyon and probably other localities in the Catalina Mountains due to recent catastrophic fires (Wallace 2003). At Saguaro National Park East, similar loss of lowland leopard frog habitat has also occurred due to post-fire sedimentation and ash flow (D. Swann, pers. comm. 2002).

The removal of upland vegetative ground cover may also induce erosion and sedimentation reaching aquatic sites Neary *et al*. (2005). The degree of this impact is likely commensurate with the extent and intensity of burning, in addition to various other features of the landscape and soils that might increase or decrease the likelihood of erosion (see Simanton *et al*. 1990). The deposition of sediments, as previously discussed, may fill in pools and tanks, thus reducing the permanence of those sites and their use for breeding (Parker 2006). Increased turbidity and accumulated fine particulates may reduce primary productivity of sites resulting in altered availability of foods for larva and adults. Sedimentation may also alter aquatic or semi-aquatic vegetation in and around aquatic sites, thus reducing feeding and cover (e.g., egg-laying, escape) habitats for frogs (Pilliod *et al*. 2003). Pulses of sediments may smother eggs.

In addition to potentially increasing sediment flow, fire may also contribute nutrient pulses to aquatic systems through runoff containing phosphorus, ammonium, nitrate, and nitrite. These increased levels may not be at levels directly relevant to Chiricahua leopard frogs (Gottfried and DeBano 1990, Pilliod *et al*. 2003), although high levels of nitrate/nitrogen in water can stress or kill amphibians (Rouse *et al*. 1999). However, nutrient inflow from fires may result in increase algal growth in aquatic systems that in turn may provide more food for tadpoles resulting in more rapid growth and larger size at metamorphosis, and perhaps increased survival (Pilliod *et al*. 2003). Increased productivity may also result in more invertebrate food resources available for adult frogs (Kiffney and Richardson 2001). Too much algal growth, however, may reduce dissolved oxygen levels that may be compounded by warmer water. The potential effects of reduced oxygen to eggs and tadpoles resulting from these effects are not known.

Other activities associated with fire management may also alter water quality by introducing chemicals (e.g., petroleum products, fire retardants) or by generating sediments (see item g, “Effects from other actions associated with fire management”, below).

c. Aquatic, semi-aquatic, and peripheral vegetation

The loss of riparian vegetation near an aquatic site may result in higher water temperatures from increased solar radiation (Pilliod *et al*. 2003). As with other impacts from fire, this potential effect is likely dependent on many variables associated with the fire and with the existing conditions at the aquatic site. Warmer waters may result in earlier reproduction, more rapid rates of embryo and larval development, shorter period of hibernation and other potential effects (USFWS 2007: 43). In addition, increases in stream temperature may increase aquatic invertebrates (Reeves *et al*. 2006) that may provide food for frogs. Warmer temperatures may also result in reduced dissolved oxygen and increased evaporative loss. Although warmer temperatures are associated with quicker hatching and larval development of Chiricahua leopard frogs, Zweifel (1968) believed the upper limiting temperature for early embryos to be about 95°F (35°C). Typically, in the range of Chiricahua leopard frogs, elevated water temperatures may not reach limiting thresholds, but in some situations this may be relevant. Increasing water temperature may also influence the susceptibility of frogs to chytridiomycosis, depending on the specific circumstances (USFWS 2007: 43).

In addition, peripheral vegetation may function to filter nutrients and sediments from entering aquatic habitat used by frogs. The loss of the vegetation then may permit increased effects to the aquatic site by both sediments and nutrients.

d. Presence of non-native aquatic predators and competitors

The same impacts from fire that might impact Chiricahua leopard frogs, might also impact non-native aquatic species (e.g., changes in water quantity and quality). In addition, some activities associated with fire management may create conditions that facilitate the spread of non-native aquatic species (see item g, "Effects from other actions associated with fire management", below).

e. Exposure to *Bd*

As with the spread of non-native aquatic species, the spread of *Bd* may be facilitated by some actions associated with fire management, fire suppression, and post-fire activities (see item g, "Effects from other actions associated with fire management", below).

f. Dispersal habitats

In general, the short-term effects from fire negatively affect habitat (e.g., filling of pools with sediment), although there may be certain circumstances where fire rehabilitates aquatic habitat (e.g., removal of cattails). In the long term, fire can improve watershed condition by improvement of vegetation communities (e.g., under circumstances when the watershed is degraded due to woody plant invasion).

In addition, fire may reduce the suitability of overland dispersal habitats. The removal of vegetation by fire across uplands near inhabited aquatic sites may affect the successful dispersal of Chiricahua leopard frogs. In surrounding uplands, the removal of ground cover may inhibit, or act as a temporary barrier, to overland dispersal of frogs and may expose those frogs moving across such a landscape to increased risk of desiccation and predation (Chan-McLeod 2003).

g. Effects from other actions associated with fire management

A variety of interrelated or interdependent actions are often associated with fire management. Projects implemented to reduce fuels may, in addition to using prescribed burning, also involve a combination of other management activities. These may include mechanical thinning, the construction of roads, and the application of herbicides. At times, managed fires (fire-use fires, prescribed burns) may "go out of prescription" at which time they are declared "wildfires" and thus require the application of suppression techniques including the construction of firebreaks and the application of chemical fire retardants/suppressants (Pilliod *et al*. 2003). These actions, tiered to an initial Federal action, may also affect Chiricahua leopard frogs and their occupied habitats, and should be considered when making effects determinations for the proposed action (e.g., fire-use plan, prescribed burn plan).

In any fire management-related activity where personnel may be visiting water sources, the opportunity exists to transfer *Bd*. This might occur if infected mud is transported to an uninfected site or water drafted or dipped from an infected site is somehow released in an uninfected site. In addition, drafting or dipping water from an occupied site for use in suppression activities (aerial or ground application) could potentially result in the capture of Chiricahua leopard frogs resulting in harm or death to the individuals. Dipping may significantly reduce water levels of stock tanks or other small aquatic sites, imperiling frog populations. Although unlikely, helicopters have crashed into pools of water while dipping water in buckets for fire suppression (e.g., Willow Fire, 1975, Apache-Sitgreaves National Forests, Arizona). After fires, water levels in stock tanks or other water sources may be replenished. The source of water for such activities should come from domestic sources or wells to eliminate the likelihood of moving non-native predators and disease.

Mechanical fuel reduction
The mechanical removal of fuels, such as thinning of understory vegetation, may also result in ground disturbance potentially influencing the quality of the area for dispersing frogs and potentially generating sediments and impacting hydrological characteristics of watersheds influencing aquatic sites used by Chiricahua leopard frogs (Madrid *et al*. 2006). The mechanisms by which these impacts may affect the frog would likely be similar to those previously discussed. In addition, with mechanical equipment in use, the potential effects of petroleum contamination of aquatic sites may be considered.

Salvage/post-fire logging
On occasion, the removal of dead trees is desired by a land management agency after a fire (typically after a wildfire), primarily as a response to an opportunity to provide commercially useable wood products and to address some ecological concerns such as providing harvest debris to intercept surface water flow, reduce fuels and thus intensity of subsequent fires ("reburn" hypothesis), and slow the buildup of insect pests (McIver and Starr 2000, Lindenmayer and Noss 2006).

In a review of literature related to environmental effects of post-fire logging, McIver and Starr (2000: 21) concluded, in part, that, "Although ground-based logging activity could mitigate for erosion problems under certain conditions, it is more likely that it will either have no effect or produce more sediment than that produced by the fire." Post-fire logging associated with road building and ground-based log retrieval will potentially compound problems with erosion and sediment transport following wildfire (McIver and Starr 2000, Reeves *et al*. 2006). The effects of sediment thus generated to occupied Chiricahua leopard frog habitats may be similar to those previously discussed.

Roads and constructed fuel/firebreaks
Unpaved roads and firebreaks may be established or maintained for use in fire management (Pilliod *et al*. 2003). Both roads and larger fuel/firebreaks within dispersal distance of occupied frog sites may inhibit dispersal (Chan-McLeod 2003). The additional mechanized traffic associated with roads may also increase the likelihood of contamination of aquatic sites with petroleum products and the adverse effects they may have on frogs (Mahaney 1994). Roads may

also act as a barrier to frog movement and dispersal. Traffic on roads near occupied frog sites may also result in direct mortality to dispersing frogs, although on lightly used roads this may be unlikely (Forman *et al*. 2003). Unpaved roads and firebreaks (mechanically or hand constructed) can contribute large quantities of sediments to aquatic sites (Pilliod *et al*. 2003). Roads constructed to waters (perhaps to obtain water for suppression activities) may facilitate the spread of non-native predators/competitors or even *Bd*. Roads and firebreaks may, on occasion, create small pools of water that may provide temporary habitat for dispersing frogs (Pilliod *et al*. 2006, USFWS 2007).

Fire retardants and suppressants
The application of chemicals is often used during efforts to control wildfires. Two general types of chemical products are often used: Long-term retardants and Foam Fire Suppressants. Long-term retardants are basically ammonium compounds (fertilizer) in a water solution (Gimenez *et al*. 2004). Although prior to 2007, retardants used by Federal agencies often contained sodium ferrocyanide, after the 2006 fire season Federal agencies no longer use retardants that contain the cyanide compound because of its toxicity to aquatic species and aquatic environments. Thus, analyses of effects should not need to consider the effects of cyanide on Chiricahua leopard frogs. Suppressant foam is basically a highly concentrated detergent (surfactant)-water solution (McDonald *et al*. 1995a).

Long-term retardant and suppressant foams are toxic to a variety of aquatic invertebrates and vertebrates. Ammonia from retardants has been shown to be lethal to tadpoles of southern leopard frogs (Calfee and Little 2003, Angeler and Moreno 2006). Little and Calfee (2002) reported toxic concentrations of retardant (LC50) to tadpoles of southern leopard frogs of about 150 mg/L. Calfee and Little (2003) reported that formulations are generally applied at concentrations of 132g/L or higher. The authors noted, though, that shallow aquatic sites (such as may be used by amphibians) with limited recharge from uncontaminated water may be particularly vulnerable to contamination at toxic levels (Calfee and Little 2003). Surfactants in foam suppressants interfere with the ability of gills to absorb oxygen from the water, resulting in suffocation of fish (Hamilton *et al*. 1996). The same process may apply to gilled tadpoles.

Both retardants and foams, however, may impact other biotic components and indirectly affect Chiricahua leopard frogs and their occupied habitats. Angeler and Moreno (2006) reported that nutrients from retardants caused the eutrophication of study ponds resulting in a shift from clear water to turbid water with the loss of aquatic macrophytes. Foams and retardants are toxic to fish, aquatic invertebrates, and algae (Calfee and Little 2003, McDonald *et al*. 1995a, 1995b). The contamination of aquatic habitats occupied by Chiricahua leopard frogs then may have direct toxic effects to tadpoles and indirect effects to the species by disrupting ecosystem function associated with feeding (algae, invertebrates) and predation by fish.

Fire-retardants may act as a source of nitrogen, phosphorous, and sulfur in uplands near aquatic sites. This addition of nutrients may result in a fertilizing effect for some plant species, and foliar and plant death among others (Bell *et al*. 2005). The impacts of retardants to post-fire watershed recovery and to frog habitat, then, may be highly variable.

2. Construction activities

Construction projects include a wide variety of actions involving the creation of new structures and the maintenance of existing ones. Construction might very well be a component (interrelated or interdependent activity) of many other types of Federal actions such as the creation or maintenance of fuelbreaks in a fire management project, in-stream fish barriers in a native fish recovery effort, and stock tanks or corrals in a livestock management activity. Other types of construction activities that may impact Chiricahua leopard frogs and their occupied or likely-to-be-occupied habitats include in-stream gravel mining and various "flood control" activities (e.g., levees, dams), bank stabilization along watercourses (concrete lining, riprap, planting riparian species), road construction (including bridges, low-water crossings, culverts, road drainage ditches, etc.), facilities (campgrounds, kiosks, buildings), utilities (powerlines and powerline corridor maintenance, pipelines, fiber-optic cables, wastewater treatment plants), and various other actions including the construction of trails.

All of these activities involve a certain amount of ground disturbance and noise. Some may occur in or immediately adjacent to aquatic sites. A few of these actions may involve major alterations to the aquatic habitats that greatly alter the suitability of the site for one or more stages of the Chiricahua leopard frog. Most may involve the use of mechanized and heavy machinery with associated crews of workers. Anthropogenic noise from construction-related activities, especially at dusk and night (perhaps from generators), may impact the advertisement calling of Chiricahua leopard frogs in some way.
As with other proposed actions, preliminary USFWS-permitted surveys of all suitable habitats within the action area of the proposed project, although not required, will assist in refining an analysis of effects. If the species is likely to be present during the project implementation, informal discussions with the USFWS will help identify if salvage of the frogs, tadpoles, or eggs is warranted. Assuming Chiricahua leopard frogs are reasonably likely to occur in the action area of the construction activity during the life of the project, the following are some considerations when making effects determinations:

If any part of the construction activity will occur in or adjacent to aquatic habitats, a variety of direct and indirect effects may occur to individual frogs, tadpoles, and/or eggs. These effects may range from behavioral disturbance (e.g., causing the frogs to move out of the immediate work area; disrupting foraging, basking, vocalization, etc.) to physical harm, injury, or mortality (e.g., crushing individuals, displacing egg masses, causing desiccation of eggs and tadpoles, etc.).

a. Water permanence and flow regimes

Unlike some activities that have landscape-wide implications (e.g., fire management, livestock management), many construction actions in areas occupied by Chiricahua leopard frogs are generally restricted to a defined area and may not have watershed-level impacts to water permanence. Exceptions to this may include (1) the construction of roads that divert or otherwise alter natural drainage patterns (Forman *et al*. 2003) and, (2) the construction of levees and dams that may severely impact the function of floodplains and channel characteristics.

Even site-specific construction projects may temporarily divert water to facilitate construction or create new pools of water. Depending on the actual impact of water diversion to an occupied aquatic site (e.g., extent of diversion, permanent vs. temporary loss of habitat, availability of adjacent habitat) and the life stages that may be present (e.g., mobile adults vs. immobile eggs), the magnitude of effects to Chiricahua leopard frogs from diverting water may vary considerably. The creation of new aquatic habitats such as pools may provide new opportunities for breeding, but may also provide habitat for non-native aquatic predators.

In some cases, the construction activity itself may not impact hydroperiod or flow regimes but the operations of the facility (an interrelated or interdependent activity) may. For example, constructing a facility to pump ground water in a watershed occupied by the frog itself may not measurably alter hydrologic characteristics impacting leopard frog habitat, but the actual extraction of the ground water may reduce the extent or permanence of nearby surface waters. On the other hand, if water pumped from a deep aquifer is used to create new surface waters, then the effect may be to actually create new habitat for the species. Again, the concept of interrelated and interdependent activities may snowball to the nth degree and informal consultation with USFWS personnel is advised to both insure that such effects are neither ignored, nor unnecessarily analyzed.

b. Water quality (temperature, sediment, contaminants)

Construction activities may impact water quality of occupied habitats in various ways, including generating sediments and removing natural capabilities to filter those sediments, and facilitating the entry of contaminants to the aquatic habitat. Ground disturbance within the watershed of occupied aquatic habitats may generate new sources of sediments and at the same time reduce the potential filtering capability of vegetation and organic debris. The disturbance of vegetation surrounding the aquatic site may remove a natural sediment filter and allow an increase in sediments entering the aquatic site. As previously discussed, sediments may inhibit food resources for frogs and the ability of embryos and tadpoles to breathe. Again, the effects of sediments should be considered to occupied habitat downstream of the actual construction site (i.e., in the action area and not just in the project area). In some instances, though, the removal of vegetative canopy shading aquatic sites may promote increased water temperature, greater primary productivity, and higher oxygen concentrations, all of which may alter the developmental rates of eggs and tadpoles, as well as survivorship of frogs (Haglund and Lovtrup 1966, Werner and Glennemeier 1999, Chelgren *et al*. 2006). Rising water temperatures may be beneficial or detrimental to Chiricahua leopard frogs, which are generally active at waters temperatures $\geq 14^0$ C (USFWS 2007). Optimal temperature range for survival and growth is unknown, but water temperatures $\geq 30^0$ C may be limiting.

Construction activities may also provide opportunities for the addition of chemicals or other contaminants to aquatic systems. The likelihood of these substances entering the aquatic site may be increased because of ground disturbance and removal of vegetation that might filter sediments containing the contaminants, the presence of fueling stations at the site, etc. In addition, if fill material is brought into the site from elsewhere, it may contain substances toxic to frogs (Maxell 2000). Types of potential contaminants present may vary considerably, but could include petroleum products (crankcase oil, hydraulic fluid, gasoline, diesel, etc.), herbicides or other pesticides used during site preparation, residue from cement trucks cleaned on-site, dust abatement chemicals used on dirt access roads to the site, and items such as paint, termite preventatives, wood preservatives and chemicals used in portable toilets. The scope of this document does not permit an analysis of all of these potential contaminants, but during project analysis potential sources of contaminants should be examined.

If construction involves concrete structures in or near water, there is a potential for toxic effects to frogs. Fresh concrete leaches salts, lime, catalysts, and potentially other toxic materials for a period of up to nine months. Toxic conditions can remain for longer than nine months if petroleum sealers are used on the concrete to extend drying times. Two-part epoxy concrete sealants are available to prevent leaching of toxins into water; however, the sealant itself can be toxic unless approved for potable water use.

c. Aquatic, semi-aquatic, and peripheral vegetation

As mentioned, above, some types of construction may disrupt or destroy aquatic or semi-aquatic vegetation and may affect the species by altering foraging sites, habitat for prey species (e.g., invertebrates), basking sites or other features that might influence water temperature, and some aspect of cover from predators. These effects may be temporary, but if soil compaction or other aspects of the construction activity (e.g., riprap, concrete lining, etc.) of the terrestrial-aquatic interface occur, the alterations in habitat may be intended to be very long-term. In-channel/in-pond work associated with construction activities may disrupt substrate characteristics such as microsites for hibernacula in addition to disrupting aquatic macrophytes, invertebrates, and generating sediments.

d. Presence of non-native predators and competitors

Human activities at construction sites may result in increased trash that attracts potential predators (e.g., ravens, raccoons, skunks) (Maxell and Hokit 1999). The presence of humans at occupied habitat may result in the behavioral avoidance of the area (e.g., streambanks) by frogs (Rodriguez-Prieto and Fernandez-Juricic 2005). Aquatic sites that are made more accessible to humans may also be at higher risk to the introduction of non-native aquatic predators and disease.

e. Exposure to *Bd*

Personnel and vehicles used where work is implemented in, or very near aquatic sites may increase the risk of transferring *Bd* from one site to another. Similarly, aquatic sites that are made more accessible to humans by a construction activity may also be at higher risk to the introduction of disease.

f. Dispersal habitats

Construction activities may create barriers of various degrees to the movement of frogs. Small in-stream barriers associated with native fish restoration projects are designed to create an effective upstream barrier to the movement of aquatic vertebrates such as tadpoles, but would likely present a minor barrier to frog movement. Even a small detour by a moving frog around such a barrier, though, may expose the individual to a greater risk of predation. Construction activities in the uplands near occupied aquatic sites might, themselves, create barriers of sorts to dispersing Chiricahua leopard frogs (Chan-McLeod 2003, Mazerolle and Desrochers 2005). The way in which the sites might pose barriers to frogs could range from increased risk to mortality (e.g., crushed on roads or parking lots) to behavioral avoidance (e.g., reluctance to move across disturbed soils).

g. Other considerations

A variety of interrelated or interdependent activities may be associated with construction activities, the effects of which should be considered. Such activities that occur away from the actual construction site will require "extending" the action area of the project. For example:

- Off-site or on-site excavation for fill (borrow pits) or, conversely, off-site deposition of cut, overburden, or spoil material from the construction site;
- Drafting of water for on-site use, or importing water for on-site use;
- Dust-abatement (sometimes using chemicals);
- Revegetation of disturbed areas; and
- Construction of temporary access roads (haul roads) and improvement of existing roads.

3. Native fish recovery activities

Efforts to restore native fish species in New Mexico and Arizona at times involve aquatic habitats within the historical range of the Chiricahua leopard frog. Several elements of native fish restoration may directly or indirectly affect Chiricahua leopard frogs, including:

- In-stream barrier construction to prevent ingress of non-native fish to recovery stream;
- Electroshocking to salvage native and non-native fish and verify post-treatment effectiveness;
- In-stream wading and netting by personnel;
- Application of piscicides to kill existing fish;
- Application of neutralizing chemicals;
- Stocking of native fish;
- Monitoring of native fish.

The construction of in-stream barriers, including backfilling behind the barrier with large volumes of cobble and boulders, results in trampling and compaction of banks, disturbance to the stream bottom, and damage to streamside riparian vegetation. During these activities eggs, tadpoles, and adults may be crushed, or displaced and exposed to predation. If motorized equipment is used (e.g., chainsaws), there is a risk of contamination to aquatic habitats from fuel spillage from cans or the equipment itself. Although in lotic systems this sort of contamination would disperse downstream, leopard frogs are sensitive to crankcase oil and would likely be affected by gas-oil mixtures typically used in chainsaws, for example, especially where the substance accumulated for extended time such as in pools and slack water along the shoreline. Noise generated by mechanized equipment may also interfere with advertisement calling, especially if the noise is created at night. In addition, in-stream work associated with barrier construction, including backfilling, is likely to produce sediments that would be transported some distance downstream. Sediments deposited in habitats occupied by Chiricahua leopard frogs may impact egg masses, tadpoles, and foods for larva and adult frogs.

Electroshocking is used in the water to stun fish for removal prior to the application of rotenone or antimycin. The effects of electroshocking to frogs have not been investigated. However, electroshocking reduces survival of fish embryos (Cho *et al*. 2002; Henry and Grizzle 2004) and is likely to have similar detrimental effects to frog embryos (eggs). In addition, electroshocking often causes injury and mortality among fish (Holliman *et al*. 2003, Henry *et al*. 2004) and is likely to have some similar detrimental impact to adult frogs. Thoms *et al*. (1997) identified electroshocking as a viable method for detecting amphibians during its application in fisheries work because amphibians were stunned in a manner similar to fish. Given that fish eggs and adults may be injured by electroshocking, it seems reasonable that all life stages of the Chiricahua leopard frog may also be exposed to some adverse impact from electroshocking. In-stream wading and netting are activities associated with electroshocking and may also affect frogs that are present. The wading and netting involved during the shocking of streams, although of brief duration at any one point, may disturb all life stages of the frog by dislodging egg masses, inadvertently capturing or trampling tadpoles and adults or causing them to move from the area, and generating in-stream sediments. These activities, as well as electroshocking itself, in occupied habitats are reasonably likely to result in take and would require formal consultation.

As discussed above (pp. II-9 to II-12), the piscicides rotenone and antimycin may affect the various life stages of the Chiricahua leopard frog directly by increasing mortality, and indirectly by affecting (at least temporarily) foods of tadpoles and adult frogs. Surviving leopard frogs, however, might experience reduced risk to predation as a result of the removal of non-native fish. Potassium permanganate, used to neutralize rotenone and antimycin, may temporarily reduce the food resources for tadpoles and adults.

After the removal of non-native (all) fish from target streams, native fish are re-introduced. A variety of native fishes have been or are planned to be reestablished into historical or occupied habitats of the Chiricahua leopard frog, such as Gila trout (*Oncorhynchus gilae*), Apache trout (*Oncorhynchus apache*), Gila topminnow (*Poeciliopsis occidentalis occidentalis*), Gila chub (*Gila intermedia*), several Rio Yaqui fishes, and several Rio Grande fishes. Most of these species probably prey to some degree on Chiricahua leopard frog life stages. Chubs (*Gila* spp.), in particular, would likely feed opportunistically on them. Thus, introduced native fish will almost certainly affect Chiricahua leopard frogs, but the level and type of effect (i.e., potential competition for food or predation) would depend on the species of fish.

Typically, native fish populations are monitored to determine the success of the reintroduction. These actions might involve visual inspection or limited in-stream activities involving electroshocking and netting. The effects during these monitoring activities to Chiricahua leopard frog would be similar to those discussed above.

4. Livestock management activities

Although the Chiricahua leopard frog apparently coexists with grazing activities at most sites where it is found (USFWS 2007: 32-34), livestock management activities include many elements that may affect the species and its aquatic habitats (Fleischner 1994, Belsky *et al*. 1999, Jones 2000). The effects of livestock grazing on Chiricahua leopard frog habitat may include both the creation of habitat and the loss and degradation of habitat (Sredl and Jennings 2005, USFWS 2007: I-1).

Some potentially positive effects include the limited reduction of dense vegetation adjacent to aquatic sites that may create basking sites, perhaps increase water temperature, and perhaps reduce some types of predation. In addition, the construction of stock tanks for livestock water has been credited with creating leopard frog habitat that has prevented the species' extirpation in many areas, although most stock tanks do not provide suitable breeding habitat (USFWS 2007: 33), and the overall additive effects of stock tanks (and with them livestock) to frogs and their habitats across the range of the species are not well studied. A limited input of livestock excrement to aquatic habitats may promote algal and macrophyte growth that ultimately increases food resources for tadpoles and frogs Maxell (2000).

However, activities associated with livestock management may also result in adverse effects to the species and its occupied habitat. These effects may be exacerbated by the many interrelated and interdependent activities associated with livestock management. For example, vehicle use associated with, or facilitated by the grazing program at or near habitats of the frog could result in frogs being run over (Carr and Fahrig 2001, Forman *et al*. 2003) in addition to potentially adding petroleum contaminants to aquatic sites (e.g., during stock tank clean-out), and providing additional opportunities for the spread of disease and non-native aquatic predators.

Direct mortality or injury of frogs may occur at livestock tanks where maintenance activities result in significant disturbance at the tank (e.g., dredging or silt removal, major repair of berms) and frogs are present during the maintenance activity. Tanks are periodically dredged out to remove silt. Dredging is usually conducted when the tank is dry or nearly dry. As tanks dry, many frogs may attempt to disperse or are killed by predators as waters recede. However, some frogs may take refuge in cracks in the mud or in clumps of emergent vegetation at the drying tanks. Frogs present in the mud or in emergent vegetation could be killed or injured during silt removal or berm repair at stock tanks. If not killed, they may be flushed from moist retreats and die of exposure or desiccation, or be killed by predators. If remaining wetted soils and emergent vegetation are completely disturbed or removed during tank maintenance activities, a frog population could be eliminated.

Eggs, tadpoles, and metamorphosing Chiricahua leopard frogs may suffer direct mortality or injury through trampling by cattle along the perimeter of stock tanks and in pools along streams, although juvenile and adult frogs can probably avoid trampling when they are warm and active (USFWS 2007: 34). Tadpoles and hibernating frogs may be subject to trampling by livestock during the winter months (USFWS 2007: 34). If cattle are present in occupied habitats during any season, incidental take is reasonably likely to occur, and formal consultation should be requested. Drought may also cause frogs to aestivate in mud and in moist areas around vegetation, or in cracks in drying mud as the water recedes, making the frogs vulnerable to being trampled under those circumstances.

a. Water permanence and flow regimes

As mentioned above, livestock management activities may create new habitats for Chiricahua leopard frogs when new stock tanks are created. Depending on the specific operation of the stock tank, the new habitats may be more or less perennial (when fed by springs, wells, or active hauling of water) or may serve as transitory habitats that may, in some cases, contribute important habitats for dispersing frogs.

Conversely, livestock impacts to watersheds and existing aquatic habitats through the removal of vegetation and the trampling and compaction of soils may promote the conversion of perennial waters to ephemeral aquatic habitats and alter stream flow patterns through mechanisms previously discussed on pages II-6 and II-7 (Belsky *et al*. 1999). In general, reduced vegetative soil cover and increased soil compaction from livestock may lead to increased soil erosion and sediment transport resulting in the sedimentation and reduced hydroperiod of natural pools and stock tanks used by frogs (USFWS 2007: 33) and increase the frequency of stock tank maintenance. Removal of vegetative buffers by livestock, in conjunction with trampling, at and around aquatic habitats (e.g. ponds, stock tanks) may also increase sediments entering the aquatic site promoting shorter hydroperiods. Watershed-scale impacts from livestock (soil compaction, loss of vegetative ground cover) may also lead to reduced infiltration by precipitation. This, in turn, may promote more extreme peak flows in streams resulting in incised channels, which in turn may lower water tables resulting in the conversion of perennial streams to ephemeral, and the loss of ephemeral streams (Belsky *et al.* 1999). Decreased water infiltration may also itself result in lowered water tables and reduced permanence of aquatic sites because less moisture is stored in the soils and is thus not available for the recharge of lotic or lentic aquatic sites during dry periods (Belsky *et al.* 1999). In some cases, sufficient numbers of livestock may be present to measurably deplete a pond or stock tank through consumption of the water.

b. Water quality (temperature, sediment, contaminants)

The removal of vegetation around aquatic sites and the tendency for various livestock-related activities to reduce water volume and/or permanence may result in elevated water temperatures through increased solar exposure (Belsky *et al.* 1999). Potential benefits or costs to frogs associated with warmer waters were previously discussed (p. II-7).

Increased sediment input into aquatic systems, facilitated by livestock or livestock-related activities, may also alter water quality parameters relevant to Chiricahua leopard frogs. As previously noted, sediment entering streams may reduce primary productivity by increasing turbidity (resulting in less sunlight to plant life) or by physically covering plants. This reduction in site productivity may result in a reduction in the algal and periphyton food base of tadpoles and the invertebrate food base of frogs.

Contamination of aquatic habitats by livestock may also have various effects on Chiricahua leopard frogs. Small amounts of livestock generated nutrients, in conjunction with warmer water temperatures may promote increased algal growth that may increase food resources for frogs. However, where nutrient inputs from livestock are greater, degraded water quality is likely to be detrimental to frogs. A die-off of Chiricahua leopard frogs at a stock tank in Arizona was attributed to cattle-associated water quality problems stemming from excessive amounts of decomposing organic material (Sredl *et al*. 1997, USFWS 2007: 34). Excessive excrement from livestock in occupied habitat may result in elevated levels of nitrogenous compounds (e.g., ammonia) that alter growth and development of various life stages of the frog, or even result in mortality. In addition, fecal contamination may cause eutrophication of water and an increase in planorbid snail numbers, number of nematode parasites, and the rate of parasite infection that cause deformities in amphibians (Johnson *et al*. 1999). However, deformities such as limb malformations are unknown in wild Chiricahua leopard frogs (USFWS 2007: 32).

c. Aquatic, semi-aquatic, and peripheral vegetation

Cattle may graze, browse and trample vegetation adjacent to an aquatic site, creating barren shorelines or banks that would otherwise provide escape cover for frogs from a variety of predators, provide a source of insect prey, and filter overland runoff. The elimination of bank vegetation (along with concomitant hoof action) may also expose the bank itself to erosion and result in the collapse undercut banks that may provide both escape cover and overwintering habitat. However, breaking-up very dense shoreline or emergent vegetation may reduce the risk of predation by gartersnakes (*Thamnophis* spp.), and the frogs may benefit from some open ground for basking. Also, where the aquatic site is heavily shaded by peripheral vegetation, a reduction in that vegetation may allow more solar radiation to the site and result in warmer water temperatures.

d. Presence of non-native predators and competitors

Maintenance of roads and tanks needed for livestock grazing may facilitate tank access by recreationists. These people (and possibly their dogs) may inadvertently introduce *Bd* from other locales. In addition, recreationists may introduce non-native predators (e.g., bullfrogs, fish, salamanders, or crayfish) for angling or other purposes. Bullfrogs, salamanders and aquatic invertebrates may also themselves be alternative host species for chytridiomycosis and function to transfer the fungus. The creation or maintenance of livestock waters may passively facilitate the dispersal of non-native predators such as bullfrogs and crayfish across landscapes that would otherwise serve as barriers to their movement.

e. Exposure to *Bd*

Bd can survive in wet or muddy environments and could conceivably be spread by livestock carrying mud on their hooves and moving among frog habitats. Personnel working at an infected tank or aquatic site and then traveling to another site, thereby transferring mud or water from the first site could also spread this disease. *Bd* could be carried inadvertently in mud clinging to wheel wells or tires, or on shovels, nets, boots, or other equipment. *Bd* may also be introduced into a site if water from an infected site is hauled to an uninfected stock tank.

f. Dispersal habitats

As mentioned above, the creation of new stock tanks associated with livestock management may create new dispersal habitats that assist in the dispersal of Chiricahua leopard frogs. However, livestock-related activities may create behavioral or physical barriers to dispersing frogs through the removal of upland vegetation or the construction of facilities, roads, etc. needed for the management of livestock, and through the reduction in riparian vegetation where livestock have access to and/or concentrate in riparian areas. In addition, as described above, the potential loss of even ephemeral waters as a result of livestock-related impacts may degrade or eliminate dispersal corridors.

III. RECOMMENDATIONS TO REDUCE OR AVOID ADVERSE EFFECTS

During 2005-2008, Chiricahua leopard frogs were known to be extant at 111 sites in the United States of America. Based on the most recent survey data, currently the species is likely extant at less than 20 percent of the historical localities in U.S. Because so few populations of Chiricahua leopard frogs are extant, and because the extent of genetic variability across the range of the species is not known, each extant population may be critical to recovering and maintaining genetic diversity within the species. The conservation and maintenance of all extant populations, but particularly breeding populations, is critical, as populations are almost always small and subject to stochastic events that could result in their extirpation (USFWS 2007: 57). Because of this, it is crucial during the development of projects that opportunities are identified and measures incorporated into the project that will reduce or avoid potential adverse effects to Chiricahua leopard frogs that might arise from the project. This section includes a variety of possible ways to do this for some of the more common types of projects that have been found to impact frogs. Not all of these measures may be relevant to or compatible with any given situation, but at a minimum they should provide a starting point for meeting project objectives and conserving Chiricahua leopard frogs. Importantly, project proponents or the action agencies, themselves, should work closely with USFWS to determine which combinations of measures are most applicable and effective to their specific project.

Management actions identified in recovery plans can be used in biological opinions as Terms and Conditions of an incidental take statement (as long as they minimize incidental take from the project and are limited to minor changes). Management actions outlined in recovery plans are also often used as Conservation Recommendations in biological opinions. Thus, initially incorporating recovery plan direction as a part of the proposed Federal activity (e.g., as conservation measures) is important to ensure that adverse effects (including take) are minimized and recovery of the species is promoted, and having these elements already in a proposed action will facilitate a more rapid conclusion of section 7 consultation needs.

The recovery plan provides substantial guidance (see Narrative Outline Recovery Actions 1 and 2 (USFWS 2007: 76-83) and general and specific management recommendations in Appendices A, H, and I) for developing conservation measures to minimize effects of Federal activities. At the same time, the recovery plan allows flexibility for agency-specific guidelines and policies to actually implement the conservation measures.

Appendix I of the recovery plan was prepared specifically to offer conservation measures that should be incorporated into all projects that may affect suitable frog habitats (occupied or not), sites selected for habitat restoration or creation, and movement corridors among sites within Management Areas. The measures may be modified as necessary to conform to the nature of the project or type of disturbance. Project conservation should also include measures for reducing the likelihood of disease transmission, which are provided in Appendix G of the recovery plan. If these measures are added to project proposals, they will reduce effects of proposed actions and increase the likelihood that the USFWS will be able to concur that a project may affect, but is not likely to adversely affect, the Chiricahua leopard frog, and in formal consultation, that a project is not likely to jeopardize the species. However, each proposed action is different, and adherence to these conservation recommendations does not guarantee any conclusion or outcome in the section 7 process. As with other aspects of section 7 consultation, informal consultation between the action agency and USFWS will help identify specific conservation measures applicable to each project.

A. General recommendations to reduce or eliminate adverse effects from any proposed action to Chiricahua leopard frogs

1. The proposed action should be able to show compliance with the direction and intent of the recovery plan, especially elements identified in the Narrative Outline for Recovery Actions that are applicable to the proposed action and that are within the authority of the agency proposing the action to implement. A review of how the proposed action complies with relevant management recommendations should be included in the effects analysis.

2. To the extent possible, adverse effects to extant populations should be avoided (USFWS 2007: I-1). An important prerequisite to avoiding adverse effects to extant populations is to know if and where extant populations occur in the action area of a proposed project. Although assuming presence is an accepted procedure for dealing with listed species (where it is reasonable to do so), this contributes nothing to the better understanding of the frog's status in the action area or in the Recovery Unit. USFWS-permitted surveys of the action area facilitate the protection of extant populations in compliance with Recovery Action 1, and also contribute information necessary to identify, restore, and protect currently unoccupied recovery sites to support viable populations and metapopulations in compliance with Recovery Action 2. The importance of USFWS-permitted survey data for evaluating project effects, but also to the recovery of the species, cannot be overemphasized. Thus, a recommendation in the recovery plan, applicable to all Federal actions within the historical range of the species, is to identify and properly survey all suitable habitats in the action area (USFWS2007: E-5). Preferably this would occur prior to preparing the analysis of effects, but could be identified as a conservation measure to be completed prior to the project implementation.

3. If adverse effects cannot be avoided, then in order of preference, such effects should be minimized, rectified, reduced, and/or compensated to the extent possible. Appendix I of USFWS (2007) provides various measures to address impacts of specific project types. Additional recommendations are found in Appendices A, G, and H.

4. Develop and incorporate into the project design, as relevant, watershed use and maintenance guidelines specific to occupied watersheds following Appendix H of the recovery plan and as recommended in Recovery Action 1.2.1. This may be done concurrently with the project planning effort and is particularly relevant for landscape activities such as livestock grazing and fire/fuels management.

   Some recommendations to reduce or avoid adverse effects, specific to livestock grazing, construction, fire management, and native fish recovery actions are provided below. Various recommendations represent different levels of reduction or avoidance of adverse effects. The bases for these recommendations include the recovery plan and various biological opinions.

Through informal consultation early in the development of a proposed action, additional opportunities are likely to arise specific to a given situation.

B. Fire management activities

Fire management projects can involve a variety of activities, potentially resulting in many types of effects to Chiricahua leopard frogs. As such, conservation measures incorporated into a proposed fire management action to avoid or minimize adverse effects may include many considerations. In addition to conservation measures listed below, review and incorporate as conservation measures additional recommendations in Appendix I specific to road construction and maintenance, hazardous materials, and restoration of disturbed areas as appropriate to the type of fire management project being proposed.

The recovery plan (USFWS 2007: Appendix I) recommends conservation measures to include in the design of fire management projects that are intended to minimize adverse effects from fire-related activities to suitable frog habitat, movement corridors, and sites selected for habitat restoration or creation. These conservation measures and others from the recovery plan are presented below, followed by other conservation measures and recommendations often identified in recent section 7 consultations as effective in minimizing take or adverse effects. Finally, an example of effective Best Management Practices (BMPs) is provided.

Each agency, and, at times, administrative units within an agency, maintains BMPs to incorporate in proposed actions that are intended to reduce adverse effects. It is not in the scope of this document to review or compile all of these. However, as an example of such, BMPs developed by the BLM (with input from USFWS) as conservation measures for that agency's "Arizona Statewide Land Use Plan Amendment for Fire, Fuels, and Air Quality Management" (September 3, 2004) are included here. The USFWS concluded that implementation of these BMPs and conservation measures would be effective in preventing take of frogs during wildland fire use, prescribed fire, or mechanical or chemical treatments.

To promote the conservation of the species, evaluate suitable habitat and unoccupied habitat to identify potential unoccupied recovery sites, particularly if the proposed fire management action lies within a Management Area. Work with USFWS and the Recovery Team to investigate such opportunities. If such sites are identified and are not already considered among habitats where frogs are reasonably likely to occur, protect them as if they were occupied (see Recovery Actions 1.1-1.4 and 2 in the recovery plan) and include them in effects analyses as such.

<u>Recovery Plan, Appendix I: Conservation measures for fire suppression and prescribed fire projects affecting Chiricahua leopard frogs</u>

The current fire management guidelines used by USFS, BLM, and other land managers should be evaluated for compatibility with these recommendations.

1. An objective of fire suppression should be protection of Chiricahua leopard frogs and their habitats.

2. All personnel on the fire should be briefed about protecting the Chiricahua leopard frog and its habitat.

3. 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.

4. 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.

5. 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).

6. 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.

7. 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.

8. 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.

9. Water should not be drafted from stock tanks or other aquatic habitats if Chiricahua leopard frogs are present or likely to be present, of if the site is known to be *Bd*-positive. If stock tanks are refilled after a fire, only sources of water known to be free of non-native predators and *Bd* (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 *Bd*.

10. 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, placement of straw bales in drainages leading into aquatic frog habitats, 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 diseases during salvage or at the holding facility, and that any repatriations are done carefully to avoiding moving anything except the frogs (i.e., unwanted snails, algae, fish, etc.) back to release sites.

11. 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.

12. Recovery of vegetation should be monitored.

13. The effectiveness of suppression activities and these measures should be evaluated after a fire. Procedures should be revised as needed.

Regarding prescribed fire (including prescribed natural fire), the following measures should be implemented. If a prescribed fire escapes prescription, the measures above for fire suppression should also be implemented.

1. An objective of prescribed fire should be enhancement of Chiricahua leopard frog habitat, with a recognition that some short-term adverse effects may occur prior to habitat enhancement.

2. Measures 2, 4, 5, 7, 11, 12, and 13 from the fire suppression measures above should be implemented.

3. 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.

<u>Other conservation measures from the recovery plan related to fire management</u>

1. Recovery Action 1.2.4. Restore natural fire regimes in the watersheds of extant populations (i.e., occupied watersheds) and in Management Areas (USFWS 2007: 76).
   Develop fire management plans for occupied watersheds including objectives for prescribed fire, managed natural fires, and wildfires that will result in restoration of hydrologic function. As a rule of thumb, to minimize watershed degradation at any one point in time, 20 percent of an occupied watershed should be the maximum area burned through the use of prescribed or other fires in any three-year period.

2. Appendix A (USFWS 2007: A-9,-10).
   Prescribed fire, herbicide treatments, and other land treatments that alter vegetation or change runoff characteristics can have a detrimental effect on aquatic sites through the introduction of ash, sediment, herbicides, and other contaminants into the aquatic environment. While these activities may have a long-term beneficial effect for the aquatic habitat, the short-term

effects could result in loss of populations. To prevent loss of populations in this manner, any land treatment upstream of a recovery project site [or occupied/likely to be occupied site] should include measures such as buffers around drainages, erosion control structures, and buffers around the sites themselves to minimize possible effects.

Additional conservation measures related to fire management

The following conservation measures have been used in various biological opinions/ concurrences and from other sources, as noted. All biological opinions cited here (e.g., AESO/SE) are available electronically on the Arizona Ecological Services Field Office website at http://www.fws.gov/southwest/es/arizona/Biological.htm and are not further listed in section IV (Citations) of this document. Some of these measures may differ slightly from those identified above. As mentioned previously, project proponents or the action agencies, themselves, should work closely with the USFWS to determine which combinations of measures are most applicable and effective to their specific project.

1. Contingency plans will be developed for all occupied sites to enable the timely salvage of Chiricahua leopard frogs if threatened by fire or by post-fire conditions (e.g., flood event that may inundate the sites with ash, sediments) if evacuation of the frogs is warranted. (AESO/SE 02-21-05-F-0495, January 23, 2006)

2. When herbicide applications are proposed associated with fuels management, the Federal agency will comply with, "Recommended protection measures for pesticide applications in Region 2 of the U.S. Fish and Wildlife Service" (White 2004), such that the chemicals will not directly or indirectly enter occupied habitats. Consideration will also be given to avoiding or minimizing impacts to likely dispersal corridors associated with occupied habitats. (in part from AESO/SE 02-21-05-F-0495, January 23, 2006)

3. No burning will occur within 300 feet (91 meters) of any aquatic habitats, and no-burn buffers will be established along riparian corridors with variable widths determined by hydrologist. To protect riparian corridors, ignition will not occur within 200-500 feet (61 – 152 meters) of riparian corridors. (AESO/SE 02-21-05-F-0214, March 17, 2005; AESO/SE 02-21-04-F-0006, May 4, 2006)

4. To minimize sediment and ash movement into aquatic habitats and riparian areas, burning will be conducted in such a manner as to create buffers of unburned areas around burned areas. (AESO/SE 02-21-04-F-0006, May 4, 2006)

5. No drafting of water from occupied or unsurveyed stock ponds during burning or suppression efforts unless firefighter safety is jeopardized or resource values are threatened. (AESO/SE 02-21-05-F-0214, March 17, 2005)

6. Fire camps, landing sites, equipment staging areas, and other significant human activity areas will be located at least 1,650 feet (503 meters) away from occupied or unsurveyed aquatic habitats, or outside buffers created for sensitive areas. Previously disturbed sites will be used whenever possible. (AESO/SE 02-21-05-F-0214, March 17, 2005)

7. Operation of off-road vehicles and creation of new routes will not occur around potential breeding sites. Creation of new access routes will be limited to suppression activities and only when alternatives are not available. (AESO/SE 02-21-05-F-0214, March 17, 2005)

8. Document in the proposed project analysis that the activity will result in: (1) no long-term loss in watershed soil conditions, or (2) no significant change in present watershed soil conditions within occupied watersheds or sub-watersheds. (AESO/SE 02-21-04-F-0006, May 4, 2006)

9. Use of fire retardants or suppressants will be avoided within 300 feet (91 meters) of waterways in accordance with "Environmental Guidelines for Delivery of Retardant or Foam Near Waterways" (Chapter 12 in National Interagency Fire Center 2006; available electronically at: http://www.nifc.gov/red_book/). The USFWS, Washington, D. C., issued a concurrence letter in 2001 to the National Office of Fire and Aviation that the application of aerial retardant or suppressant foam outside of 300 feet (91 meters) of a waterway may affect, but is not likely to adversely affect, listed aquatic species and no further consultation for aquatic species was necessary.

Example of BMPs related to fire management

The following section is an excerpt from the BLM, Arizona State Office, Biological Evaluation for the Proposed Statewide Land Use Plan Amendment for Fire, Fuels and Air Quality Management, Finding of No Significant Impact and Environmental Assessment, March 2004, pages 205 to 224, as modified during consultation with the USFWS, Arizona Ecological Services Field Office. Each Federal agency will likely have its own set of similar BMPs that may be incorporated into fire management projects, as appropriate.

> **7.0 CONSERVATION MEASURES**
>
> For all fire management activities (wildfire suppression, wildland fire use, prescribed fire, and mechanical, chemical, and biological vegetation treatments), the following Conservation Measures will be implemented as part of the proposed action. These Conservation Measures are intended to provide Statewide consistency in reducing the effects of fire management actions on Federally threatened, endangered, proposed, and candidate ("Federally protected") species. Conservation Measures noted as "Recommended" are discretionary for implementation, but are recommended to help minimize effects to Federally-protected species. Procedures within the Interagency Standards for Fire and Fire Aviation Operations 2003[11], including future updates, relevant to fire operations that may affect Federally protected species or their habitat are incorporated here by reference.
>
> Firefighter and public safety is the first priority in every fire management activity. Setting priorities among protecting human communities and community infrastructure, other property and improvements, and natural and cultural resources must be based on the

[11] National Interagency Fire Center. 2003. *Interagency Standards for Fire and Fire Aviation Operations 2003*. Department of the Interior, Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service; Department of Agriculture, U.S. Forest Service. (Note: This document is updated annually. The 2007 version may be accessed at http://www.nifc.gov/red_book/)

values to be protected, human health and safety, and costs of protection (2001 Federal Wildland Fire Management Policy). However, implementing the following Conservation Measures during fire suppression to the extent possible, and during the proposed fire management activities as required, would minimize or eliminate the effects to Federally-protected species and habitats.

During fire suppression actions, Resource Advisors will be designated to coordinate concerns regarding Federally-protected species, and to serve as a liaison between the Field Office Manager and the Incident Commander/Incident Management Team. They will also serve as a field contact representative (FCR) responsible for coordination with the USFWS. The Resource Advisors will have the necessary information on Federally-protected species and habitats in the area and the available Conservation Measures for the species. They will be briefed on the intended suppression actions for the fire, and will provide input on which Conservation Measures are appropriate, within the standard constraints of safety and operational procedures. The Incident Commander has the final decision-making authority on implementation of Conservation Measures during fire suppression operations.

Because of the number of species located within the action area for the proposed Statewide LUP Amendment, combined with a variety of fire suppression and proposed fire management activities, conflicts may occur in attempting to implement all Conservation Measures for every species potentially affected by a particular activity. Implementing these Conservation Measures effectively would depend on the number of Federally-protected species and their individual life history or habitat requirements within a particular location that is being affected by either fire suppression or a proposed fire management activity. This would be particularly true for timing restrictions on fuels treatment activities, if the ranges of several species with differing restrictions overlap, making effective implementation of the activity unachievable. Resource Advisors (in coordination with the USFWS), Fire Management Officers or Incident Commanders, and other resource specialists would need to coordinate to determine which Conservation Measures would be implemented during a particular activity. If Conservation Measures for a species cannot be implemented, BLM would be required to initiate Section 7 consultation with the USFWS for that particular activity.

BLM will update their local Fire Management Plans and prepare implementation level plans to include site-specific actions for managing wildfire and fuels in accordance with the new Federal fire policies, based on guidance provided in the Decision Records for this Statewide LUP Amendment. These plans will be coordinated with the USFWS and the Arizona Game and Fish Department (AGFD) to address site-specific concerns for Federally-protected species. The Fire Management Plans and implementation level plans will incorporate the Conservation Measures included in this Statewide LUP Amendment for Federally-protected species occurring within each Fire Management Zone. Consultation with the USFWS will occur on implementation-level plans, as necessary.

7.1 Conservation Measures for Fire Management Activities

7.1.1 Wildland Fire Suppression (FS)

The following Conservation Measures will be implemented during fire suppression operations, unless firefighter or public safety, or the protection of property, improvements, or natural resources, render them infeasible during a particular operation. Each Conservation Measure has been given an alphanumerical designation for organizational purposes (e.g., FS-1). Necessary modifications of the Conservation Measures or impacts to Federally-protected species and habitat during fire suppression operations will be documented by the Resource Advisor, and coordinated with the USFWS.

FS-1 Protect known locations of habitat occupied by Federally-listed species. Minimum Impact Suppression Tactics (M.I.S.T.) will be followed in all areas with known Federally-protected species or habitat [Appendix U, *Interagency Standards for Fire and Aviation Operations 2003*, or updates (see footnote on page III-7, above)].

FS-2 Resource Advisors will be designated to coordinate natural resource concerns, including Federally-protected species. They will also serve as a field contact representative (FCR) responsible for coordination with the USFWS. Duties will include identifying protective measures endorsed by the Field Office Manager, and delivering these measures to the Incident Commander; properly surveying prospective campsites, aircraft landing and fueling sites; and performing other duties necessary to ensure adverse effects to Federally-protected species and their habitats are minimized. On-the-ground monitors will be designated and used when fire suppression activities occur within identified occupied or suitable habitat for Federally-protected species.

FS-3 All personnel on the fire (firefighters and support personnel) will be briefed and educated by Resource Advisors or designated supervisors about listed species and the importance of minimizing impacts to individuals and their habitats. All personnel will be informed of the conservation measures designed to minimize or eliminate take of the species present. This information is best identified in the incident objectives.

FS-4 Permanent road construction will not be permitted during fire suppression activities in habitat occupied by Federally-protected species. Construction of temporary roads is approved only if necessary for safety or the protection of property or resources, including Federally-protected species habitat. Temporary road construction should be coordinated with the USFWS, through the Resource Advisor.

FS-5 Crew camps, equipment staging areas, and aircraft landing and fueling areas should be located outside of listed species habitats, and preferably in locations that are disturbed. If camps must be located in listed species habitat, the Resource Advisor will be consulted to ensure habitat damage and other effects to listed species are minimized and documented. The Resource Advisor should also consider the potential for indirect effects to listed species or their habitat from the siting of camps and staging areas (e.g., if an area is within the water flow pattern, there may be indirect effects to aquatic habitat or species located off-site).

FS-6 All fire management protocols to protect Federally-protected species will be coordinated with local fire suppression agencies that conduct fire suppression on BLM-administered lands to ensure that the agency knows how to minimize impacts to Federally-protected species in the area.

FS-7 The effectiveness of fire suppression activities and Conservation Measures for Federally protected species should be evaluated after a fire, when practical, and the results shared with the USFWS and AGFD. Revise future fire suppression plans and tactical applications as needed and as practical.

7.1.2 Fuels Treatments (prescribed burning and other fuels management) (FT)
The following Conservation Measures **are mandatory** when implementing wildland fire use, prescribed fires, and the proposed vegetation treatments (mechanical, chemical, biological):

FT-1 Biologists will be involved in the development of prescribed burn plans and vegetation treatment plans to minimize effects to Federally-protected species and their habitats within, adjacent to, and downstream from proposed project sites. Biologists will consider the protection of seasonal and spatial needs of Federally-protected species (e.g., avoiding or protecting important use areas or structures and maintaining adequate patches of key habitat components) during project planning and implementation.

FT-2 M.I.S.T. will be followed in all areas with known Federally-protected species or habitats.

FT-3 Pre-project USFWS-permitted surveys and clearances (biological evaluations/assessments) for Federally-protected species will be required for each project site before implementation. All applicable Conservation Measures will be applied to areas with unsurveyed suitable habitat for Federally-protected species, until a USFWS-permitted survey has been conducted by qualified personnel to clear the area for the treatment activity.

FT-4 Use of motorized vehicles during prescribed burns or other fuels treatment activities in suitable or occupied habitat will be restricted, to the extent feasible, to existing roads, trails, washes, and temporary fuelbreaks or site-access routes. If off-road travel is deemed necessary, any cross-country travel paths will be surveyed prior to use and will be closed and rehabilitated after the prescribed burn or fuels treatment project is completed.

FT-5 As part of the mandatory fire briefing held prior to prescribed burning, all personnel (firefighters and support personnel) will be briefed and educated by Resource Advisors or designated supervisors about listed species and the importance of minimizing impacts to individuals and their habitats. All personnel will be informed of the Conservation Measures designed to minimize or eliminate take of the species present.

7.1.3 Rehabilitation and Restoration (RR)

RR-1 When rehabilitating important areas for Federally-listed species that have been damaged by fire or other fuels treatments, the biologist will give careful consideration to minimizing short-term and long-term impacts. Someone who is familiar with fire impacts and the needs of the affected species will contribute to rehabilitation plan development. Appropriate timing of rehabilitation and spatial needs of Federally-listed species will be addressed in rehabilitation plans.

RR-2 Seed from regionally native or sterile alien (non-native) species of grasses and herbaceous vegetation will be used in areas where reseeding is necessary following ground disturbance to stabilize soils and prevent erosion by both wind and water.

RR-3 Sediment traps or other erosion control methods will be used to reduce or eliminate influx of ash and sediment into aquatic systems.

RR-4 Use of motorized vehicles during rehabilitation or restoration activities in suitable or occupied habitat will be restricted, to the extent feasible, to existing roads, trails, or washes, and to temporary access roads or fuelbreaks created to enable the fire suppression, prescribed burn, or fuels treatment activities to occur. If off-road travel is deemed necessary, any cross-country travel paths will be properly surveyed prior to use and will be closed and rehabilitated after rehabilitation or restoration activities are completed.

RR-5 All temporary roads, vehicle tracks, skid trails, and off-road vehicle (ORV) trails resulting from fire suppression and the proposed fire management activities will be rehabilitated (water bars, etc.), and will be closed or made impassible for future use.

RR-6 Burned area emergency rehabilitation (BAER) activities and long-term restoration activities should be monitored, and the results provided to the USFWS and AGFD. Section 7 consultation for BAER activities will be conducted independently, if necessary.

7.2 Conservation Measures For Fire Management Activities in Riparian and Aquatic Habitats (RA)

7.2.1 Wildland Fire Suppression and Rehabilitation

The following Conservation Measures will be implemented during fire suppression operations in riparian, wetland, or aquatic habitats, unless firefighter or public safety, or the protection of property, improvements, or natural resources, render them infeasible during a particular operation. Necessary modifications of the Conservation Measures or impacts to Federally-protected species and habitat during fire suppression operations will be documented by the Resource Advisor, and coordinated with the USFWS. The BLM's 1987 policy Statement on riparian area management defines a riparian area as "an area of land directly influenced by permanent water. It has visible vegetation or physical characteristics reflective of permanent water influence. Lakeshores and streambanks are typical riparian areas. Excluded are such sites as ephemeral streams or washes that do not exhibit the presence of vegetation dependent upon free water in the soil."

RA-1 During wildfire suppression, apply M.I.S.T. within riparian areas. Fire suppression actions in riparian areas should be prioritized to minimize damage to stands of native vegetation from wildfire or suppression operations. To the extent possible, retain large, downed woody materials and snags that are not a hazard to firefighters.

RA-2 Fire suppression and rehabilitation in riparian corridors will be coordinated with the Resource Advisor or qualified biologist approved by BLM.

RA-3 Site-specific implementation plans that include project areas with Federally-protected aquatic or riparian-obligate species will specify fire management objectives and wildland fire suppression guidance, taking into account the special concerns related to these species.

RA-4 In riparian areas, use natural barriers or openings in riparian vegetation where possible as the easiest, safest method to manage a riparian wildfire. Where possible and practical, use wet firebreaks in sandy overflow channels rather than constructing firelines by hand or with heavy equipment.

RA-5 Construction or development of a crossing for motorized vehicles across a perennial stream will not be permitted, unless an established road already exists or where dry, intermittent sections occur.

RA-6 Avoid the use of fire retardants or chemical foams in riparian habitats or within 300 feet (91 meters) of aquatic habitats, particularly sites occupied by Federally-protected species. Apply operational guidelines as Stated in the *Interagency Standards for Fire and Fire Aviation Operations 2003 (or updates),* "Environmental Guidelines for Delivery of Retardant or Foam Near Waterways," Chapter 8 (pp. 8-13 through 8-15) (see footnote on page III-7, above).

RA-7 Priority for placement of fire camps, fire staging areas, and aircraft landing or refueling sites will be outside riparian areas or river/stream corridors.

RA-8 When using water from sources supporting Federally-protected species, care must be taken to ensure adverse impacts to these species are minimized or prevented. Unused water from fire abatement activities will not be dumped in sites occupied by Federally-protected aquatic species to avoid introducing non-native species, diseases, or parasites.

RA-9 If water is drafted from a stock tank or other body of water for fire suppression, it will not be refilled with water from another tank, lakes, or other water sources that may support non-native fishes, bullfrogs, crayfish, or salamanders.

RA-10 Use of containment systems for portable pumps to avoid fuel spills in riparian or aquatic systems will be required.

7.2.2 Fuels Treatments (prescribed fire; mechanical, chemical, and biological treatments)

The following Conservation Measures are mandatory when implementing wildland fire use, prescribed fires, and the proposed vegetation treatments (mechanical, chemical, biological) within riparian, wetland, or aquatic habitats.

RA-12 All Conservation Measures for wildland fire suppression (**RA-1 to RA-11, Section 2.1**) also apply to fuels treatment activities (prescribed fire; mechanical, chemical, and biological treatments) in riparian, wetland, and aquatic habitats.

RA-13 Fire management treatments within or adjacent to riparian and aquatic habitats will be designed to provide long-term benefits to aquatic and riparian resources by reducing threats associated with dewatering and surface disturbance, or by improving the condition of the watershed and enhancing watershed function.

RA-14 For priority fire/fuels management areas (e.g., WUIs) with Federally-protected species or designated critical habitat downstream, BLM biologists and other resource specialists, as appropriate, in coordination with USFWS and AGFD, will determine:

A) The number of acres and the number of projects or phases of projects to occur within one watershed per year.
B) An appropriately-sized buffer adjacent to perennial streams in order to minimize soil and ash from entering the stream.
C) Where livestock grazing occurs in areas that have been burned, specialists will determine when grazing can be resumed. Such deferments from grazing will only occur when necessary to protect streams from increased ash or sediment flow into streams.[12]

[12] (NOTE: Since issuing these BMPs, the handbook mentioned, below, apparently has been modified to the Interagency Burned Area Emergency Response Guidebook, February 2006, found at http://fire.r9.fws.gov/ifcc/esr/Policy/es%20handbook%202-7-06.pdf). The Interagency Burned Area Emergency Stabilization and Rehabilitation Handbook, Exhibit 4-2 ,BLM supplemental guidance, page 5 of 9 (http://fire.r9.fws.gov/ifcc/ESR/handbook/) establishes the following policy for livestock exclusion following burns: Exclusion of livestock is critical for the recovery of burned vegetation or establishment and maintenance of new seedings and use of these areas should not be permitted until the vegetation recovers or is established. Both re-vegetated and, burned but not re-vegetated areas, will be closed to livestock grazing for at least two growing seasons following the season in which the wildfire occurred to promote recovery of burned perennial plants and/or facilitate the establishment of seeded species. Livestock permittees must be informed of the closure early during the plan preparation process, and livestock closures will be made a condition or term on the grazing license or permit through the issuance of grazing decision (see 43 CFR 4160). Livestock closures for less than two growing seasons may be justified on a case-by-case basis based on sound resource data and experience. Livestock management following seedling establishment and/ or burned area recovery should maintain both non-native and/or native species to meet land use (including Standards for Rangeland Health and Guidelines for Grazing Management) or activity plan objectives.

If agreement cannot be reached or treatment will not meet fuel reduction objectives, BLM will re-initiate consultation. Our authority to make these types of changes is in the regulations at 43 CFR 4110.3-3(b).

7.3 Species Specific Conservation Measures

In addition to the general Conservation Measures listed in **Sections 1.0** and **2.0**, the following species-specific Conservation Measures will be applied during wildfire suppression to the extent possible, and will be required during fuels treatment activities (wildland fire use, prescribed fire, vegetation treatments). Necessary modifications of the Conservation Measures or impacts to Federally-protected species and habitat during fire suppression operations will be documented by the Resource Advisor, and coordinated with the USFWS.

7.3.1 Amphibians [Chiricahua leopard frog]

AM-1 Implement the Conservation Measures for Fire Management Activities in Riparian and Aquatic Habitats.

AM-2 For fire management sites with habitat for the Chiricahua leopard frog, unsurveyed sites will be considered occupied unless surveyed prior to project implementation.

AM-3 Install sediment traps, as determined by a Resource Advisor or qualified biologist approved by BLM, upstream of tanks and ponds occupied by Chiricahua leopard frogs in order to minimize the amount of ash and sediment entering the water. Consultation with a qualified biologist during the planning phase will aid in determining sediment trap installation requirements (see Conservation Measures FT-1 and FT-3).

AM-4 All personnel performing fire management activities at any creek crossing will be informed of the potential presence of Chiricahua leopard frogs, their status, and the need to perform their duties to avoid impacts to the frog and its habitat.

AM-5 Except as needed in emergency situations to abate immediate fire threat or loss of life or property, no water will be drafted for fire suppression from bodies of water known to be occupied by the Chiricahua leopard frog.

C. Construction activities

The recovery plan (USFWS 2007: I-12) identifies some types of construction activities that should not be authorized where such activities would adversely affect occupied Chiricahua leopard frog sites, unless it is unavoidable. These types of activities include pumping of groundwater, construction of impoundments, and diversion of surface water. Conservation measures for these types of activities may 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 or otherwise destroy these plants.

To the extent possible, surface-disturbing construction projects should be located outside of occupied Chiricahua leopard frog habitat. If a project must be located in occupied habitats or in an occupied watershed, try to locate the project in a previously disturbed area, where the habitat quality is poor, or where impacts to the frog and habitat will otherwise be minimized (I-5).

During the development of construction projects, incorporate the following conservation measures, as applicable, to reduce or avoid adverse effects from the proposed action in occupied habitat or occupied watersheds. In addition, incorporate, as appropriate, recovery plan recommendations in Appendix I for conservation measures specific to road construction and maintenance, hazardous materials, and restoration of disturbed areas.

Survey all suitable habitats for the Chiricahua leopard frog within the action area of construction projects according to recovery plan protocol (Appendix E). If it is likely the species will be present during construction activities, coordinate with AGFD/NMDGF and USFWS to determine the need for salvaging frogs, tadpoles, eggs from the site prior to construction activities.

Identify and delineate possible dispersal corridors to and from the construction site, in collaboration with USFWS and State biologists, and avoid ground disturbance and the creation of barriers within these areas (including ephemeral drainages within 3 miles, uplands within 1 mile, and perennial drainages within 5 miles).

Within occupied habitats, the area of disturbance (vegetation, soil, water) should be kept to a minimum.

- The number of access routes, number and size of staging areas, and the total area of the activity shall be limited to the minimum necessary to implement the project.
- All project work areas should be clearly flagged otherwise obviously demarcated at the outer boundaries to define the limit of work activities.
- Locate project activities out of wetted sites to the extent practicable.
- Locate equipment staging areas, borrow sites, material stockpiles well away from occupied habitat.
- Minimize new surface disturbance (including new roads), but instead use existing disturbed areas when possible.
- Where grading is necessary, stockpile surface soils for use during site restoration. Stockpiles should be outside of riparian/wetland areas.

Incorporate into the proposed action a water quality management plan prepared by or authorized by qualified agency personnel that identifies:

- Precautions to be taken to avoid discharge or accidental spills of pollutants into aquatic sites. Develop and implement hazardous materials spill contingency planning and prevention.
- All fueling and maintenance of vehicles and other equipment and staging areas shall occur at least 20 meters from any riparian or water body as determined by qualified hazardous materials personnel or existing laws and regulations, to ensure that contamination of habitat does not occur.

- Preventative measures to control silting and erosion and to intercept and settle any runoff of muddy or sediment-laden waters from all sites during and after construction. Specific methods (e.g., agency accepted BMPs) to be used will be determined in response to on-site needs and conditions.
- Measures that will ensure hazardous materials (e.g., pesticides/herbicides, fuels, oil, and other chemicals) are stored well away from occupied frog habitats, likely to be occupied habitats, and project sites selected for restoration/creation. Such materials should be stored downslope or in another drainage from frog sites. Use of such materials should not occur in frog habitats and only in such a way that these materials do not enter frog habitats. If use of such materials is necessary, only use those that have been approved for use in aquatic systems and that have known effects on amphibians where possible. For pesticides/herbicides, adhere to the USFWS's Region 2 Pesticide Use Guidelines for Chiricahua leopard frog (White 2004).
- Measures will be developed, identified in the planning document, and implemented to avoid or minimize runoff into and sedimentation of frog habitats.
- That work will comply with applicable Federal and State laws, regulations, and water quality standards concerning the control and abatement of water pollution.
- Construction methods that will prevent entrance or accidental spillage of solid matter, contaminants, debris, and other pollutants and wastes into any occupied habitats, and/or any underground water source. Such wastes include but are not limited to eroded soils, refuse, garbage, cement, concrete, sanitary waste, industrial waste, oil and other petroleum products, mineral salts and spirits, and thermal pollution.
- Methods for the prevention, control, and abatement of excessive dust that may enter occupied frog habitats;

As deemed necessary (considering the scope of the project), identify that a USFWS-approved monitor(s) and/or "field contact representative" who will be present during the project, from start-up through habitat restoration to ensure compliance with conservation/protective measures, and effectiveness of various protective measures being implemented (e.g., sediment and erosion control mechanisms). The monitor and/or field representative will have authority to halt any action that is in violation of agreed upon conservation measures.

Develop and implement a worker education/training program for all construction personnel that includes:

- Field identification cards of frogs, egg masses, tadpoles;
- Review of protection measures specifically designed for that project to reduce impacts to the frog and its habitat;
- Function of on-site boundary delineations (authorized work area);
- Reporting procedures if a frog is encountered.

Monitor frog habitats in the action area periodically to ensure effects to the species are minimized.

- Inspect all hazardous sites (e.g., open trenches, holes, or other deep excavations) daily and prior to backfilling for the presence of frogs.
- Regularly inspect all stream crossings (occupied habitat) used by traffic associated with construction for the presence of eggs, tadpoles, and frogs.

- If avoiding disturbance to a frog, egg mass, or tadpole is not possible, or if a frog is encountered trapped in an excavation, the affected animals should be captured and relocated, or held at a holding facility in consultation with the permitting State agency and USFWS.

Identify measures, as needed, to minimize the risk of disease transmission. If vehicle/equipment use will occur in more than one frog habitat, ensure that all equipment is clean and dry or disinfected before it moves to another habitat (if the presence/absence of the disease is well known in the area, these rules could be varied; see Appendix G of the recovery plan for additional information).

If the status of *Bd* at the construction site is unknown, water imported to the construction site will be obtained from ground-water source(s) and not from surface water that might be contaminated with disease. Water upstream or downstream of the occupied site may be used if mechanisms are in place to insure that extracting water will not result in take of frogs, tadpoles, or eggs.

To prevent inadvertent introduction of non-native aquatic species to the construction site, water will only be imported from off-site surface waters where non-native aquatic species do not occur (determination to be made by State or Federal biologist).

Newly created access routes should be restricted from non-authorized access by appropriate barricades, fencing, signage, etc. until the project and habitat restoration are completed.

Sites will be re-vegetated with native species (riparian, aquatic, terrestrial) suitable to the area. A species list, restoration plan, and monitoring plan will be included with the project proposal (if submitted by an applicant) for approval by the responsible Federal agency and USFWS. A plan must include the location of the restoration, species to be used, source of plants, restoration techniques and timing, criteria for identifying success, and remedial actions if the success criteria are not met. To minimize the risk of transmitting disease in the soil and water associated with aquatic or semi-aquatic plants (e.g., *Bd*), the source of these plants should preferably come from the same drainage system/watershed as the construction site.

If a work site is to be temporarily dewatered by pumping, intakes shall be completely screened with wire mesh not larger than 5 millimeters to prevent Chiricahua leopard frogs from entering the pump system. If dewatering is in a lotic system, water shall be released downstream at an appropriate rate to maintain flows but to avoid scouring the channel. In lentic systems, discharged water will be spread over the landscape to avoid creating rills or other types of surface disturbance likely to generate sediments that reenter the site. Upon completion of construction activities, any barriers in lotic systems will be removed in such a manner that would allow flow to resume with least disturbance to the substrate. In lentic systems that are drained for work, arrangements will made to restore water levels to pre-drained levels (considering qualifications to source water, above). All non-native predatory aquatic vertebrates encountered during de-watering activities will be destroyed, as permitted by State authorities.

D. Native fish recovery activities

Unlike many actions associated with fire management, livestock management, and construction, native fish recovery efforts typically have little flexibility in the timing and location of implementation. If the Chiricahua leopard frog is present, take of the species is almost certain from actions typically associated with the restoration of native fish to lotic systems. Nonetheless, incorporating the following conservation measures in the proposed action will likely reduce adverse effects to, and take of the species and avoid the inadvertent extirpation of frogs.

1. Survey all suitable habitats in the action area for Chiricahua leopard frogs according to protocol identified in the recovery plan or as updated. If the species is detected within the action area of the proposed project, prior to any barrier construction, electroshocking, or poison application:
   - Work with State and USFWS to collect as many eggs, tadpoles and frogs from the action area for off-site holding, using procedures and protocols currently in effect.
   - If the collection of individuals occurs more than 2 weeks prior to the initial construction of a barrier, in-stream shocking, or poison application, an additional walk-through survey of the area to be impacted will be conducted, but may be restricted to those areas where the species had been previously encountered. Eggs, tadpoles, and frogs encountered during this follow-up survey(s) will be collected for off-site holding.
   - Specimens will be retained at permitted holding facilities and returned to the site of collection as soon as possible.

2. During barrier construction or during fish salvage operations (e.g., during shocking activities prior to piscicide application), eggs, tadpoles, or frogs might also be encountered. Ensure that appropriate equipment and expertise are present with which to collect and transport individuals and deposit them at a holding facility. Likewise, during poison application, be prepared to salvage eggs, tadpoles, and frogs encountered.

3. To minimize risks of adverse effects to the frog and to invertebrates, closely monitor application of piscicides and other chemicals to avoid exceeding minimum concentrations required to obtain project objective(s). This consideration may be especially important during hand application of piscicides (e.g., hand pouring piscicide from containers) in vegetated shallows and backwaters where tadpoles and eggs have been previously collected.

4. If work is being done in more than one drainage, then to minimize the possibility of transferring disease, procedures for disinfecting equipment will follow those identified in the recovery plan (USFWS 2007: Appendix G) or more current standards.

5. If the opportunity exists, consider using mechanical techniques for the removal of target species *in lieu* of poisoning. This may be particularly effective in backwaters at least temporarily isolated from the stream or river.

6. If the timing of egg-laying and tadpole metamorphosis is generally known at the project site, evaluate whether the application of piscicides could be implemented following the metamorphosis of most tadpoles.

7. To avoid contamination of aquatic sites with petroleum products, use battery powered electroshocking equipment when possible. If gas powered shockers are used, store fuel and refuel unit well away from water

8. Ensure that chemical toilets used for work crews during renovations are placed well away from stream and stream floodplain, and in such a manner that if they were to tip over, the contents would not end up in the stream or on the floodplain.

E. Livestock management activities

Any livestock access to occupied sites or to sites where frogs are reasonably likely to occur (including dispersal corridors or habitat) is likely to result in adverse effects to the species. Livestock use in occupied habitat at any time of the year is reasonably certain to result in incidental take and requires formal consultation. The most effective way to eliminate direct adverse effects to the species is to preclude access by livestock to these aquatic sites. Regulated access to these sites may reduce the likelihood of adverse effects, but take would still likely occur through trampling and habitat modification (harm, harassment, injury, or death). Long-term benefits may accrue in some sites if cattle can be used to periodically reduce emergent vegetation that otherwise might overrun a site and result in elimination of frogs. However, such use will still have short-term adverse effects requiring consultation. For further discussion of the effects of livestock management activities, see Section II, subsection 4, page 28.

Indirect effects from livestock to the species may be minimized by modifying livestock use in occupied watersheds to maintain or promote satisfactory watershed condition such that the effects of livestock in the watershed do not alter flow regimes, accelerate erosion and sediment transport into occupied sites, or contribute excrement to aquatic sites.

Many detailed management suggestions are presented in the recovery plan and are not reiterated here. These suggestions should be reviewed in Appendix A (A-6 through A-12), Appendix H (H-11 through H-16, “Watershed Use and Maintenance Guidelines”), Appendix I (I-1 through I-3) and integrated into livestock management projects as appropriate.

Additional conservation measures that have been recommended or implemented to consider incorporating in projects during planning include the following, based largely on Recovery Actions and existing consultations:

1. To avoid direct and indirect adverse effects associated with livestock activities[13]:
   a. No grazing or livestock management activities will occur in occupied habitat or where the frog is reasonably likely to occur, including aquatic sites and potential dispersal corridors where the frog is reasonably likely to occur.

[13] If an effective method of maintaining stock ponds includes periodic grazing to reduce emergent vegetation, then the long-term benefit of stock pond maintenance and the contribution to species recovery should be evaluated in addition to the potential short-term adverse effects to individuals when deciding how a stock pond is to be managed. However, attempting to determine the net impact of beneficial and adverse effects to the species (i.e., “weighing the effects”) is not relevant to the effects analysis or determination. As mentioned previously if there are any adverse effects that are not discountable or insignificant, then the correct determination is "may affect, likely to adversely affect".

   b. No grazing or livestock management activities will occur in occupied watersheds.

2. To minimize effects (and take) associated with maintenance and livestock use of stock tanks within dispersal distance from occupied sites:
   a. All earthen stock tanks within reasonable dispersal distance of occupied habitat will be surveyed for Chiricahua leopard frogs prior to maintenance activities.
   b. Where frogs are present in stock tanks needing maintenance, coordinate with the USFWS to develop and implement a site specific plan to either: 1) forego maintenance; 2) salvage and temporarily hold frogs (following recovery plan guidance); 3) limit disturbance and work areas to the minimum practicable (i.e., leave stands of emergent vegetation in place, implement measures to minimize the likelihood of disease transmission); 4) fence portions of the occupied pond or tank (portions may be left unfenced to allow some access by livestock); or 5) otherwise develop a comprehensive plan as part of the proposed action to provide necessary tank maintenance that addresses protection of Chiricahua leopard frogs.
   c. Where frogs are present, implement recommendations and guidance provided in the recovery plan for stock tank use and maintenance (Appendix A and I).

3. To minimize adverse effects (and take) associated with grazing within occupied habitat (or habitat where the frog is reasonably likely to occur) that is not already excluded from livestock:
   a. Identify habitats and survey suitable habitats for the presence of frogs (using protocol in the recovery plan, Appendix E) prior to livestock entry, or work with USFWS to establish a specified time frame in which surveys will be completed.
   b. Where frogs are found, coordinate with USFWS to develop a site-specific plan to either: 1) ensure that Chiricahua leopard frog habitat will be maintained, or 2) preclude grazing from the site. This may involve constructing alternate water source(s) for livestock (see recovery plan, Appendix A).
   c. Water shall not be pumped or diverted from a site occupied by Chiricahua leopard frogs.
   d. To minimize trampling and/or ingestion of frogs, metamorphosing frogs, larvae, and eggs in occupied habitat, protect stock tanks sufficiently to permit regeneration of emergent and submergent vegetation.

4. To minimize the contamination of occupied Chiricahua leopard frog habitat by non-native species and *Bd*:
   a. Where new or existing sites occupied by Chiricahua leopard frogs occur, water shall not be hauled to the site from another aquatic site that supports leopard frogs, bullfrogs, tiger salamanders, crayfish, or fish.
   b. To avoid the transfer of *Bd*, water hauled to occupied sites should originate from sources either within the same drainage as the target site, or preferably from ground water or domestic/treated sources.
   c. The permittees and their employees will be instructed to sanitize (following recovery plan recommendations) or dry out equipment used in maintenance of stock tanks or after other activities occurring in wetland or riparian areas prior to visiting occupied sites to prevent the spread of chytridiomycosis.

d. When new tanks are to be constructed, coordinate with AGFD or NMDGF and USFWS to identify known locations of non-native aquatic species in relation to the proposed new tanks. Assess the threats and review the locations of the new tanks based on the occurrence of non-native species and their likely dispersal ranges.
e. Live fish, crayfish, bullfrogs, leopard frogs, salamanders, or other aquatic organisms shall not be intentionally moved by permittees or their employees among livestock tanks or other aquatic sites.

5. To reduce adverse effects to aquatic sites from livestock impacts in surrounding uplands (e.g., sediment input to occupied habitats):
   a. Apply utilization standards (e.g., forage use guidelines) or other accepted methods to ensure upland and riparian vegetation conditions provide filtration of sediments and protect bank stability. Identify a means of monitoring the standard or method and identify action that will be taken to prevent exceeding the standard.
   b. Establish a non-grazed buffer around or along occupied aquatic sites sufficient to adequately filter sediments and excrement generated by livestock use of surrounding uplands.

6. To reduce adverse effects to occupied habitats from other land treatments associated with livestock management (e.g., herbicide application, prescribed fire, road construction), incorporate measures such as buffers around drainages (upstream and downstream of occupied sites), erosion control structures, and buffers around the sites themselves. If herbicides are proposed, use recommendations from White (2004).

7. To reduce adverse effects to frogs that may disperse from occupied sites to unoccupied sites within the action area:
   a. Identify likely or potential dispersal corridors with the assistance of Recovery Team/USFWS personnel. Include uplands, and ephemeral and perennial drainages within accepted dispersal distances.
   b. Protect these habitats from livestock use or concentrations of livestock during likely times of dispersal, or minimize impacts from livestock and associated land treatments to these habitats during those times.

8. To promote the conservation of the species, evaluate suitable habitat to identify potential recovery sites, particularly if the grazing allotment lies within a Management Area. Work with USFWS and the Recovery Team to investigate such opportunities. If such sites are identified and are not already considered among habitats where frogs are reasonably likely to occur during the life of the grazing project, protect them as if they were occupied (see Recovery Actions 1.1-1.4 and 2 in the recovery plan) and include them in effects analyses as such.

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