United States Department of the Interior

U.S. Fish and Wildlife Service
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 FAX: (602) 242-2513

In Reply Refer To:
AESO/SE
22410-2007-F-0197-R002

May 7, 2013

Mr. M. Earl Stewart
Forest Supervisor
Coconino National Forest
1824 South Thompson Street
Flagstaff, Arizona 86001-2529

RE: Fossil Creek Range Allotment

Dear Mr. Stewart:

Thank you for your request to reinitiate formal consultation with the U.S. Fish and Wildlife Service (FWS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (ESA or Act). Your request was dated March 4, 2013, and received by us on March 5, 2013. This consultation concerns the possible effects of livestock grazing and management activities on the Fossil Creek Range Allotment (FCRA) located on the Red Rock Ranger and Mogollon Rim Ranger Districts in Coconino and Yavapai Counties, Arizona. The Forest Service has determined that the proposed action may affect the threatened Chiricahua leopard frog (*Lithobates {=Rana} chiricahuensis*) and its designated critical habitat.

You also requested our concurrence that the proposed project may affect, but is not likely to adversely affect, the threatened Mexican spotted owl (*Strix occidentalis lucida*) and its critical habitat, the endangered southwestern willow flycatcher (*Empidonax trailli extimus*), the endangered razorback sucker (*Xyrauchen texanus*) and its critical habitat, the endangered loach minnow (*Tiaroga cobitis*) and its critical habitat, the endangered spikedace (Meda fulgida) and its critical habitat, and the endangered Gila topminnow (*Poeciliopsis occidentalis occidentalis*). Additionally, the Forest determined that the proposed project is not likely to jeopardize the candidate yellow-billed cuckoo (*Coccyzus americanus*), the candidate Northern Mexican gartersnake (*Thamnophis eques*), the candidate roundtail chub (*Gila robusta*), and the candidate headwater chub (*Gila nigra*). We concur with your determinations. The basis for our concurrences is found in Appendix A.

You also determined that the action would result in "no effect" to critical habitat for the southwestern willow flycatcher and the Verde River experimental, nonessential population of Colorado pikeminnow (*Ptychocheilus lucius*). "No effect" determinations do not require review from the Fish and Wildlife Service, and are not addressed further.

This biological opinion replaces the February 9, 2009, February 26, 2010, and April 23, 2012, biological opinions for the FCRA. This opinion is based on information provided in the March 4, 2013, biological assessment (BA), the December 12, 2012, Preliminary Environmental Assessment (EA) Fossil Creek Allotment Rangeland Management Analysis, meetings, conversations and electronic correspondence with your staff, and other sources of information found in the administrative record supporting this biological opinion. Literature cited in this biological opinion is not a complete bibliography of all literature available on the species of concern or on other subjects considered in this opinion. A complete administrative record of this consultation is on file at this office. The most recent 2012 biological opinion and incidental take statement, as they relate to the Chiricahua leopard frog are hereby withdrawn and no longer have any force and effect.

Consultation History

Details of the consultation history are summarized in Table 1.

Table 1. Summary of Consultation History

Date	Event
June 2002 to present	Ongoing discussions, meetings, and on-the-ground work have occurred with the FWS, Arizona Game and Fish Department (AGFD), Forest Service, and livestock permittee regarding livestock grazing and Chiricahua leopard frog habitat management on the FCRA.
September 30, 2002	We issued a biological opinion analyzing the effects to spikedace and loach minnow critical habitat on eight allotments and one sheep driveway on the Coconino National Forest. This biological opinion included the FCRA.
October 2004	Due to drought and a decline in range and watershed conditions, livestock were voluntarily removed from the FCRA.
October – November 2004	Fossil Creek Native Fish Restoration Project implemented.
March 2005	Six stock tanks within FCRA and Hackberry/Pivot Rock Range Allotment treated by FWS to remove nonnative fish.
June 2005	Full flows returned to Fossil Creek.
October 20, 2006	The Forest Service requested our concurrence that authorization of livestock to graze seven pastures on the FCRA may affect, but would not likely adversely affect the Chiricahua leopard frog.
November 13, 2006	We concurred with the above determination.
November 2006	Livestock were returned to seven pastures on the FCRA.
May 9, 2007	The Forest Service requested our concurrence to add an additional three pastures to their October 20, 2006, request.
May 31, 2007	We concurred with the above determination.

March 7, 2008	The Forest Service requested comments regarding the FCRA DEA.
April 7, 2008	We provided our comments on the FCRA DEA to the Forest Service.
July 10, 2008	The Forest Service requested formal consultation for potential adverse affects to the Chiricahua leopard frog, razorback sucker, loach minnow, and spikedace resulting from implementation of the FCRA allotment management plan.
August 8, 2008	We acknowledged your request for formal consultation with a 30-day letter. In this letter we also requested additional information regarding two candidate species.
November 5, 2008	We received the information we requested in our August 8, 2008, letter regarding the candidate yellow-billed cuckoo.
November 24, 2008	We received the information we requested in our August 8, 2008, letter regarding the candidate headwater chub.
February 9, 2009	We issued a final biological opinion for the FCRA (AESO Consultation #22410-2007-F-0197).
April 2, 2009	The Forest Service issued the final EA for the Fossil Creek Range Allotment.
February 26, 2010	Based upon discussions with the Forest Service and the Center for Biological Diversity we clarified our incidental take statement in the FCRA biological opinion, and re-issued the document.
March 15, 2011	We published a proposed rule to reassess the listing status and propose critical habitat for the Chiricahua leopard frog.
September 21, 2011	We made available the draft environmental assessment and draft economic analysis for the proposed designation of critical habitat and reopened public comment on the proposed rule.
January 23, 2012	As a result of litigation, the FWS re-analyzed the effects and revised the incidental take statement for the Chiricahua leopard frog to address the Court's findings.
February 13, 2012	We received the Forest Service's request for reinitiation on the FCRA.
March 20, 2012	We published the final rule for listing and designation of critical habitat for the Chiricahua leopard frog.
April 17, 2012	We received the Forest Service's clarification letter regarding the 2/3's effective ground cover objective.
April 20, 2012	We provided a draft biological opinion to the Forest Service for their review and comment. We received their feedback on the same day and incorporated their comments.
April 23, 2012	We issued a revised biological opinion to the Forest Service regarding Chiricahua leopard frogs on the FCRA.
April – October 2012	FWS, AGFD, and Forest Service conducted survey and recovery work for the Chiricahua leopard frog on the

	FCRA.
September 28, 2012	The Forest Service was ordered to prepare a revised EA to address a claim of a NEPA violation.
December 12, 2012	The Forest Service released the revised Preliminary EA for the FRCA. This EA replaces the 2009 EA.
March 5, 2013	The Forest Service requested formal consultation for potential adverse affects to the Chiricahua leopard frog on the FCRA.
March 22, 2013	We provided the Forest Service with a draft biological opinion for review.
March 25, 2013	The Forest Service provided comments on the draft BO and we incorporated and/or addressed their comments.

DESCRIPTION OF THE PROPOSED ACTION

The FCRA is located on the Red Rock Ranger District, Coconino National Forest, in Yavapai County, Arizona. The allotment is approximately five to 15 miles southeast of Camp Verde and is roughly bounded by Highway 260 on the north and Fossil Creek on the east. Elevations range from approximately 3,000 feet to 6,300 feet and vegetation regimes adhere to the typical elevation regimes: ponderosa pine stringers are present at the highest elevations, pinyon-juniper woodlands and chaparral dominate mid-elevations, and semi-desert grasslands/desert scrub vegetation types are typical at the lower elevations. The FCRA is approximately 42,200 acres in size, divided into 28 main grazing pastures and several small livestock management pastures and water-lots that are less than 100 acres in size. The entire allotment is located within the Fossil Creek watershed, a tributary to the Verde River. In addition, two pastures border the Verde River (Chalk Springs and Surge pastures), but fencing prevents livestock from accessing the river corridor.

The action area for this project is defined as all areas affected directly or indirectly by the Federal action. Thus, the action area is larger than the allotment boundaries because impacts may be carried downstream with flows and may also affect upstream areas. Watersheds and subwatersheds are comprised of numerous interconnected upland and riparian areas that function together as an ecological unit. Therefore, we are defining the action area as the entirety of Fossil Creek, from Fossil Springs down to the confluence with the Verde River, and the Verde River, approximately five miles upstream of the confluence to the northern boundary of the Chalk Springs pasture, and approximately one mile downstream of the confluence. The action area includes the 100-year floodplain of the Verde River and Fossil Creek within these areas. Included within this action area are all seeps, springs, stock tanks, ephemeral drainages, tributaries of Fossil Creek originating on the Coconino National Forest within the allotment boundary, and the uplands that drain into these tributaries and Fossil Creek. The consultation covers a period of 10 years.

Under the proposed action, livestock grazing would continue on Fossil Creek Allotment under a deferred rotational grazing system, which includes conservative forage utilization guidelines. Additionally, there are specific rangeland improvements, specific restoration projects, and an

expansion of the use of adaptive management. The proposed action is based upon a grazing intensity (amount of herbage removed through grazing or trampling during the grazing period) of light to moderate (0 to 50 percent) and conservative utilization rate (30 to 40 percent forage utilization as measured after the end of the growing season). Pasture rotation would be conducted in the spring and fall, but could be modified later in the season to respond to environmental changes and/or monitoring results. The proposed action consists of the following components: Authorization, Improvements, Monitoring, Adaptive Management, and Mitigation. These components are described in more detail below. The proposed action follows current guidance from Forest Service Handbook 2209.13, Chapter 90 (Grazing Permit Administration; Rangeland Management Decision making, September 2005).

Authorization

The Red Rock Ranger District (RRRD) of the Coconino National Forest proposes to continue to authorize livestock grazing for Fossil Creek Allotment under the following terms:

- The maximum number of animal unit months (AUMs) that could be authorized each year under the permit would be 5,800. This number was calculated as a maximum that could be reached if all the soils in impaired and unsatisfactory condition were improved to satisfactory condition and vegetative conditions reached a state where they were producing their full forage potential. Current conditions would not support 5,800 AUMs. The current conditions on the allotment would support a maximum of 3,600 AUMs year long.

- Annual authorized livestock numbers would be based on existing conditions, available water and forage, and predicted forage production for the year. Adjustments to the annual authorized livestock numbers (increase or decrease) may occur during the grazing year, based on conditions and/or range inspections. Over time, as soil and vegetation conditions improve to the state that forage production also increases, the AUMs could be increased. In contrast, the AUMs could also be decreased if conditions deteriorate.

- The permitted season of use would be yearlong.

- Grazing would occur through a rotational management system (deferred grazing) which would allow for plant growth and recovery.

- The permittee would be requested to leave water in earthen stock tanks for wildlife use after domestic livestock have been removed from the grazing unit. In addition to the occupied leopard frog tanks, important earthen stock tanks for other wildlife include: Herbies, Hogback, Natural, Mail Trail Tank #2, Pine, Tanque Aloma, and any other earthen stock tanks identified as being occupied by Chiricahua leopard frogs. These stock tanks would be identified in the annual operating instructions (AOIs). As information is provided, the AOIs would be updated.

- Stehr Lake Pasture would be utilized as trail-through pasture only. Livestock use would be limited to a three day period when trailing through this pasture. Livestock would be

moved to Stehr Lake Basin and Mescal Tank providing the opportunity for the calves to mother up with the cows to avoid the issue of the cattle going back looking for the calves and dispersing throughout the pasture. The livestock would be moved the next day to the intended pasture. Livestock would not be authorized access to the riparian area (Fossil Creek) to graze or water.

- Livestock will only have access to Fossil Creek at the Boulder Water Gap.

Actual livestock numbers and AUMs would be authorized on an annual basis in cooperation with the permittee at levels that promote desired conditions. At the onset of a grazing period (3/1 to 2/28), livestock numbers would be based on water availability and range readiness. Within season adjustments may occur based off of resource conditions that are evaluated through monitoring. Livestock numbers within the permitted amount would continue to be adjusted to meet resource and other objectives based on changing conditions. This resource monitoring strategy is supported by Coconino National Forest range readiness direction and the Coconino National Forest drought management strategy.

The AOI would state the planned graze period for each pasture for each grazing year. However, the actual duration within each pasture would depend on current growing conditions and the need to provide for plant re-growth following grazing. The length of the grazing period within each pasture would also be dictated by the allotment-wide allowable use guidelines (see pages 6-8 of the BA).

Improvements

The following is a list of structural range improvements planned for management of livestock on the FCRA. These projects would improve management of the livestock, decrease impacts to wildlife, and help to maintain/improve desired condition.

- Construct wedge fences at earthen stock tanks as needed for improving Chiricahua leopard frog habitat.

- Livestock exclosure fencing may be constructed at spring/seep and riparian areas if desired conditions are not achieved through the control of livestock grazing. Exclosure fencing would be designed and constructed to protect the important riparian vegetation while still providing for livestock watering if feasible.

- Replace Divide Tank. Divide Tank is infested with crayfish and the crayfish are a threat to downstream frog sites. Methods for addressing this situation would include either:

    - Replacing Divide Tank with a water collection, storage, pipeline, and trough system that does not provide suitable habitat for crayfish
    - Replacing Divide Tank with fabricated troughs and having the permittee haul water to the troughs as needed.

Further coordination between agencies the FWS, AGFD, the Forest Service and the Permittee is necessary to determine which of the above methods would be used.

Vegetation treatments to help improve soil conditions in locations where soil impairment is exacerbated by canopy encroachment of juniper are also included as part of the proposed action. These treatments are planned to reduce the competitive tree overstory and distribute (lop and scatter) branches and limbs on bare soil areas to help increase the nutrient cycling. This would also increase the cover of perennial grasses; increase the hydrologic function of the soils by increasing infiltration, decrease soil compaction, and decrease erosion on these treatment areas. These treatments would include crews with chainsaws hand cutting and lopping and scattering.

The highest priority pastures to target for vegetative treatments to help improve soil conditions are those that have 70 percent or more impaired soils. Twelve pastures on the Fossil Creek allotment were found to have 70 percent or more impaired soils. The twelve pastures are listed in Table 1of the BA (pages 10-11) which includes the approximate acreage of impaired soils and the percent of the pasture that contains impaired soils. Under the proposed action approximately 100 acres in each of these pastures would be treated for a total of 1,200 total acres. Treatment areas would be prioritized according to where on the ground observations have shown canopy cover to be impeding herbaceous understory growth (generally >10 percent canopy), where erosion issues upstream from earthen stock tanks occupied by Chiricahua leopard frog have been identified as an issue, and where treatment efforts have the highest potential for success. Twelve hundred acres was selected as a reasonably achievable goal for the next ten years, given budget and personnel projections. If these treatments are completed quicker than expected or budget allows for additional treatments, supplemental NEPA may be completed to allow for additional work.

Monitoring

Resource protection measures are identified with the objective of improving and/or maintaining long-term diversity, density, and production of upland vegetation. Two types of monitoring would be used for monitoring vegetation, implementation monitoring, and effectiveness monitoring:

- Implementation monitoring would be conducted on an annual basis and would include, but is not limited to: livestock actual use data, grazing intensity evaluations during the grazing season (within key areas), utilization at the end of the growing season (within key areas) in order to practice adaptive management and make necessary management changes needed for plant development and plant from livestock grazing. Managing for plant development and recovery will provide for increased ground cover and potential changes in species composition. Implementation monitoring may also include the condition of range improvements and deviations from the AOI.

- Effectiveness monitoring (also known as long-term condition and trend monitoring) will be used to assess the effectiveness of the proposed livestock management in achieving the desired objectives. This monitoring may include, but is not limited to, measurements to track upland vegetative and soil conditions towards achievement of the objectives.

Examples of techniques used for effectiveness monitoring may include the dry-weight rank, pace transects, pace quadrat frequency, and Parker 3-step methods. Effectiveness monitoring would occur within key areas on permanent transects at an interval of five to 10 years, but may also be conducted if data and observations from implementation monitoring (annual monitoring) indicate a need. The need for this data could be triggered by drought (or other environmental cause) or following input from partner agencies. Two to three years of initial baseline monitoring would occur as part of the proposed action. Initial baseline effectiveness monitoring has occurred in 2006 and 2007, and 2012.

Monitoring frequency of vegetation and soil condition and trend would be accomplished collaboratively by Forest Service personnel, permittee, and cooperating agencies as funding, personnel, and time are available. Typically trend data are collected within a five to ten year period to reflect the greatest amount of change/trend. Both qualitative and quantitative monitoring methods would be used in accordance with the Interagency Technical References, Region 3 Rangeland Analysis and Management Training Guide, and the Region 3 Allotment Analysis Handbook. These are available for review at the RRRD.

Utilization monitoring would occur at the end of the growing season within each of the main grazing pastures. Utilization is defined as the proportion or degree of current year's forage production that is consumed or destroyed by animals (including insects). Utilization is measured at the end of the growing season when the total annual production can be accounted for and the effects of grazing in the whole management unit can be assessed.

Utilization measurements would be taken in key areas which reflect grazing effects within an entire pasture. A minimum of one key area would be established within each main grazing pasture, at existing long-term monitoring sites if possible, to represent overall pasture utilization. Utilization guidelines are not intended as inflexible limits. Utilization measurements can indicate the need for management changes prior to this need being identified through long-term monitoring. Utilization data would not be used alone, but would be used along with actual-use, climate and condition/trend data, to determine stocking levels and pasture rotations for future years. If monitoring shows that the utilization guideline was exceeded in a pasture, the grazing schedule and/or cattle numbers would be adjusted for the following year. If utilization is exceeded after these adjustments are made, then changes would be made to the grazing management system.

Both qualitative and quantitative monitoring methods would be used in accordance with the Interagency Technical References, and the Region 3 Rangeland Analysis and Management Training Guide, and the Region 3 Allotment Analysis Handbook (USDA – Forest Service 1997). See the 2008 BAE, Appendix B, Monitoring and Adaptive Management for further information on the proposed rangeland monitoring. Additional monitoring required for other resources is described below.

Range Resources

- The following would be monitored: permit compliance; actual livestock use, grazing intensity, grazing utilization, forage production and vegetative ground cover, vegetation condition and trend, noxious weeds and precipitation.

Soil, Watershed and Fisheries Resources

- The Forest Service would conduct soil condition assessments at least once every ten years, with the exception of unsatisfactory soils in the Boulder and Stehr Lake pastures. In these pastures, baseline soil condition data would be collected along established transects prior to implementing the first year of authorized grazing. After the baseline data have been collected, soil condition would be monitored every two years to determine extent of soil improvement, if any. If monitoring indicates soil conditions are not improving towards satisfactory, current livestock grazing utilization and intensity would be immediately adjusted and may include pasture deferral or reduced grazing utilization and intensity. In all other pastures, transects would be read at least every 10 years by Forest Service personnel to assess the effects of grazing. If monitoring indicates that soil conditions are not improving towards satisfactory conditions, the current livestock grazing strategy would be adjusted using the adaptive management strategy.

- Vegetation transects would be monitored at least once every ten years within each Terrestrial Ecosystem Map Unit using 20 meter transects (with a 30 x 50 cm hoop read every two meters for a total of ten readings per 20 meter transect). Species composition, effective ground cover, and species diversity would be read from each 30 x 50 cm hoop. Monitoring sites would be placed in key areas representative of the map unit. Key areas would be more than 0.25 mile from water.

- Riparian areas within the allotment would continue to be monitored for Proper Functioning Condition (PFC). Sycamore Canyon and Mud Tanks Draw would all be monitored in the first year of the permit and all other reaches would be monitored at least once every ten years.

- Aquatic habitat monitoring would be conducted on all perennial streams in the allotment using established regional protocols. This monitoring would establish the condition and trends of the aquatic habitat in response to grazed riparian and upland areas. The frequency for this monitoring is unknown.

- Vegetation conditions at livestock water access points along Fossil Creek would be monitored annually using established regional protocols which may include a combination of measurements, observations and photo points.

Wildlife

- The Forest Service would periodically monitor water quality in water bodies (especially tanks and springs) where livestock have access. Parameters that may be monitored include (but are not limited to) nitrates, nitrites, ammonium, coliform, pH, and/or dissolved oxygen. There is no protocol at this time. The Forest Service states they would use the initial baseline data to compare to the available literature that cites tolerable limits of these parameters for aquatic and amphibian species.

- The FWS and AGFD have committed to monitoring the core Chiricahua leopard frog sites (Middle, Black, Walt's, Buckskin, and Sycamore Basin Tanks) and any other stock tanks where we agree to establish Chiricahua leopard frogs. The Forest Service will assist with monitoring suitable and additional occupied habitats within the FCRA.

Wild and Scenic Rivers

- The Forest Service proposes to monitor effects to bank stability and riparian vegetation at existing and proposed livestock water access points on Fossil Creek during and following livestock use of these areas.

Heritage Resources

- The Forest Service would periodically monitor known archaeological sites to ensure they have been avoided.

Noxious and Invasive Weeds

- Noxious and invasive weeds would be monitored during regular range allotment monitoring. As noxious weed populations are found they would be mapped and entered into the Invasive Plants database. Control or treatment options would be considered and implemented depending on the class and priority of identified weeds and funding.

Adaptive Management

The proposed action will use adaptive management to modify the grazing system if information obtained from monitoring that indicates the grazing strategy is not meeting desired conditions. Implementation and effectiveness monitoring would provide the basis for modifying management in coordination with the Permittee. Elements of the grazing system that might be modified include: timing, intensity, frequency, and duration of grazing. Adaptive management would also allow for the construction of range improvements, if they are determined through monitoring to be necessary for moving the allotment toward desired conditions. For example, livestock exclosure fencing may be constructed at spring, seep, and riparian areas if desired conditions are not achieved through the control of livestock grazing. Exclosure fencing would be designed and constructed to protect the important riparian vegetation and wildlife habitat while still providing for livestock watering, if feasible.

Modifications would be implemented through the AOIs. See Table 2: Triggers and Adaptive Management Options in the BA (page 12) for examples of adaptive management evaluation points and possible management responses for Fossil Creek Allotment.

Mitigation

- The placement of salt, minerals, and/or other supplements used for the purposes of livestock management would not be placed within 0.25 mile of sensitive resource areas unless it can be demonstrated that the placement of these supplements does not adversely affect the sensitive resource area.

- Structural range improvements (ex. fences, water developments, and livestock handling facilities) would be located at least 0.25 mile from sensitive resource areas unless it can

be demonstrated that these facilities are necessary to mitigate effects to sensitive resource areas. Existing structural range improvements may be relocated or modified when found incompatible.

- Vegetation treatments would be designed and implemented in a way that does not conflict with sensitive resource areas.

- Where high priority invasive plants are present, restrictions on livestock numbers or timing may be used in conjunction with removal and/or control treatments.

- In order to minimize the risk for introducing and spreading disease among aquatic systems, approved protocols would be followed when conducting work in earthen livestock tanks. This protocol would be attached to the AOI.

- Biologists would be given at least 60 days notice prior to conducting work in earthen tanks. This notice would allow for surveys, if needed, and/or mitigation to reduce adverse affects to Chiricahua leopard frogs.

STATUS OF THE SPECIES

The Chiricahua leopard frog was listed as a threatened species without critical habitat in a Federal Register notice dated June 13, 2002. Included was a special rule to exempt operation and maintenance of livestock tanks on non-Federal lands from the section 9 take prohibitions of the Act. Critical habitat was proposed in 2011 (USFWS 2011a, 2011b) and identified potential critical habitat units in Arizona and New Mexico. The Chiricahua Leopard Frog Final Recovery Plan (Recovery Plan) was finalized in April 2007 (USFWS 2007) and the final rule for reassessing the listing and designating critical habitat was promulgated in March 2012 (USFWS 2012).

The frog is distinguished from other members of the *Lithobates pipiens* complex by a combination of characters, including a distinctive pattern on the rear of the thigh consisting of small, raised, cream-colored spots or tubercles on a dark background; dorsolateral folds that are interrupted and deflected medially; stocky body proportions; relatively rough skin on the back and sides; and often green coloration on the head and back (Platz and Mecham 1979). The species also has a distinctive call consisting of a relatively long snore of 1 to 2 seconds in duration (Platz and Mecham 1979, Davidson 1996). Snout-vent lengths of adults range from approximately 2.1 to 5.4 inches (Platz and Mecham 1979, Stebbins 2003). The Ramsey Canyon leopard frog (*Lithobates* "*subaquavocali*s"), found on the eastern slopes of the Huachuca Mountains, Cochise County, Arizona, has recently been subsumed into *Lithobates chiricahuensis* (Crother 2008) and recognized by the FWS as part of the listed entity (USFWS 2009).

The range of the Chiricahua leopard frog includes central and southeastern Arizona; west-central and southwestern New Mexico; and, in Mexico, northeastern Sonora, the Sierra Madre Occidental of northwestern and west-central Chihuahua, and possibly as far south as northern Durango (Platz and Mecham 1984, Degenhardt et al. 1996, Lemos-Espinal and Smith 2007, Rorabaugh 2008) (Figure 1). Reports of the species from the State of Aguascalientes (Diaz and

Diaz 1997) are questionable. The distribution of the species in Mexico is unclear due to limited survey work and the presence of closely related taxa (especially *Lithobates lemosespinali*) in the southern part of the range of the Chiricahua leopard frog (see further discussion below).

The Chiricahua leopard frog is an inhabitant of montane and river valley cienegas, springs, pools, cattle (stock) tanks, lakes, reservoirs, streams, and rivers. The species requires permanent or semi-permanent pools for breeding and water characterized by low levels of contaminants and moderate pH, and may be excluded or exhibit periodic die-offs where *Batrachochytrium dendrobatidis (Bd)*, a pathogenic chytridiomycete fungus, is present (see further discussion of this in the threats section below and in USFWS 2011c). The frog is excluded from ephemeral habitats by its requirements for surface moisture for adult survival and a relatively long larval period (minimum of three months). The diet of the Chiricahua leopard frog includes primarily invertebrates such as beetles, true bugs, and flies, but fish and snails are also eaten (Christman and Cummer 2006).

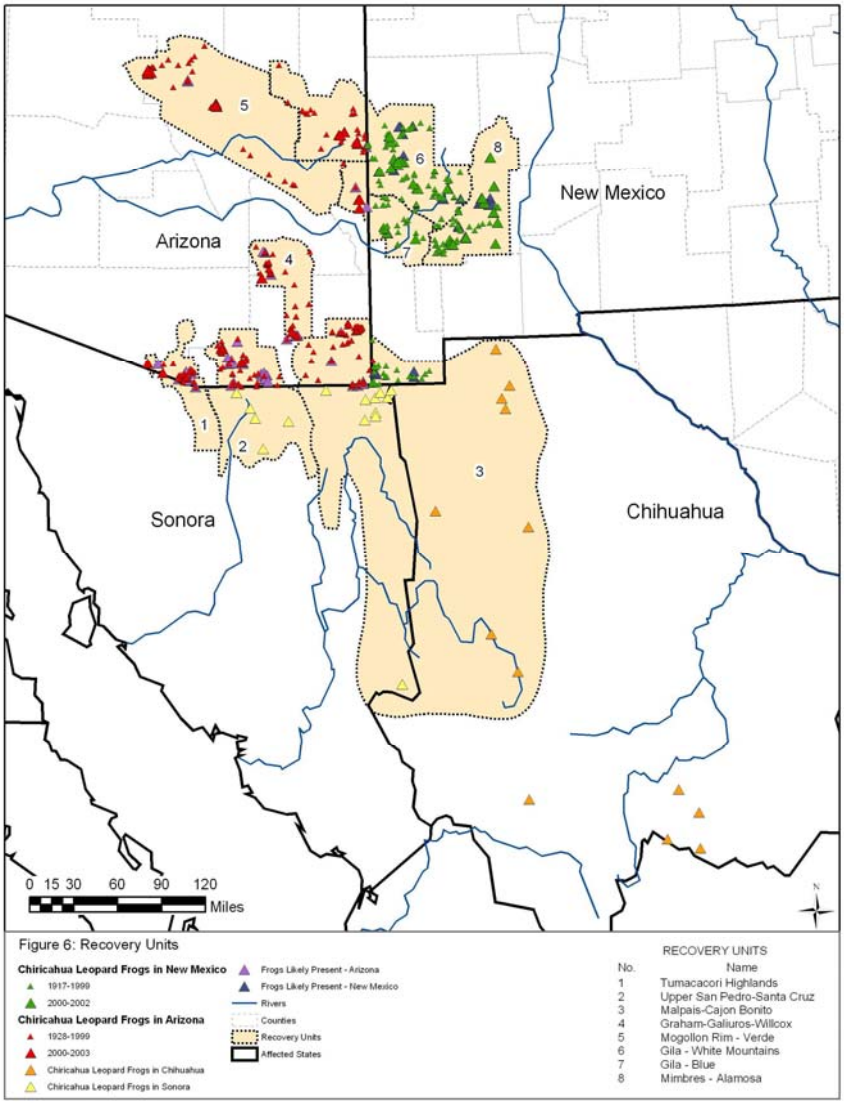

Figure 1. Map of the known range of the Chiricahua leopard frog as of 2007. The map covers areas in Arizona, New Mexico, and Mexico. All eight recovery units (RUs) are delineated by number.

Prior to the invasion of perennial waters by predatory, nonnative species (American bullfrog, crayfish, fish species) the Chiricahua leopard frog was historically found in a variety of aquatic habitat types. Today, leopard frogs in the Southwest are so strongly impacted by harmful nonnative species, which are most prevalent in perennial waters, that their occupied niche is increasingly restricted to the uncommon environments that do not contain these nonnative predators, and these now tend to be ephemeral and unpredictable. This increasingly narrow realized niche is a primary reason for the threatened status of the Chiricahua leopard frog.

The life history of the Chiricahua leopard frog can be characterized as a complex life cycle, consisting of eggs and larvae that are entirely aquatic and adults that are primarily aquatic, making the species a habitat specialist (USFWS 2007). The species has a distinctive call and males can be temporarily territorial (USFWS 2007). Amplexus is axillary and the male fertilizes the eggs as the female attaches a spherical mass to submerged vegetation. Eggs are laid from February into October, with most masses found in the warmer months (USFWS 2007). Numbers of eggs in a mass range from 300 to 1,485 (Jennings and Scott 1991) and may be correlated with female body size. The hatching time of egg masses in the wild ranges between 8-14 days, depending on water temperature (USFWS 2007). Upon hatching, tadpoles are mainly herbivorous and remain in the water, where they feed and grow, with growth rates faster in warmer conditions. Tadpoles have a long larval period, from three to nine months, and may overwinter. After metamorphosis, Chiricahua leopard frogs eat an array of invertebrates and small vertebrates and are generally inactive between November and February (USFWS 2007). Males reach sexual maturity at 2.1-2.2 in (5.3-5.6 cm), a size they can attain in less than a year (Sredl and Jennings 2005). Under ideal conditions, Chiricahua leopard frogs may live as long as 10 years in the wild (Platz et al. 1997, p. 553).

Chiricahua leopard frogs can be found active both day and night, but adults tend to be active more at night than juveniles (Sredl and Jennings 2005). Chiricahua leopard frogs presumably experience very high mortality (greater than 90 percent) in the egg and early tadpole stages, high mortality when the tadpole turns into a juvenile frog, and then relatively low mortality when the frogs are adults (Zug et al. 2001, USFWS 2007). Adult and juvenile Chiricahua leopard frogs avoid predation by hopping to water (Frost and Bagnara 1977). They also possess an unusual ability among members of the Rana pipiens complex; they can also darken their ventral skin under conditions of low reflectance and low temperature (Fernandez and Bagnara 1991; Fernandez and Bagnara 1993), a trait believed to enhance camouflage and escape predation (USFWS 2007).

Males have larger home range sizes than females, with the largest home range for a male documented at 251,769 ft2 (7,674 by 32 ft, or 23,390.2 m2 [2,339 by 9.8 m]) (USFWS 2007). The maximum distance moved by a radio-telemetered Chiricahua leopard frog in New Mexico was 2.2 miles (3.5 km) in one direction (preliminary findings of telemetry study by R. Jennings and C. Painter, Technical Subgroup, 2004). In 1974, Frost and Bagnara (1977) noted passive or active movement of Chiricahua and Plains (*Lithobates blairi*) leopard frogs for five miles or more along West Turkey Creek in the Chiricahua Mountains. In August 1996, Rosen and Schwalbe (1998) found up to 25 young adult and subadult Chiricahua leopard frogs at a roadside puddle in the San Bernardino Valley, Arizona. They believed that the only possible origin of

these frogs was a stock tank located 3.4 miles away. Although amphibians are known to have limited dispersal and colonization abilities due to physiological constraints, limited movements, and high site fidelity (Blaustein et al. 1994), Chiricahua leopard frogs can disperse to avoid competition, predation, or unfavorable conditions (Stebbins and Cohen 1995). Dispersal most likely occurs within favorable habitat, making the maintenance of corridors that connect disjunct populations possibly critical to preserve populations of frogs. Active or passive dispersal (while carried along stream courses) of juveniles or adults to discrete aquatic habitats facilitates the creation and maintenance of metapopulations (USFWS 2007), an important option for a water-dependent frog in an unpredictable environment like the arid Southwest.

For far more detailed information on this species, please refer to the Recovery Plan (USFWS 2007), which is the baseline in regard to the current status, biology, and threats to the Chiricahua leopard frog.

Population Status in Arizona, New Mexico, and Mexico

Evidence indicates that since the time of listing, the species has probably made at least modest population gains in Arizona, but is apparently declining in New Mexico. Overall in the U.S., the status of the Chiricahua leopard frog is either static or, more likely, improving, with much of the increase attributable to an aggressive recovery program that is showing considerable results on the ground through the reestablishment of populations (mainly in Arizona), captive rearing programs, creation of refugial populations, and enhancement and development of habitat have helped stabilize or improve the status of the species in some areas (USFWS 2011c). In Arizona and New Mexico, there are currently two main captive breeding facilities – the Phoenix Zoo and the Ladder Ranch. In Arizona, a captive breeding program was established with the Phoenix Zoo in 2005 and the Ladder Ranch (a private 155,553 acre ranch in Sierra County, New Mexico) began captive propagation-headstarting-release in 2011. These programs, in concert with habitat restoration activities occurring across both states, are contributing to range-wide recovery of the frog. Population status and trends in Mexico are unknown.

Arizona

In Arizona, the frog still occurs in seven of eight major drainages of historical occurrence (Salt, Verde, Coronado, San Pedro, Santa Cruz, Yaqui/Bavispe, and Magdalena river drainages), but appears to be extirpated from the Little Colorado River drainage on the northern edge of the species' range. Within the drainages where the species occurs, it was not found recently in some major tributaries and/or in river mainstems. For instance, the species has not been reported since 1995 from the following drainages or river mainstems where it historically occurred: White River, West Clear Creek, Tonto Creek, Verde River mainstem, San Carlos River, upper San Pedro River mainstem, Santa Cruz River mainstem, Aravaipa Creek, Babocomari River mainstem, and Sonoita Creek mainstem. In southeastern Arizona, no recent records (1995 to the present) exist for the following areas: Pinaleno Mountains, Peloncillo Mountains, and Sulphur Springs Valley. Moreover, the species is now absent from all but one of the southeastern Arizona valley bottom cienega complexes. Large valley bottom cienega complexes may have once supported the largest populations in southeastern Arizona, but nonnative predators are now so abundant that the cienegas do not presently support the frog in viable numbers (USFWS 2002).

A review of the status of the species in Arizona from 2002, when the species was listed, to 2009 was conducted by Rorabaugh (2010). A comparison of survey results during 2005-2009 versus 1999-2002 revealed increasing numbers of sites occupied by Chiricahua leopard frogs from 2002-2008. The total number of occupied sites increased from 49 in 2002 to 80 in 2008 and 90 in 2009, while the number of robust breeding populations increased from 5 in 2002 to 13 in 2008, and then declined slightly to 11 in 2009. The total number of breeding populations increased from 26 in 2002 to 34 in 2008 and then declined by one for a total of 33 sites in 2009. These trends were also generally reflected at the Recovery Unit (RU) level of analysis. Exceptions included a reduction in number of breeding populations in RU 3 from three to two and in RU 6 from three to zero. Recovery Unit 5 also exhibited a reduction in the number of robust breeding populations from two to zero following the 2002 drought. The current status is that we have reestablished robust breeding populations at Middle and Walt's Tanks on the Coconino National Forest and the Tonto National Forest has also established several robust breeding populations in RU 5 since 2009. Overall, the data suggest that there has been an increase in the number of occupied sites from 2002-2009. However, the increase in sites may only represent a positive response to temporarily favorable environmental conditions (i.e., such as adequate summer rains in rare years that allow for limited dispersal, rather than an intrinsic improvement that will endure over time due to factors such as long-term drought) and/or it could be a result of our underestimating the number of sites in 2002 due to lack of surveys in areas the frog may have occurred in at that time.

The above data suggest substantial gains in the number of known locations of Chiricahua leopard frogs since the time of listing. However, basing status and trends on differences in numbers of occupied sites from 2002-2009 can be problematic for several reasons. First, if increasing trends are accurate, they may represent population response to temporarily favorable environmental conditions, such as adequate summer rains that allow dispersal, rather than an intrinsic improvement that will endure over time. Second, there are sources of bias that affect the conclusions. For instance, both data sets likely underestimate the number of occupied sites existing at the time, because some sites were unknown or surveys had not been conducted within the last three years to categorize all sites as occupied or unoccupied. But there is further bias in the survey data in that the 2009 data set benefits from recent discoveries of populations that could have existed in 2002, but we did not know of them at the time.

The latter type of bias can be eliminated by adding to the 2002 total all of the occupied sites that were discovered after 2002; except for those for which we are reasonably certain were unoccupied in 2002. If analyzed in this way, the total number of occupied sites, in 2002, increases from 49 to 83. This is roughly the same number of occupied sites as in 2008 (85). Based on this, the total number of occupied sites was fairly stable or increasing slightly in Arizona from 2002 (83) to 2008 (85) and 2009 (92). However, this correction inserts yet another type of bias into the sample: analyzed in this way, the 2002 total is based not only on what was found during 1999 to 2002, but also surveys during period 2003 to 2009. Yet the 2008 and 2009 totals are only based on surveys during 2005-2008 and 2006-2009 respectively. The number of occupied sites in 2009 would no doubt increase if we could add in new sites during the equivalent future period (through 2016). Though we cannot provide an exact number of expected new sites that may be established by 2016, each RU stakeholder group has identified

locations for potential new sites to reestablish or introduce frogs, so we potentially could work towards establishing four to eight new sites per year (though not all of these site are guaranteed to be successful).

As a result, concluding there were 83 extant sites in 2002, 85 extant sites in 2008, and 92 extant sites in 2009 is likely the worst case scenario, in that this analysis is most likely to show any declines in occupied frog sites, if they occurred from 2002-2009. The actual trend is probably somewhere between "roughly stable" to what was concluded in the Rorabaugh (2010) analysis which was "substantial increases." In conclusion, there is no evidence of decline of the number of sites occupied by Chiricahua leopard frogs in Arizona; rather, the data suggest at least modest increases.

New Mexico

In New Mexico, the frog historically occurs in west-central and southwestern New Mexico in Catron, Grant, Hidalgo, Luna, Socorro, and Sierra Counties and has been collected or observed at 182 localities over time (Painter 2000). In 1995, Jennings reported that frogs still occurred at only eleven sites in New Mexico. Based on additional work, Painter (2000) listed forty-one localities at which frogs were found from 1994-1999. Thirty-three of these are north of Interstate 10 and eight are in the southwestern corner of the state. Thirty-one of the 41 populations were verified extant during 1998-1999 (Painter 2000). However, during May-August 2000, the frog was found at only eight of 34 sites (USFWS 2002). Three populations east of Hurley in Grant County declined or were extirpated during 1999 to 2000, and preliminary data indicate another population on the Mimbres River, also in Grant County, has experienced a significant die-off (U.S. Fish and Wildlife Service 2002). Survey results from the 2004 field season indicate that there are 31 locations where the frog can be considered as likely to occur in New Mexico (R. Williams, FWS, 2004, unpubl. data; R. Jennings, Western New Mexico University, 2005, unpubl. data).

A similar analysis as was done for Arizona populations (see above) was not possible in New Mexico because all sites have not been monitored annually and much of the reported survey information is reported as presence or absence. Due to the evolving nature of Chiricahua leopard frog monitoring since the early 1990s and the ability of frogs to move up to 5 miles (8 km), survey information has resulted in different definitions of "sites" and "populations" over time. Often site boundaries are indistinct making some connected areas a single site, and other connected areas several sites. Thus it is difficult to assess the frog's status by enumerating occupied sites and often comparisons among sites are not equivalent. However, based upon the data available, we can conclude that the number of sites occupied by frogs has continued to decline annually in New Mexico since listing.

As background, the final rule listing the species indicated the frog had been found at 41 sites from 1994-1999, and 31 of these 41 sites were verified as extant during 1998-1999. The rule explains that frogs were found at only 8 of 34 surveyed sites (of the original 41 sites) in 2000. The Recovery Plan indicated that 30-35 populations of Chiricahua leopard frogs were likely extant in New Mexico at the time of writing (2006-7). The tally of these 30-35 populations included dispersal sites, which indicates that not all of these populations were robust, breeding

sites. Starting with the 41 sites from 1994-1999, 27 of those sites are now extirpated, four of them are considered unstable with low population numbers or are possibly extirpated, two are considered dispersal observations with no reproduction, one has an unknown status due to inaccessibility, and seven sites support reproduction and no significant die-off or population loss has been observed.

Based on the above data, collected from 2002 to 2010, 27 of the 41 sites are considered extirpated, representing a 66 percent drop in the known Chiricahua leopard frog sites in New Mexico during this 5-year period (USFWS 2011c). Since listing in 2002, an additional 30 new sites have been identified. To date, of these 30 new sites, 15 have become extirpated, six are unstable with low population numbers or are possibly extirpated, four are considered dispersal observations with no reproduction, one site is on private property with an unknown population status, and at four sites reproduction is occurring and no significant die-off or population loss has been observed. New sites have been found due to increased surveying efforts in remote areas and growing access to private lands through partnership activities. Although undiscovered occupied sites may still exist, the rate and likelihood of finding new sites will diminish, as the area of unsurveyed habitat is reduced each year. Furthermore, while the frog has a large capacity for dispersal, because of the many of the new observations were not near known occupied sites, we assume that most of the new observations were existing locations and not newly colonized locations. Thus in the past eight years, these newer sites have reflected a similar trend of decline, with half of the sites no longer occupied.

Disease, particularly infection caused by Bd, has accounted for the majority of Chiricahua leopard frog declines. This disease seems to present more of a threat to the frog in New Mexico than it does in Arizona, perhaps due to the higher elevations and cooler conditions found at sites in New Mexico. However, nonnative species (American bullfrogs, crayfish, and nonnative fish) also continue to significantly impact extant populations and threaten the frog in New Mexico. All remaining frog populations in New Mexico are extremely vulnerable to extirpation from disease, nonnative species, small population sizes, habitat drying, and lack of connectivity between other suitable habitats or populations.

In recent years, New Mexico Chiricahua leopard frog partners have gained momentum in conservation actions. In an effort to prevent permanent genetic losses, much of the recovery activities in New Mexico have been focused on creating off-site refugia populations. This entails collecting wild eggs, tadpoles, or metamorphs and bringing them into captivity for rearing and disease testing and treatment if needed, and releasing them into confined steel rim tanks or utilizing offspring from disease-free captive reproducing adults. Currently, the New Mexico Ecological Services Field Office and the Bureau of Land Management have the capacity to rear, hold, and treat animals; and the Forest Service has set up a quarantine holding facility and one tank for captive management. In 2012, the Ladder Ranch's "Ranarium" has become fully operational, and consists of outdoor holding pens for adult frogs (for captive reproduction) and outdoor tanks for rearing tadpoles. For the Chiricahua leopard frog in New Mexico, the hope is that not only will the refugia sites serve as a back-up if there is a die-off at the source population, but that with time, they will also serve as a source for additional repatriation efforts. The facilities that are contributing to these efforts will also serve to produce animals for repatriation projects once extant populations have been boosted. As of 2012, nine refugia populations have

been established, multiple augmentations at two sites, and three re-introduction efforts have been conducted.

Mexico: Sonora and Chihuahua

Based on published and unpublished reports and perusal of Sonora, Mexico collection data from 23 museums, the Chiricahua leopard frog is known from about 26 localities in Chihuahua, Mexico and 19 localities in Sonora (Lemos-Espinal and Smith 2007). *Lithobates* [*Rana*] *chiricahuensis* have been reported as far south as the Mexican state of Aguascalientes, but frogs south of central Chihuahua are of questionable identification (USFWS 2007). Based on limited surveys, populations of leopard frogs, gartersnakes, and other native aquatic herpetofauna are generally more intact and nonnative predators are much less widely distributed in Sonora and at least parts of Chihuahua (Rosen and Melendez 2010, Lemos-Espinal and Smith 2007, Rorabaugh 2008). However, specifically for the Chiricahua leopard frog, data are insufficient to determine status or trends in Mexico. None of the Chiricahua leopard frog localities in Sonora have been revisited recently, with the exception of one in the Sierra Los Ajos. No frogs were found at that site (L. Portillo, pers. comm. 2009). Chiricahua leopard frogs have been observed recently at several sites in Chihuahua (R. Jennings, pers. comm. 2007), but not enough is known to assess status or trends.

Summary of Population Status

In conclusion, the data and recent recovery efforts suggest the status of the Chiricahua leopard frog is at least stable and improving in Arizona, starting to improve in New Mexico, and unknown in Mexico. In pooled data for the U.S., a worst case analysis shows essentially no change in the number of occupied sites from 2002 to 2009 (133 versus 131, respectively); however, as discussed above, this likely underestimates the status of the species in Arizona, overestimates the status of the species in New Mexico, and includes data that are not standardized to be truly comparable. The actual situation is probably that the status of the species is stable in the U.S overall, but the different conditions between Arizona and New Mexico indicate that improvement is occurring only in Arizona at this time, while in New Mexico, frog numbers continue to decline. Continued and new aggressive recovery actions are needed to address threats to the species rangewide, to maintain positive trends in Arizona, to stabilize population losses in New Mexico, and to assist partners in Mexico with their conservation efforts. If on-going recovery actions are interrupted, drought worsens, or other threats intensify, the status of the species across its range could easily deteriorate.

<u>Threats</u>

The primary threats to this species are predation by nonnative organisms and die-offs caused by a fungal skin disease – chytridiomycosis. The chytridiomycete skin fungus, (*Bd* is the organism that causes chytridiomycosis) is responsible for global declines of frogs, toads, and salamanders (Berger et al. 1998, Longcore et al. 1999, Speare and Berger 2000, Hale 2001). Additional threats include: drought, floods, degradation and loss of habitat as a result of water diversions and groundwater pumping, poor livestock management, altered fire regimes, mining, development, and other human activities; disruption of metapopulation dynamics, resulting from

an increased chance of extirpation or extinction resulting from small numbers of populations and individuals, and environmental contamination (USFWS 2007). Loss of Chiricahua leopard frog populations is part of a pattern of global amphibian decline, suggesting other regional or global causes of decline may be important as well (Carey et al. 2001). Witte et al. (2008) analyzed risk factors associated with disappearances of ranid frogs in Arizona and found that population loss was more common at higher elevations and in areas where other ranid population disappearances occurred. Disappearances were also more likely where introduced crayfish occur, but were less likely in areas close to a source population of frogs.

The goal of the Recovery Plan (USFWS 2007) is to improve the status of the species to the point that it no longer needs the protection of the Endangered Species Act. The recovery strategy calls for reducing threats to existing populations; maintaining, restoring, and creating habitat that will be managed in the long term; translocation of frogs to establish, reestablish, or augment populations; building support for the recovery effort through outreach and education; monitoring; conducting research needed to provide effective conservation and recovery; and application of research and monitoring through adaptive management. Recovery actions are recommended in each of eight recovery units throughout the range of the species. Management areas are also identified within recovery units where the potential for successful recovery actions is greatest.

The Recovery Plan identifies eight RUs in Arizona and New Mexico (Figure 1, Table 2). Focus areas, referred to as management areas (MAs), are identified within each RU. Management areas are areas with the greatest potential for successful recovery actions and threat alleviation. Hydrologic units and mountain ranges are used as MA boundaries. Within MAs, sites where metapopulations and robust, isolated populations occur or will be established are referred to herein as "recovery sites." MAs have been delineated to include all habitats of known extant Chiricahua leopard frog populations as well as other sites with the highest potential for recovery, including sites where habitat restoration or creation, and establishment or re-establishment of Chiricahua leopard frog populations will likely occur or has already occurred. We include all known extant populations within MA boundaries because of the high value of those populations for recovery.

For the Chiricahua leopard frog to be recovered, conservation must occur in each RU (Table 2) (USFWS 2007). Successful conservation is not necessary in every MA and recovery does not depend upon an even distribution of recovery efforts across an RU. Rather, we anticipate that recovery efforts will be focused in those MAs and portions of RUs in which opportunities are best. Recovery criteria, as identified in the Recovery Plan (USFWS 2007), to delist the Chiricahua leopard frog includes: 1) at least two metapopulations located in different drainages, plus at least one isolated and robust population in each RU; 2) protection of these populations and metapopulations; 3) connectivity and dispersal habitat protection; and, 4) reduction or elimination of threats and long-term protection (USFWS 2007). As noted in the FWS's 1998 Consultation Handbook, RUs are population units that have been documented as necessary to both the survival and recovery of the species. Avoiding loss of populations or other serious adverse effects in a RU will ensure continued contribution of that RU to the recovery of the species.

Existing populations and suitable habitat in MAs will be protected through management (USFWS 2007). As identified in the Recovery Plan, management will include maintaining or improving watershed conditions both upstream and downstream of Chiricahua leopard frog habitats to reduce physical threats to aquatic sites and allow for Chiricahua leopard frog dispersal, reducing or eliminating nonnative species, preventing and managing disease, and other actions. Suitable or potentially suitable unoccupied habitat with high potential for supporting Chiricahua leopard frog populations or metapopulations (referred to here as recovery sites) will be protected, and restored or created as needed, within MAs (USFWS 2007). These habitats should include aquatic breeding habitats and uplands or ephemeral aquatic sites needed for movement among local populations in a metapopulation. Activities to achieve this include habitat management, removal of nonnative species (e.g. American bullfrogs, nonnative fishes, and crayfish), enhancing water quality conditions, and reducing sedimentation. Populations of Chiricahua leopard frogs will be established or reestablished in these MAs.

Table 2. The eight RUs as identified in the Recovery Plan and the current status of the delisting criteria for the Chiricahua leopard frog in each RU (USFWS 2011c).

Recovery Unit	RU#	Recovery Criteria 1	Recovery Criteria 2	Recovery Criteria 3	Recovery Criteria 4
Tumacacori-Atascosa-Pajarito Mountains, Arizona and Mexico	1	Met	Not met	Not met	Not met
Santa Rita-Huachuca-Ajos Bavispe, Arizona and Mexico	2	Not met	Not met	Not met	Not met
Chiricahua Mountains-Malpai Borderlands-Sierra Madre, Arizona, New Mexico, and Mexico	3	Not met	Not met	Not met	Not met
Pinaleno-Galiuro-Dragoon Mountains, Arizona	4	Not met	Not met	Not met	Not met
Mogollon Rim-Verde River, Arizona	5	Not met	Not met	Not met	Not met
White Mountains-Upper Gila, Arizona and New Mexico	6	Not met	Not met	Not met	Not met
Upper Gila-Blue River, Arizona and New Mexico	7	Not met	Not met	Not met	Not met
Black-Mimbres-Rio Grande, New Mexico	8	Not met	Not met	Not met	Not met

Critical Habitat

The 2012 critical habitat rule for the Chiricahua leopard frog designated 39 critical habitat units (approximately 10,346 acres [4,187 ha]) in the eight RUs within the range of the species in Arizona and New Mexico (USFWS 2012). The purpose of the designation of critical habitat is to conserve the physical or biological features that are essential to the conservation of the species and which may require special management consideration or protection. Based on our current knowledge of the physical or biological features and habitat characteristics required to sustain

the species' life-history processes, we determined that the primary constituent elements (PCEs) specific to the Chiricahua leopard frog are:

1. Aquatic breeding habitat and immediately adjacent uplands exhibiting the following characteristics:
    a. Standing bodies of fresh water (with salinities less than 5 parts per thousand, pH greater than or equal to 5.6, and pollutants absent or minimally present), including natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, off-channel pools, and other ephemeral or permanent water bodies that typically hold water or rarely dry for more than a month. During periods of drought, or less than average rainfall, these breeding sites may not hold water long enough for individuals to complete metamorphosis, but they would still be considered essential breeding habitat in non-drought years.
    b. Emergent and or submerged vegetation, root masses, undercut banks, fractured rock substrates, or some combination thereof, but emergent vegetation does not completely cover the surface of water bodies.
    c. Nonnative predators (e.g., crayfish (*Orconectes virilis*), American bullfrogs (*Lithobates catesbeiana*), nonnative predatory fishes) absent or occurring at levels that do not preclude presence of the Chiricahua leopard frog.
    d. Absence of chytridiomycosis, or if present, then environmental, physiological, and genetic conditions are such that allow persistence of Chiricahua leopard frogs.
    e. Upland areas that provide opportunities for foraging and basking that are immediately adjacent to or surrounding breeding aquatic and riparian habitat.

2. Dispersal and non-breeding habitat, consisting of areas with ephemeral (present for only a short time), intermittent, or perennial water that are generally not suitable for breeding, and associated upland or riparian habitat that provides corridors (overland movement or along wetted drainages) for frogs among breeding sites in a metapopulation with the following characteristics:
    a. Are not more than 1.0 mile (1.6 kilometers) overland, 3.0 miles (4.8 kilometers) along ephemeral or intermittent drainages, 5.0 miles (8.0 kilometers) along perennial drainages, or some combination thereof not to exceed 5.0 miles (8.0 kilometers).
    b. In overland and non-wetted corridors, provides some vegetation cover or structural features (e.g., boulders, rocks, organic debris such as downed trees or logs, small mammal burrows, or leaf litter) for shelter, forage, and protection from predators; in wetted corridors, provides some ephemeral, intermittent, or perennial aquatic habitat.
    c. Are free of barriers that block movement by Chiricahua leopard frogs, including, but not limited to, urban, industrial, or agricultural development; reservoirs that are 50 acres (20 hectares) or more in size and contain predatory nonnative fishes, bullfrogs, or crayfish; highways that do not include frog fencing and culverts; and walls, major dams, or other structures that physically block movement.

With the exception of impoundments, livestock tanks, and other constructed waters, critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries.

All areas designated as critical habitat will require some level of management to address the current and future threats to the Chiricahua leopard frog and to maintain or restore the PCEs. Special management in aquatic breeding sites will be needed to ensure that these sites provide water quantity, quality, and permanence or near permanence; cover; and absence of extraordinary predation and disease that can affect population persistence. In dispersal habitat, special management will be needed to ensure frogs can move through those sites with reasonable success.

Approximately 36 percent of all designated critical habitat for the Chiricahua leopard frog is located on five National Forests in Region 3 (the Coronado, Gila, Tonto, Coconino, and Apache-Sitgreaves National Forests). In total, approximately 3,762 acres (1,524 ha) of critical habitat occurs on these five National Forests and the majority of these CHUs are represented by populations occupying stock tanks. The Coconino National Forest, which is the subject of this biological opinion, includes approximately six percent (232 acres [94 ha]) of the critical habitat designated on National Forest System lands in Region 3.

ENVIRONMENTAL BASELINE

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

Status of the Chiricahua leopard frog and its critical habitat within the Action Area

Currently occupied, recently and historically occupied, and suitable habitat for the Chiricahua leopard frog on the Coconino National Forest is located within RU 5. Recovery Unit 5 lies along the Mogollon Rim (Rim) in Arizona, including mostly forested lands both above and below the Rim. The Coconino National Forest occurs within the northwest portion of the RU. Historically, Chiricahua leopard frogs were widely-distributed both above and below the Rim in RU 5, including records from the Fossil Creek, West Clear Creek, and East Clear Creek watersheds on the Coconino National Forest.

Over the past decade, we have struggled to maintain Chiricahua leopard frogs within the project area. However, following several years of reintroduction and implementation of habitat protection measures, we currently have gone from four occupied sites to 13 occupied sites (see Table 3) as frogs have successfully reproduced at core breeding sites and expanded into suitable habitat on the allotment. The overall status of the Chiricahua leopard frog on the FCRA has improved significantly since we last issued a biological opinion on this action.

Chiricahua leopard frog occupied habitat on the Coconino National Forest consists almost entirely of stock (cattle) tanks within the FCRA boundary. However, in 2012, frogs moved into natural pools and springs on the allotment as well. We do not know yet if breeding will occur at these natural sites, but we will monitor these areas to determine their ability to support breeding frogs. The area of occupied habitat on the Coconino National Forest is referred to as the Buckskin Hills Conservation Management Area for Chiricahua leopard frogs (or simply the Buckskin Hills). This area is located east of Camp Verde, Arizona and south of Highway 260 and consists of stock tanks in the uplands of the Fossil Creek Watershed (but not areas within Fossil Creek itself). Fossil Creek proper is occupied by lowland leopard frogs (*Lithobates yavapaiensis*) and we have no historical data to indicate that Chiricahua leopard frogs ever occupied Fossil Creek. The Chiricahua leopard frogs likely occupy the stock tanks because they are the only source of perennial pools of sufficient size for breeding habitat in the area. The Buckskin Hills area and all occupied stock tanks are located within the FCRA.

Stock tanks have been developed on public lands throughout the Southwest for livestock and wildlife use. In many areas, they have both indirect beneficial and detrimental effects on aquatic systems. They benefit aquatic systems by limiting and trapping sediment that otherwise would continue down ephemeral channels into perennial streams. They also may benefit species, such as the Chiricahua leopard frog, by providing habitat that is currently needed for the species recovery and survival. Stock tanks also capture surface water and precipitation that has the potential to increase the flashiness of a stream during a storm event and allow water to percolate into the soil, providing some recharge of the subsurface aquifer and potentially adding to stream base flows. Stock tanks are detrimental to aquatic systems when the sediment berms that are built to capture overland flows fail and cause acute sediment pulses into aquatic systems. An additional negative impact of stock tanks to aquatic systems is the spread of nonnative organisms including crayfish, nonnative fish, and American bullfrogs. These nonnative species can negatively affect native aquatic species that may occur nearby, and the nonnative species can be transported downslope to perennial aquatic systems during high flow events where they can have dramatic negative effects to the native ecosystem. Following the native fish restoration project in Fossil Creek, all stock tanks containing nonnative fishes that drained into the watershed were treated to remove these fish (Hedwall and Sponholtz 2005). This work was repeated at three stock tanks in 2008 (USFWS files), and we will continue to work with the Forest Service to ensure that stock tanks within the FCRA are managed to inhibit the movement of and/or to remove nonnative aquatic species that become established. However, we currently have no means of removing crayfish from the area and they currently occur in several stock tanks on the Fossil Creek Allotment (e.g., Divide Tank) and in stock tanks adjacent to the allotment.

The FCRA contains currently occupied, previously occupied, and potentially suitable unoccupied Chiricahua leopard frog habitat (Table 3). The currently and recently (within the last decade or so) occupied sites are stock tanks and are located in the central part of the allotment. Frogs may no longer occur in historically occupied sites due to drought, crayfish, or other unknown habitat issues. It is unknown if tanks that have never been known to have frogs (e.g., Ernie's Tank, Herbie's Tank) are actually suitable habitat or if leopard frogs would persist in these areas. At this time, if we have not identified a reason why the tanks would be considered unsuitable habitat, we are assuming frogs could someday occur there if we are successful in re-establishing a functioning metapopulation in this watershed.

In addition to stock tanks, there are multiple ephemeral drainages in the Buckskin Hills (such as Boulder Canyon, Sycamore Canyon, Mud Tanks Draw, Tin Can Draw, Cimarron Creek), but these drainages are typically dry during the breeding season (e.g., Boulder and Sycamore Canyons, Tin Can Draw, Cimarron Creek) or contain predacious crayfish (e.g., Mud Tanks Draw) and, thus, are not considered breeding habitat for Chiricahua leopard frogs. Prior to 2012, there were no springs or seeps on the FCRA that we considered to be suitable permanent breeding habitat for the frogs. However, in 2012, Chiricahua leopard frogs were located in Boulder Spring. If this site maintains perennial water, it may also support breeding frogs.

Up until 2002, the Buckskin Hills appeared to contain a functioning metapopulation (as defined in USFWS 2007, p. K-3) of Chiricahua leopard frogs (in stock tanks). Since 1993, Chiricahua leopard frogs have been detected at 15 sites within or adjacent to the FCRA (Table 3). Three of these sites were last occupied in 1993 (Contractor [formerly Kewitt] Tank, Mud Tank #2, Tanque Aloma), except for Divide Tank, where Chiricahua leopard frogs have not been located since 1983. In 2001, there were eight sites where Chiricahua leopard frogs were detected within the FCRA; however, only three of the sites (Buckskin, Sycamore Basin, and Walt's Tanks) appeared to support breeding frogs at that time. Since this time, frogs have been reintroduced at Middle, Buckskin, Black and Walt's Tanks, and from these four sites, Chiricahua leopard frogs in 2012 began expanding back out to previously occupied sites such as Sycamore Basin Tank, Doren's Defeat Tank, Needed Tank, Partnership Tank, and several other sites on the FCRA.

Table 3: Tanks that are currently (as of 2012), recently, or historically occupied by Chiricahua leopard frogs or that are considered suitable habitat, but currently unoccupied by frogs. Tanks in bold text are designated critical habitat.

Tank Name	Currently Occupied	Recently/ Historically Occupied	Potential Cause for Extirpation/ Lack of occupancy	Suitable Habitat	Currently Unsuitable due to:
Antelope Tank	Yes*	N/A	N/A	Yes	*Frogs dispersed on their own to Antelope tank in 2012, but due to a need to clean the tank we moved those frogs to Middle Tank in fall 2012
Black Tank (formerly Peak)	Yes	Yes	Nonnatives (fish removed in 2005)	Yes	N/A
Blue Tank	No	No	N/A	Yes	Dries frequently, not a lot of perimeter vegetation
Buck Tank	No	Yes (last occupied 2001)	Drought (tank dried in 2002)	Yes	N/A

Tank Name	Currently Occupied	Recently/ Historically Occupied	Potential Cause for Extirpation/ Lack of occupancy	Suitable Habitat	Currently Unsuitable due to:
Buckskin Tank	Yes	Yes	Drought (tank dried in 2002, 2007)	Yes	N/A
Charley's Tank	Yes	N/A	N/A	Yes	N/A
Contractor Tank (formerly Kewitt)	No	No (last occupied 1993)	Crayfish, then tank dried	No	Crayfish
Divide Tank	No	No (last occupied 1983)	Nonnatives (fish removed in 2005)	No	Crayfish
Doren's Defeat Tank	Yes	Yes (last occupied 2012)	Drought (tank dried in 2002)	Yes	N/A
Ernie's Tank	No	No	N/A	Yes	N/A
Freckles Tank	Yes	No	N/A	Yes	N/A
Gnat Tank	No	No	Crayfish	No	Crayfish
Herbies Tank	No	No	N/A	Yes	N/A
Little Buckskin Tank	No	Yes (last occupied 2001)	Drought (tank dried in 2002); Tank repaired and deepened in 2012	Yes	N/A
Middle Tank	Yes	Yes	Nonnatives (fish removed in 2005)	Yes	N/A
Mud Tank No. 2	No	No (last occupied 1993)	Crayfish	No	Crayfish
Natural Tank	No	No	Crayfish	No	Crayfish (comment from ranch manager in 2006 that this tank has never gone dry)
Needed Tank	Yes	Yes	Drought	Yes	Stepping Stone Habitat
Partnership Tank	Yes	Yes (last occupied 2002)	Drought (tank dried in 2002)	Yes	N/A
Pete's/Turkey Tank	No	No	N/A	Yes	N/A
Pine Tank	Yes	Yes (last occupied in 2000)	N/A	Yes (?)	N/A
Powerline Tank	No	N/A	N/A	N/A	N/A

Tank Name	Currently Occupied	Recently/ Historically Occupied	Potential Cause for Extirpation/ Lack of occupancy	Suitable Habitat	Currently Unsuitable due to:
Road Tank	No	No	Drought (tank dried in 2007 and likely in 2002); crayfish likely	No	Tank small and dries easily; connects to Mud Tanks Draw which has crayfish
Salmon Lake	No	No	N/A	Yes	N/A
Sycamore Basin Tank	Yes	Yes (last confirmed occupied 2007)	Cause unknown, berm repaired in 2012	Yes	N/A
Tanque Aloma	No	No (last occupied 1993)	Crayfish	No	Crayfish
Tin Can Tank	No	No	No	Yes	N/A
Upper Boulder Canyon (natural pools) and Boulder Spring, and drainage below	Yes	N/A	N/A	Yes	N/A
Walt's Tank	Yes	Yes	N/A	Yes	N/A
Wan Tank	No	No	N/A	Yes	N/A
Yvette Tank	No	No	N/A	No	Ephemeral; when holds water, likely has crayfish

Following the 2002 drought, many previously occupied stock tanks "died out" as the waters dried and the frogs became extremely susceptible to other fatality factors (e.g., predation, possibly disease, etc.). From 2002-2006, the FWS and AGFD monitored the decline of Chiricahua leopard frogs in the Buckskin Hills and in 2005, the FWS removed frogs from the population to start a captive breeding program at The Phoenix Zoo. In September/October 2005, one female and three male frogs we collected from Sycamore Basin Tank. These were the last remaining Chiricahua leopard frogs that could be located on the Coconino National Forest. After much effort from the Phoenix Zoo, two of these males, and two female Chiricahua leopard frogs (collected from Gentry Creek, Tonto NF), produced the frogs that FWS and AGFD released into Middle Tank on April 10, 2008 (26 subadult, pure Buckskin Hills Chiricahua leopard frogs released) and October 15, 2008 (18 subadults and 48 tadpoles of Buckskin Hills/Gentry Creek mixed lineage, 1 adult frog originally from Sycamore Basin Tank released). Since this time, we have conducted additional augmentation (reintroduction) of frogs to Middle Tank and at Walt's Tank, Black Tank, and Buckskin Tank. Since reintroductions began in 2008 (and have continued through the present) we have confirmed breeding Chiricahua leopard frogs at Middle, Walt's, Black, and Buckskin Tanks. Middle, Black, Buckskin, and Walt's Tanks have done so well in producing frogs, that in 2012 frogs spread to many other sites (Table 3) and breeding was confirmed at Sycamore Basin, Doren's Defeat and Pine Tanks (none of which we reintroduced

frogs into). Surveys for 2013 have only just begun, but FWS and AGFD confirmed breeding at Buckskin Tank on April 10, 2013.

The FWS and AGFD, in cooperation with the permittee of the FRCA and the Coconino National Forest, intend to continue stocking frogs at additional suitable (stock tank) habitats on the FCRA, in order to continue to improve the status of the species within the action area. Our goal is to manage the following tanks – Middle, Walt's, Black, Buckskin, and Sycamore Basin Tanks - as core breeding habitats (stock tanks) as they have reliably supported breeding Chiricahua leopard frogs in the past and meet the habitat requirements identified in the Recovery Plan.

In addition to reintroducing frogs to historically known locations, the FWS, AGFD, and Forest Service, and the permittee have worked to improve habitat at sites prior to restoring frogs by removing nonnative fishes (Hedwall and Sponholtz 2005), removing/cleaning sediment from tanks and repairing tank berms, fencing portions of the tanks to limit livestock access, removal of encroaching junipers, closing user-created roads, and installing erosion socks on hillsides adjacent to tanks to reduce sediment inputs into the tanks. It is likely that all of these actions have contributed to the success of Chiricahua leopard frogs in the Buckskin Hills.

The FWS designated critical habitat for the Chiricahua leopard frog on the Coconino National Forest in the Buckskin Hills, Critical Habitat Unit (CHU) 24 (USFWS 2012). This CHU includes 232 ac (94 ha) of Coconino National Forest lands in Yavapai County, Arizona. This unit was designated critical habitat because it was occupied at the time of listing and has the features essential to the conservation of the species (PCEs 1 and 2). Included in this CHU are eight tanks occupied at the time of listing (Sycamore Basin, Middle, Walt's, Partnership, Doren's Defeat, Needed, Black, and Buckskin Tanks) that could function as a metapopulation. Frogs currently occur at all of these sites and are confirmed breeding at all but Needed Tank. Needed Tank may not support breeding frogs as it does not always have water, but we think it provides an important stopover site for dispersing frogs. The critical habitat also includes drainages and uplands likely used as dispersal corridors among these tanks, including: 1) from Middle Tank downstream in Boulder Canyon to its confluence with an unnamed drainage that comes in from the northwest, to include Black Tank, then upstream in that unnamed drainage to a saddle, to include Needed Tank, downstream from the saddle in an unnamed drainage to its confluence with another unnamed drainage, downstream in that drainage to the confluence with an unnamed drainage, to include Walt's Tank, and upstream in that unnamed drainage to Partnership Tank; 2) from Doren's Defeat Tank upstream in an unnamed drainage to Partnership Tank; 3) from the confluence of an unnamed drainage with Boulder Canyon west to a point where the drainage turns southwest, then directly overland to the top of Sycamore Canyon, and then downstream in Sycamore Canyon to Sycamore Basin Tank; and, 4) from Buckskin Tank upstream in an unnamed drainage to the top of that drainage, then directly overland to an unnamed drainage that contains Walt's Tank.

Since the frogs almost disappeared from the Buckskin Hills and the FCRA, much recovery work has been accomplished in CHU 24, including the reintroduction of frogs, the elimination of nonnative predatory fishes, the installation of erosion control structures and removal of sediment from tanks, and fencing tanks to exclude livestock from portions of critical habitat (as described in the proposed action for this project).

Factors Affecting the Chiricahua leopard frog and Critical Habitat within the Action Area

The factors affecting the Chiricahua leopard frog and its critical habitat within the action area, the Coconino National Forest, are discussed in this section.

Five site-specific biological opinions covering four projects have been issued to the Forest Service addressing adverse effects to Chiricahua leopard frogs from projects implemented within or adjacent to the action area on the Coconino National Forest and one opinion addressing fire suppression activities at the national level (AESO Consultation #22410-2007-F-0197-R001). These site-specific projects included three range management plans (Fossil Creek [AESO Consultation #22410-2007-F-0197], Hackberry-Pivot Rock [AESO Consultation #22410-2007-F-0198], and Thirteen Mile Rock [AESO Consultation #22410-2001-F-0124]) Allotments, a recreation project (Historic Mail Trail [AESO Consultation #22410-2004-F-0103), and the fire retardant consultation noted above. Within the four project-specific biological opinions, some form of incidental take was issued for all but the Historic Mail Trail Project. This biological opinion will replace the incidental take statement previously completed for the Fossil Creek allotment and though Hackberry-Pivot Rock and Thirteen Mile allotments currently have no frogs, we are reasonably certain that over the life of these projects, frogs could move onto these allotments (which are adjacent to the FCRA). The Coconino National Forest provided conservation measures that would minimize the impacts to Chiricahua leopard frogs in these formal consultations and each of these consultations resulted in a non-jeopardy biological opinion for the species.

The greatest threats to Chiricahua leopard frogs on the Coconino National Forest are nonnative species, drought, and disease. Divide Tank, which is adjacent to Highway 260 and up-drainage of occupied stock tanks, currently has crayfish and has supported nonnative fishes in the past (it has likely been used by local residents to stock nonnative bait fishes due to its easy access from the highway). If re-established there, nonnative fishes could spread to currently occupied tanks and tanks designated as critical habitat. The commitment in the current FRCA proposed action from the Forest Service to work with the FWS, AGFD, and the permittee to remove this tank is exceptional. In addition, all of the stock tanks are filled by runoff; hence, they are vulnerable to drying during drought. Chytridiomycosis has not been found in any wild frogs in the Buckskin Hills; however, the disease occurs in Arizona treefrogs (*Hyla wrightorum*) and western chorus frogs (*Pseudacris triseriata*) less than 10 mi (16 km) to the east, and frogs collected from Walt's Tank (2002) subsequently tested positive for the disease in captivity. It is unknown whether they contracted the disease in the wild or while captive.

Current predictions of drought and/or higher winter low temperatures may also stress ponderosa pine stringers and piñon-juniper woodlands in the watershed in which the Chiricahua leopard frog occurs. Drought stress makes these stringers and woodland habitat more susceptible to unnaturally intense wildland fires. Drier climates in conjunction with increased fuel loading could result in larger, more frequent, and more severe wildfires in the southwestern U.S. Wildland fires are expected to reduce vegetative cover and result in greater soil erosion from increased droplet splash-erosion and reduced infiltration capacity, subsequently resulting in increased sediment flows in streams (Fulé 2010). Increases in the number and severity of

wildland fires on the landscape are likely to translate into more suppression activities and therefore more use of retardants, which could potentially impact Chiricahua leopard frogs (USFWS 2011, AESO Consultation #22410-2008-F-0149-R001).

EFFECTS OF THE ACTION

Effects of the action means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action that will be added to the environmental baseline. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

Effects of the Action on the Chiricahua leopard frog

The proposed action is expected to result in adverse effects and long-term benefits to the Chiricahua leopard frog and its habitat. The habitat fencing strategy and FWS/AGFD plans for additional reintroductions of the species within the action area will contribute to the species recovery within the action area. In addition, because there is limited perennial water in the uplands of the FCRA, the maintenance and management of stock tanks, which is part of the proposed action, is critical to the continued survival of the Chiricahua leopard frog on the FCRA. Specifically, we believe that the stock tanks that must be protected to ensure survival of the Chiricahua leopard frog on the allotment are Middle Tank, Black Tank, Walt's Tank, Buckskin Tank, and Sycamore Basin Tank. These tanks are critical to the frog's survival for the following reasons: 1) These tanks consistently hold water, even in dry years; 2) These tanks consistently have the appropriate types of emergent and submerged vegetation around their banks to provide for food, cover, and shelter of frogs in all live stages; 3) These tanks are connected via drainages and upland habitat that the frogs have used in the past to move between and among these sites (connectivity); and, 4) Prior to our active management in the allotment a decade ago, these tanks were the sites the frogs originally occupied and selected for breeding sites. All other suitable stock tanks on the allotment are important in terms of providing connectivity (such as Needed Tank which we designated as critical habitat) or expansion (such as Partnership and Doren's Defeat Tanks, also designated critical habitat), but they are not critical to the continued survival of Chiricahua leopard frogs on the allotment. Chiricahua leopard frogs, like other ranid frogs, expand and move into additional habitat in wet years, but in dry years tend to retract back to core habitats. Based on almost 15 years of survey, we have identified these five tanks as the core habitats needed to ensure breeding Chiricahua leopard frogs persist in the Fossil Creek watershed. There are no springs or seeps on the allotment that we consider to be perennially suitable breeding habitat for the frogs. Areas such as Boulder Springs that the frogs moved into on their own can function as habitat when wet, but have tended to dry in drought years. We will continue to monitor these areas to determine the importance of these natural sites (springs, seeps, drainages) to frog persistence.

The Chiricahua leopard frog Recovery Plan (USFWS 2007) provides a lengthy discussion of potential effects to frogs from livestock grazing activities, with an emphasis on effects to Chiricahua leopard frogs during the warmer periods of the year when the species is assumed to be surface-active and/or reproductive. Livestock are adapted to mesic habitats and select riparian

habitats for water, shade, and cooler temperatures. They tend to spend a disproportionate amount of their time in riparian zones and can adversely affect these systems in a number of important ways (see Fleischner 1994, Belsky et al. 1999, Jones 2000, and references therein). Below, we summarize the adverse effects that can result from livestock grazing, but also note that limited grazing around an occupied leopard frog habitat can also provide openings in the vegetation that provide beneficial basking and foraging sites for frogs.

Livestock grazing can cause a decline in diversity, abundance, and species composition of riparian herpetofauna communities from direct or indirect threats including: 1) declines in the structural richness of the vegetative community; 2) losses or reductions of the prey base; 3) increased aridity of habitat; 4) loss of thermal cover and protection from predators; and, 5) a rise in water temperatures to levels lethal to larval stages of amphibian development (Szaro et al. 1985, Schulz and Leininger 1990, Belsky et al. 1999). Livestock grazing may also lead to a loss in soil fertility from erosion and gaseous emissions spurred by a reduction in vegetative ground cover, particularly at lower elevations (Schlesinger et al. 1990). Specific attributes of ecosystems, such as composition, function, and structure, have been documented as being altered by improper livestock management through a variety of means including: 1) decreasing the density and biomass of individual species, reducing species richness, and changing biological community organization; 2) interfering with nutrient cycling and ecological succession; and, 3) changing vegetation stratification, contributing to soil erosion, and decreasing availability of water to biotic communities (Fleischner 1994).

Both direct and indirect adverse effects may occur through a variety of means during the non-active (i.e., non-breeding) seasons of the year for Chiricahua leopard frogs, including trampling of hibernating frogs or tadpoles; erosion and/or siltation of stream courses; elimination of undercut banks that provide cover for frogs; loss of wetland and riparian vegetation and backwater pools; and spread of disease and nonnative predators (Arizona State University 1979, Hendrickson and Minckley 1984, Ohmart 1995, Jancovich et al. 1997, Belsky et al. 1999, Ross et al. 1999, USFWS 2000, Sredl and Jennings 2005). Increased watershed erosion caused by grazing can accelerate sedimentation of deep pools used by frogs (Gunderson 1968). The indirect effects of grazing in the FCRA on frog habitat may also include increases in sedimentation generated by grazing levels. Sediment can alter primary productivity and fill interstitial spaces in drainage materials with fine particulates that impede water flow, reduce oxygen levels, and restrict waste removal (Chapman 1988). These effects will likely occur on the FCRA, but are expected to be minimal, and attenuated through consistent monitoring, mitigation measures (e.g., erosion control), and adaptive management as proposed by the Coconino National Forest in their livestock management plan.

Direct mortality of amphibian species, in all life stages, from being trampled by livestock has been documented in the literature (see Bartelt 1998, Ross et al. 1999), but most likely occurs to egg masses. Trampling of Chiricahua leopard frogs by livestock has not been documented; however, it likely occurs, particularly in confined, simple habitats such as stock tanks and has been documented to occur with other frog and toad species. Juvenile and adult frogs can probably often avoid trampling when they are active; however, leopard frogs are known to hibernate on the bottom of ponds (Harding 1997) where they may be subject to trampling during the winter months. We are reasonably certain that increased risks of trampling to hibernating

frogs, carry-over tadpoles from previous years that have not yet metamorphosed, and egg masses may occur at sites that are occupied or may become occupied by frogs due to dispersal from nearby sites during the life of the project. Chiricahua leopard frogs inhabit the action area, and we expect that over the life of the action there will be more occupied sites across the allotment as allotment condition improves and implementation of Chiricahua leopard frog habitat enhancement actions occurs. With respect to the effects of the action on the frog, we believe there is a potential for impacts to frogs during tank maintenance activities such as dredging or silt removal; injury at tanks due to transmission of disease by livestock or ranch hands; and direct or indirect fatality at those tanks grazed by livestock as a result of cattle wading into stock tanks, removing shoreline or aquatic cover at egg deposition sites, and increasing turbidity. However, the FWS, AGFD, Forest Service, and permittee built "frog fences" at Middle, Black, Walt's, Buckskin, and Sycamore Basin Tanks (core breeding habitats on the allotment) in order to provide livestock-free habitat for frogs, while still providing livestock access to water. This action has likely reduced the opportunity for livestock to accidentally trample frogs at these tanks, but would not completely remove the threat of trampling at these sites or at other occupied sites.

In review of the potential effects to occupied Chiricahua leopard habitat and individual frogs discussed above, and in acknowledgement of the head-starting for the reintroduction activities planned for Chiricahua leopard frogs in this area, we are reasonably certain that trampling of egg masses, early-stage tadpoles, or dormant-season metamorphosed frogs will occur at some rate over the life of the grazing permit. Additionally, we are reasonably certain that adverse effects to bankside and aquatic vegetation in occupied habitat, causing loss of cover for frogs, will also occur at some level during the duration of this proposed action. We anticipate these direct and indirect effects could occur on any of the current or future occupied habitat areas within the FCRA.

The proposed action is a reduction in grazing utilization and intensity from past management and is intended to authorize livestock grazing in a manner that maintains and/or moves the FCRA toward Forest Plan objectives and desired conditions. The BAE notes that studies have found that new grazing systems similar to the proposed action may only serve to slow the rate of degradation of watersheds, not reverse it (Armour et al. 1994, Belsky et al. 1999, Elmore and Kauffman 1994). Under the proposed action, the following indirect effects (described in detail above) may continue if actions to improve vegetative and soil conditions are not implemented as stated in the EA and BA. These effects may be reduced if adaptive management and the associated monitoring are adept at making appropriate changes to the AOI in a timely fashion. With utilization, intensity, and AUM's managed at decreased levels until conditions improve, there is a possibility that the proposed action would result in long-term recovery of the watershed. However, these lower levels may not be sufficient to result in measurable benefits to upland watershed conditions over the life of the project, especially given predicted climate variability. If there is continued drought, even the reduced level of utilization and intensity that are proposed may result in continued watershed degradation. Potential improvements to watershed condition by lower initial annual stocking and use rates may be negated if these rates are increased too soon or under inappropriate climatic conditions.

While watershed effects such as increased siltation are often associated with livestock grazing of upland habitats, we are reasonably certain that monitoring, mitigation, conservative use, and adaptive management proposed by the Coconino National Forest for the FCRA will minimize potential effects of upland grazing on occupied frog habitat in the area of reintroduction sites such that these sites, as well as other suitable habitats on the allotment, will continue to function as breeding and dispersal sites. In 2012, frog populations continued to grow and expand under a similar livestock management approach.

Effects of the Action on Chiricahua leopard frog Critical Habitat

In our analysis of the effects of the action on critical habitat, we consider whether or not a proposed action will result in the destruction or adverse modification of critical habitat. In doing so, we must determine if the proposed action will result in effects that appreciably diminish the value of critical habitat for the recovery of a listed species. To determine this, we analyze whether the proposed action will adversely modify any of the PCEs that are the components of critical habitat. To determine if an action results in adverse modification of critical habitat, we must also evaluate the current condition of all critical habitat units, and the PCEs of those CHUs, to determine the overall ability of all critical habitat to support recovery. Further, the functional role of each of the CHUs in recovery must also be considered because, collectively, they represent the best available scientific information as to the recovery needs of the species.

The FWS designated critical habitat for the Chiricahua leopard frog on March 20, 2012, and the rule became effective on April 19, 2012. Implementation of the FCRA EA may result in adverse effects, and beneficial effects, to the PCEs of critical habitat. The PCEs related to Chiricahua leopard frog aquatic breeding habitat (including immediately adjacent uplands) and dispersal habitat and the potential effects from implementation of the FCRA EA are described below.

1. Aquatic breeding habitat and immediately adjacent uplands exhibiting the following characteristics:

> *PCE 1a:* Standing bodies of fresh water, including natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, off-channel pools, and other ephemeral or permanent water bodies that typically hold water or are rarely dry for more than a month. During periods of drought, or less than average rainfall, these breeding sites may not hold water long enough for individuals to complete metamorphosis, but they would still be considered essential breeding habitat in non-drought years.
>
> *Effect:* Actions implemented under the FCRA are expected to retain and recover this PCE for frogs. There are conservation measures in place to ensure that areas (stock tanks) are not dewatered or impaired to the point that they cannot support frogs. Cleaning (i.e., draining and or removal of sediment) of stock tanks that provide habitat for Chiricahua leopard frogs could result in the loss and/or reduction (reduced depth) of this PCE for short periods of time. However, occasional drying for short periods (less than one month) may be beneficial in that the frogs can survive, but nonnative predators, particularly fish, and in some cases, populations of aquatic forms of tiger salamanders,

will be eliminated during the dry period (USFWS 2007). Therefore, this PCE will not be adversely modified by the proposed action.

PCE 1b: Emergent and or submerged vegetation, root masses, undercut banks, fractured rock substrates, or some combination thereof, but emergent vegetation does not completely cover the surface of water bodies.

Effect: The FCRA EA is expected to result in adverse effects to this PCE. Livestock will eat and/or modify emergent and submerged vegetation at sites they occupy resulting in loss of cover for frogs. However, because we have worked with the Coconino National Forest to fence off portions of Middle, Black, Walt's, Buckskin, and Sycamore Basin Tanks (all occupied, breeding habitats), and designated these locations as critical habitat, the expected effect is that vegetation inside the protective fences will be protected and will maintain sufficient vegetation at these stock tanks to support breeding frogs (e.g., vegetation to attach egg masses, provide cover and food to tadpoles, etc.). The critical habitat stock tanks and drainages that are not fenced can still provide habitat for the Chiricahua leopard frog (i.e., Doren's Defeat, Partnership, and Needed Tanks and connecting drainages). However, at this time we have made the decision to fence portions of only the core tanks as these are the areas we know that the frogs can retract into when conditions are poor (e.g., extended drought) and may need extra protection. It may be determined in the future that fencing is needed within all designated critical habitat to protect Chiricahua leopard frogs. However, at this time, fencing portions of these core habitats (tanks) allows us to ensure that recovery of frogs on the allotment is not risked and adverse modification of this PCE does not occur, even during extreme drought years.

PCE 1c: Nonnative predators absent or occurring at levels that do not preclude presence of the Chiricahua leopard frog.

Effect: The Coconino National Forest is implementing conservation measures to ensure that actions implemented under the FCRA do not transfer nonnative species between occupied or potential frog habitats. These measures include mandatory notification of Forest Service biologists and the FWS 60-days prior to cleaning any stock tank located within Chiricahua leopard frog areas. Efforts are also made to ensure that Forest Service employees are aware of what stock tanks contain frogs and nonnative species so that the potential for inadvertent transfers of nonnative species to occupied habitat is reduced. Therefore, we believe that these actions associated with livestock grazing on the FCRA will significantly reduce the probability transferring nonnative species to occupied or suitable habitats and will not result in adverse modification of this PCE. In addition, as part of the proposed action, the Forest Service has agreed to look at options for removing the threat of crayfish at Divide Tank (see proposed action). This action, when completed, will aid in securing critical habitat, and Chiricahua leopard frogs on the allotment.

PCE 1d: Absence of chytridiomycosis (Bd), or, if present, then environmental, physiological, and genetic conditions are such that they allow persistence of Chiricahua leopard frogs.

Effect: There is the potential that actions authorized under the FCRA, such as the cleaning/sediment removal of stock tanks and moving machinery among stock tanks could result in the movement of Bd, or other diseases, to critical habitat. However, the Coconino National Forest has included preventative measures in the proposed action that require the livestock allotment permittee and Forest Service field personnel working in/near critical habitat to disinfect equipment used between sites. Pathogens, such as Bd, can easily be transferred between habitats on equipment and footwear. Disinfecting equipment between sites should significantly reduce the potential for Bd to be transmitted to critical habitat. Therefore, these preventative measures should significantly reduce the potential for Bd to be introduced to Chiricahua leopard frog habitat on the FCRA and not result in adverse modification of this PCE. It is important to note, that because stock tanks are important habitat to Chiricahua leopard frogs on the FCRA, the FWS, AGFD, and the Forest Service have cleaned out stock tanks as part of ongoing recovery actions. Therefore, this action would continue with our without the proposed action.

PCE 1e: Upland areas that provide opportunities for foraging and basking that are immediately adjacent to or surrounding breeding aquatic and riparian habitat.

Effect: Implementing the FCRA EA may result in reduced vegetative habitat immediately around and surrounding critical habitat. However, fencing at occupied habitat will leave some areas adjacent to and most of the area immediately surrounding the stock tanks vegetated by denying livestock access. Livestock will be able to eat, trample, and/or otherwise modify vegetation outside the fenced area. Though this will modify some habitat for frogs, it will also result in some beneficial effects to frog habitat by providing needed basking (e.g., open areas) and foraging habitat for frogs. Therefore, though there will be some adverse effects to this PCE, the fencing at core stock tanks will ensure this PCE is not adversely modified and the overall grazing and rotation strategy should ensure that other suitable habitat (unfenced stock tanks) maintain some level of aquatic and riparian habitat for frogs and other wildlife.

2. Dispersal and non-breeding habitat, consisting of areas with ephemeral (present for only a short time), intermittent, or perennial water that are generally not suitable for breeding, and associated upland or riparian habitat that provide corridors (overland movement or along wetted drainages) for frogs to move among breeding sites in a metapopulation. The dispersal and non-breeding habitat need to have the following characteristics:

PCE 2a: Are not more than 1.0 mile overland, 3.0 miles along ephemeral or intermittent drainages, 5.0 miles along perennial drainages, or some combination thereof not to exceed 5.0 miles.

Effect: Actions implemented under the FCRA should not result in the loss of stock tanks within critical habitat that would change the movement distance (connectivity) between stock tanks. Anticipated range management actions to maintain stock tanks as perennial waters (such as repairing the berms at Sycamore Basin, Antelope, and Little Buckskin Tanks as was done in 2012), would also aid in protecting this PCE.

PCE 2b: In overland and non-wetted corridors, provides some vegetation cover or structural features (e.g., boulders, rocks, organic debris such as downed trees or logs, small mammal burrows, or leaf litter) for shelter, forage, and protection from predators; in wetted corridors, provides some ephemeral, intermittent, or perennial aquatic habitat.

Effect: Actions implemented under the FCRA should not significantly reduce or modify this PCE within critical habitat. Though actions may result in small reductions in organic debris as a result of livestock grazing, these impacts are not likely to significantly modify this PCE.

PCE 2c: Are free of barriers that block movement by Chiricahua leopard frogs, including, but not limited to, urban, industrial, or agricultural development; reservoirs that are 50 acres or more in size and contain predatory nonnative fishes, bullfrogs, or crayfish; highways that do not include frog fencing and culverts; and walls, major dams, or other structures that physically block movement.

Effect: Actions implemented under the FCRA would not result in the creation of barriers to movement within critical habitat.

Effects of the Action on Recovery

The minimum habitat features that we consider necessary to preserve the frog's recovery opportunities are based upon active management and protection of the core breeding habitats. Core breeding habitats must have the following feature: perennial water; shallow water with emergent and perimeter vegetation for egg deposition, tadpole and adult thermoregulation or basking sites, and foraging sites; and deeper water, root masses, and undercut banks for refuge from predators and potential hibernacula (see Status of the Species for more details). Independent of the proposed action, FWS and AGFD conducted an analysis to determine which habitats on the FCRA would provide this type of habitat with some active management. We identified five stock tanks that were all somewhat connected by drainages that could provide the permanent breeding habitat necessary for the frog's survival and recovery on the allotment. Middle, Black, Walt's, Buckskin, and Sycamore Basin Tanks were then cleaned (sediment removed), fences constructed, and where appropriate, erosion control measures taken to ensure that these tanks will do better at sustaining intensive drought conditions and be more resilient to other ongoing management (e.g., the proposed livestock grazing action) in the area. Other tanks that were cleaned out to support frogs into the future were Needed, Doren's Defeat, and Partnership Tanks (also all designated critical habitat). These tanks provide connectivity and places for frogs to disperse to as populations in the core breeding habitats expand (as they appear to be doing now). The proposed action includes actions that have assisted in implementation of Chiricahua leopard frog recovery on the FCRA.

The proposed action does not appreciably reduce the likelihood of Chiricahua leopard frog recovery in the Buckskin Hills. We make this conclusion for the following reasons:

- From the late 1990s (when the frogs were discovered) through 2001, Chiricahua leopard frogs occupied multiple stock tanks on the FCRA. These stock tanks included the areas we designated as critical habitat for the frog. Livestock grazing occurred at this time, but with higher numbers of cattle and more intensive grazing periods in many of the pastures. The proposed action will result in reduced intensity in livestock grazing and more measureable criteria for meeting ecological and watershed health objectives across the allotment.

- In 2002, the Chiricahua leopard frog was almost extirpated from the allotment due to intensive drought. Many stock tanks and natural habitats dried for longer periods of time than the frog could survive. The FWS and AGFD monitored the eventual demise of the frog across the occupied areas and, though we maintained hope that one or two frogs may have continued to occupy sites and we just could not detect them, we were forced to bring the last frogs we could find into captivity. By establishing a captive breeding program and implementing actions to improve the drought tolerance of the frog habitat on the allotment (such as cleaning/maintaining stock tanks, fencing portions of tanks to maintain vegetation, etc.), the frog is currently on a trajectory towards recovery. These actions are not only part of the proposed action, but have continued with active livestock management on the allotment.

The proposed action also includes actions that are recommended in the Recovery Plan. These actions were identified as being necessary to recover the Chiricahua leopard frog, and the Coconino National Forest is either implementing or assisting with implementation of these actions in critical habitat on the FCRA. These actions include the following:

- The Coconino National Forest has and continues to design projects in occupied Chiricahua leopard frog habitat on the FCRA which address the appropriate components of the Recovery Plan, with the goal of implementing projects with beneficial effects to Chiricahua leopard frogs.

- The Coconino National Forest has and continues to implement actions to minimize the effects to frogs of stock pond management and maintenance as identified in the Recovery Plan. As recommended by the Recovery Plan, occupied stock tanks have been fenced and stock-pond management guidelines are being followed according to the Forest Service.

- The Coconino National Forest, working with FWS and AGFD, has been monitoring potential habitat following the standardized interagency monitoring protocol for the Chiricahua leopard frog. This will allow us to identify additional suitable habitats for frogs within the FCRA, and surrounding areas.

- The Coconino National Forest maintains Geographic Information Systems (GIS) layers for the current distribution of Chiricahua leopard frogs on the FCRA and this information is used to guide fire management and mitigation to avoid or minimize the effect of wildland fires on the species. Fire use operational plans are reviewed and updated prior to each fire season and are followed during a fire use event. Forest Service and FWS

biologists are consulted prior to determining if a natural fire ignition may be allowed to burn in frog habitat and designated critical habitat.

- The Forest Service Threatened and Endangered Species Program (i.e., the Forest Service's Southwestern Regional Office) has taken the lead in organizing and hosting Chiricahua leopard frog conservation coordination meetings. The team of agency personnel and other interested parties established several workgroups to address various aspects of protecting populations, identifying information needs, information access, seeking funding and resources, establishing partnerships, and other tasks. The Regional Office of the Forest Service has financially supported reintroduction projects, survey training workshops, and frog propagation efforts. In addition, the biologists on the Coconino National Forest are active members of the Chiricahua leopard frog multi-organization Stakeholder Group working with the Recovery Team to implement the Recovery Plan. Further, the Coconino National Forest biologists have also helped with habitat improvements and re-introduction of populations on the FCRA.

These actions should continue to increase the sustainability and resiliency of Chiricahua leopard frog habitat. Therefore, implementation of the FCRA EA is not expected to diminish the conservation contribution of critical habitat to the recovery of the Chiricahua leopard frog.

Since the April 23, 2012, FCRA biological opinion was issued, the environmental baseline for Chiricahua leopard frog within the action area has improved with the occurrence of livestock grazing due to extensive recovery efforts implemented by FWS, AGFD, the Forest Service, and other partners. The Coconino National Forest is actively participating in recovery actions that are benefiting the frog (U.S. Fish and Wildlife Service 2011c).

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. The Fossil Creek Watershed is predominately managed by the Coconino and Tonto National Forests and the section of Verde River abutting the FCRA is managed by the Coconino National Forest. Since the land within the action area is almost exclusively managed by the Forest Service, most activities that could potentially affect listed species are Federal activities and subject to additional section 7 consultations.

Future non-Federal actions within the project area that may be reasonably certain to occur include the potential development and/or modification of a private property in-holding along Fossil Creek and high-volume streamside recreation. These activities may result in increased overland flow and/or sedimentation into aquatic species habitat (from construction of impermeable surfaces) and the potential for further nonnative aquatic species introductions. There is only one private in-holding on Fossil Creek and the landowners are cooperative and helpful in the management of Fossil Creek. In addition, there is the potential for the land to be acquired by the Forest Service in the near future.

Unregulated activities on Federal and non-Federal lands, such as trespass livestock, inappropriate use of off-highway vehicles, and illegal introduction of nonindigenous aquatic species are cumulative effects and can adversely affect the species through a variety of avenues. Illegal introductions of nonindigenous fishes (e.g., topminnow, red shiner, and guppies) and other aquatic invasive species (e.g., crayfish) are routinely made by the public.

CONCLUSION

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat in 50 CFR 402.02 because of various court cases surrounding the Service's jeopardy and adverse modification analyses. Instead, we have relied upon the statutory provisions of the Act to complete our analysis with respect to critical habitat. Critical habitat is defined in section 3 of the Act "as the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the Act, on which are found those physical and biological features essential to the conservation of the species and that may require special management considerations or protection; and specific areas outside the geographical area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species." We have also relied upon the Consultation Handbook which provides guidance on determining adverse modification of critical habitat and jeopardy pursuant to the following: "Adverse effects on individuals of a species or constituent elements or segments of critical habitat generally do not result in jeopardy or adverse modification determinations unless that loss, when added to the environmental baseline, is likely to result in significant adverse effects throughout the species' range, or appreciably diminish the capability of the critical habitat to satisfy essential requirements of the species" (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998:4-34).

After reviewing the current status of the Chiricahua leopard frog and its critical habitat, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, we conclude that implementation of the proposed livestock grazing management on the FCRA will not jeopardize the continued existence of the frog, will not risk recovery of the frog on the FCRA, and will not destroy or adversely modify critical habitat.

We present this conclusion for the following reasons:

- The ecological condition of the FCRA should be maintained or improved during the 10-year life of the project. This will allow for currently occupied and potential suitable habitat for the Chiricahua leopard frog to persist, improve, and contribute to the overall recovery of the species. If the ecological condition of the allotment were in peril, then recovery would be at risk; however, though we have shown in the effects section that incidental take could occur, the action will not appreciably diminish recovery opportunities on the FCRA.

- Full implementation of the EA (including the conservation measures) is expected to greatly reduce the risk of direct impacts to individual Chiricahua leopard frogs through fencing and exclusion of livestock from significant portions of occupied areas at

important breeding sites. This will allow a core population of leopard frogs to persist unmolested at these sites even when livestock are present.

- The Chiricahua leopard frog's environmental baseline has improved on the Coconino National Forest as a result of conservation actions implemented by FWS, AGFD, the Forest Service, and permittee. These actions, such as habitat improvements and reintroductions, have resulted in an increase in the number of stock tanks occupied since 2002 and protection of critical habitat (e.g., fencing at occupied tanks to prevent livestock access to portions of the tank). These actions have occurred in the presence of drought and livestock grazing on the allotment, and grazing activities have not impeded our ability to improve PCEs and increase frog populations at these core sites or for the frogs to disperse to additional sites on their own.

The conclusions of this biological opinion are based on full implementation of the project as described in the Description of the Proposed Action section of this document, including any Conservation Measures that were incorporated into the project design.

INCIDENTAL TAKE STATEMENT

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

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

Amount of Take

Incidental take of Chiricahua leopard frogs is reasonably certain to occur as a result of implementation of the FCRA EA. This incidental take is expected to be in the forms of harm (including direct fatality) and harassment resulting from the effects of the proposed action on Chiricahua leopard frogs. We recognize that providing a numerical estimate of incidental take is the preferred method of measuring take and that for some animals this method is biologically defensible as the ecology of the animal lends itself to them being more detectible (e.g., long-lived, territorial species such as the desert tortoise). However, it is impossible to quantify the number of individual frogs taken because: 1) dead or impaired individuals are almost impossible to find (and are readily consumed by predators) and losses may be masked by seasonal fluctuations in environmental conditions; 2) the status of the species is changing over time through immigration, emigration, and natural loss or active creation of habitat through management; and, 3) the species is small-bodied, well camouflaged, and occurs under water of varying clarity, and thus individuals are difficult to detect.

It is not meaningful to provide a number for incidental take of frogs associated with this action because all a surveyor can count is what they see and there is much we cannot see under the water, in root wads, and in other hiding locations. We are capable of counting frogs at tanks to some extent (particularly if we put a certain number of frogs into an unoccupied site), but weather conditions (wind blowing), the presence of predators, and many other factors can all modify the number of frogs we see at a tank on any given visit. "Detectability" refers to the reality that even in locations actually occupied by a given species of interest, it is very common for individual animals and even species to be missed and go undetected (MacKenzie et al. 2006). Based upon our knowledge of Chiricahua leopard frog ecology, we know that this species can have very low detectability. Even very experienced surveyors can miss frogs, egg masses, and tadpoles or think they hear frogs when none are actually there. In addition, it is one thing to reintroduce a known number of frogs at a stock tank and then try to find them soon after they were put there and when little fatality, emigration, or immigration has occurred (i.e., there is a known number and it can appear that you are precise in your estimate of animals) and an entirely different scenario to have an unknown number of frogs at a tank and then try to "guesstimate" the number of animals present based on surveys (see discussion below).

All of these factors result in even the most experienced leopard frog biologist being unable to show that any estimated numerical take occurred or did not occur at a site. There is no means of equating one dead frog (assuming one was found) to a number of dead frogs not observed. Establishing a number for incidental take becomes even more impracticable when we acknowledge that Chiricahua leopard frogs naturally experience very high mortality rates (greater than 90 percent) in the egg and early tadpole stages, high mortality when the tadpole turns into a juvenile frog, and then relatively lower mortality rates when the frogs become adults (USFWS 2007). Even the recovery strategy and delisting criteria in the Recovery Plan for the Chiricahua leopard frog are built upon numbers of populations (not individuals) and we use counts of frogs only to define a "robust" population, which depending upon the habitat can range from an estimate of 40 to 60 adults, depending upon whether the habitat is drought-resistant (USFWS 2007).

The standard Visual Encounter Surveys (VES) method is the survey protocol used to conduct Chiricahua leopard frog surveys (USFWS 2007, Appendix E). The VES method will generate presence/absence data if used independently and generate information from which inferences about relative frog abundance and trends can be made at a specific site. This method was not developed to census frogs or to identify thresholds, such as incidental take. We do not have a means of counting or conducting a census of all individual frogs at a site. As noted above, we cannot measure the number of frogs taken as a result of this action because these frogs are almost impossible to find, particularly if they are already dead or impaired; the frog is challenging to see when it is alive due to its size, cryptic coloring, and complex habitat. In addition, egg masses and tadpoles are frequently hidden in submerged vegetation and cannot be counted precisely. Therefore, though we can generate counts of frogs seen by surveyors, results from these surveys do not consistently provide an accurate estimate of the number of frogs present at the site. If we are unable to provide a reliable, predictive number of frogs at a site (particularly since it changes each year due to emigration, immigration, and fatality), it follows logically that we would be unable to provide a numerical estimate of the number of frogs incidentally taken as a result of the proposed action.

Since we cannot estimate the number of individual frogs that will be incidentally taken for the reasons listed above, the FWS is providing a mechanism to quantify when take would be considered to be exceeded as a result of the implementing the FCRA EA within the Buckskin Hills: We will use the existing number of core breeding sites on the FCRA to determine when take is exceeded. By setting a threshold of one site, we have set an incidental take limit that is measurable, irrefutable, and indicates that the frogs are being impacted at a level where management needs to change. We are confident that repeated VES surveys can tell us whether a site is occupied or not, which will clearly show if incidental take is exceeded. We conclude that the incidental take of Chiricahua leopard frogs will be considered exceeded if there is a net loss of any one of the currently occupied core stock tanks for one year (Middle Tank, Black Tank, Walt's Tank, Sycamore Basin, and Buckskin Tank), as a result of the implementation of the FCRA EA. This incidental take will be measured by repeated surveys conducted from March to October (frog activity season) in order to determine presence or infer absence of frogs.

We have identified actions that may result in the incidental take of individual frogs (due to actions implemented through the EA and discussed in the Effects section above); however, we do not anticipate the complete loss of an entire occupied stock tank as a result of any action authorized under the FCRA EA. The actions analyzed under the FCRA EA could take individual frogs of various life stages including frogs, tadpoles, and eggs (though we are unable to count the exact number) through direct fatality or harm from trampling (human, animal, or machine), and harm and/or harassment through habitat modification (e.g., as a result of livestock, and/or the movement of disease or nonnative predators through cleaning of stock tanks). If the loss of a currently occupied site occurs, in coordination with the Coconino National Forest, we will determine whether it was the result of the proposed action or if environmental conditions such as drought caused the loss (as occurred in 2002, see Environmental Baseline). If the loss of a core breeding site is a result of the proposed livestock grazing action, then as provided in 50 CFR Section 402.16, reinitiation of formal consultation would be required as the amount or extent of incidental take would be exceeded. If the loss of an occupied site occurs as a result of drought or other environmental factors in combination with the proposed action, then reinitiation would also

be necessary in light of the new information regarding the status of the Chiricahua leopard frog on the FRCA.

This amount of incidental take will not prevent the population from recovering to pre-take levels because the core breeding sites are all within frog dispersal distance of one another (frogs can move up to 5 miles, see Status of the Species) and connected via critical habitat. Therefore, if frogs cease to be present at one site, the frogs will be able to recolonize the site on their own, or we can assist them as we have done in the past. We expect the Coconino National Forest to continue to work with the FWS and AGFD to implement actions such as habitat protection and enhancement (e.g., removal of Divide Tank, fencing, silt fences, etc.) that will result in the continued expansion of Chiricahua leopard frogs on and adjacent to the FCRA.

We conclude that this level of incidental take does not place recovery of the Chiricahua leopard frog at risk. We know that regardless of whether the Coconino National Forest continues to authorize grazing on the FCRA, environmental factors such as drought, movement of nonnative species, maintenance of stock tanks, and natural fluctuations in frog populations will result in changes in the occupancy of stock tanks across the allotment. This is why we have and are working so closely with the Forest Service and AGFD to implement the Recovery Plan (USFWS 2007) throughout suitable habitat on the Coconino National Forest, and with other partners throughout the species' range. Recovery of the species will not be achieved or lost within the Buckskin Hills population of Chiricahua leopard frogs as it includes only a small portion of the overall range of the species. However, by implementing the proposed action with the included Recovery Plan actions, the prospects for this population to recover and contribute to the overall recovery of the species are very high, even with the potential temporary loss of one core site over the life of this project.

Effect of the Take

In this biological opinion, the FWS determines that this level of anticipated take is not likely to result in jeopardy to Chiricahua leopard frogs. While the proposed action may adversely affect the frog in the short-term through the loss of individual frogs of various life stages through any of the forms of incidental take described above, none of these actions as described in the BAE should result in the loss of all frogs at a given stock tank.

REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

The FWS thinks that the following reasonable and prudent measures are necessary and appropriate to minimize take of Chiricahua leopard frogs.

1. Protect Chiricahua leopard frogs on the FCRA.
2. Protect and maintain identified core Chiricahua leopard frog habitats on the FCRA.
3. Monitor the impacts of implementation of the FCRA EA on the Chiricahua leopard frog.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the Forest Service must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The following terms and conditions will implement reasonable and prudent measure 1:

1.1 The Coconino National Forest shall protect occupied Chiricahua leopard frog breeding sites, which may include exclusion fencing of stock tanks, erosion control (e.g., seeding, road maintenance), or other identified measures found to be necessary to maintain the integrity of the habitat. For the five identified stock tanks where fencing is planned to occur, the Forest Service shall ensure that fencing is constructed and maintained at all five core habitat stock tanks (Middle, Black, Walt's, Sycamore Basin, and Buckskin) prior to livestock using these stock tanks. This fencing has been completed at these tanks, but maintenance of these fences will continue into the future.

1.2 The Coconino National Forest shall work with FWS, AGFD, and the permittee to devise a plan for the disposition of Divide Tank within one year of this biological opinion.

1.3 Where feasible, all equipment that comes into contact with aquatic habitats will be cleaned and disinfected before visiting a different aquatic site by removing all soil, mud, and debris and disinfecting or drying the equipment to ensure that Bd or other disease are not spread between sites.

1.4 The Forest Service shall continue to work with FWS, AGFD, and the permittee to define when conditions warrant fencing of habitat improvements, installation of erosion control structures, or other measures needed to improve soil and vegetative conditions around stock tanks or other suitable habitats (e.g., Boulder Spring).

1.5 The Forest Service shall provide FWS and AGFD staff at least 60 days notice prior to the permittee conducting work in earthen tanks. This notice will allow for surveys, frog capture if needed, and/or mitigation to reduce adverse effects to Chiricahua leopard frogs.

1.6 The Forest Service shall modify livestock management in cooperation with the permittee, FWS, and AGFD if monitoring indicates that desired resource conditions, as described in the EA, are not being achieved.

The following terms and conditions will implement reasonable and prudent measure 2:

2.1 Live fish, crayfish, American bullfrogs, leopard frogs, salamanders, or other aquatic organisms shall not be moved among earthen stock tanks or other aquatic sites by Coconino National Forest employees or permittee unless approved by the FWS.

2.2 Water shall not be hauled to any occupied leopard frog habitat or potentially suitable stock tanks by Coconino National Forest employees, permittee, or anyone operating under Forest Service authorization, from another aquatic site or tank that supports leopard frogs, American bullfrogs, crayfish, or fish. If water is needed to address drought concerns for the frog or livestock, the Forest Service must seek FWS approval prior to adding any water to a stock tank occupied by Chiricahua leopard frogs.

2.3 If nonnative aquatic species are detected within occupied Chiricahua leopard frog habitat or habitat that connects to occupied Chiricahua leopard frog habitat on the FCRA, the Coconino National Forest shall immediately initiate a multi-stakeholder planning effort with the FWS and AGFD to remove the nonnative species from the stock tank as quickly as possible. If complete drying of a stock tank is deemed as the most effective management tool to address the threat of nonnatives, the Coconino National Forest may time this action so as to not place an unnecessary burden on the permittee.

The following terms and conditions will implement reasonable and prudent measure 3:

3.1 The Coconino National Forest shall submit an annual summary report to our Flagstaff Suboffice by January 31 of each year. This annual report shall summarize the livestock grazing management that occurred (e.g., livestock numbers, pastures used, timing of use, etc.), a summary of situations (and corrective actions) that pertain to the above items, relevant frog or other aquatic species survey information, and any other pertinent information about the project's effects on the Chiricahua leopard frog. The report shall also make recommendations for modifying or refining these terms and conditions to enhance leopard frog protection.

3.2 The Coconino National Forest shall notify (written correspondence, e-mail, or phone call) our Flagstaff Suboffice as soon as practicable of the observed occurrence or the discovery of aquatic nonnative species in any stock tank on the FCRA to provide for collaborative emergency planning and corrective action as required in reasonable and prudent measure 2 and its implementing terms and conditions.

3.3 The Coconino National Forest shall notify (written correspondence, e-mail, or phone call) our Flagstaff Suboffice as soon as practicable of any observation of any pasture boundary or exclusion fence line failure or fence line disrepair that is

adjacent to known occupied habitat within the FCRA and the corrective actions implemented.

Disposition of Dead or Injured Listed Species

Upon locating a dead, injured, or sick listed species initial notification must be made to the FWS's Law Enforcement Office, 4901 Paseo del Norte NE, Suite D, Albuquerque, New Mexico, 87113, telephone (505) 248-7889, within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a photograph if possible, and any other pertinent information. The notification shall be sent to the Law Enforcement Office with a copy to the AESO. Care must be taken in handling sick or injured animals to ensure effective treatment and in handling dead specimens to preserve the biological material in the best possible state. If possible, the remains of intact species shall be provided to the AESO. If the remains of the species are not intact or are not collected, the information noted above shall be obtained and the carcass left in place. Injured animals should be transported to a qualified veterinarian by an authorized biologist. Should the treated species survive, contact our office regarding the final disposition of the animal.

CONSERVATION RECOMMENDATIONS

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

1. We recommend that the Coconino National Forest implement Forest-specific actions within the Recovery Plan (U.S. Fish and Wildlife Service 2007).

2. We recommend that the Coconino National Forest work with us and AGFD to reintroduce the Chiricahua leopard frog to suitable habitats identified through habitat assessment and surveys conducted throughout the range of the frog on the Coconino National Forest.

3. We recommend the Coconino National Forest work with us and the AGFD to continue to control nonnative aquatic organisms on the Forest, particularly American bullfrogs, nonnative fish, and crayfish.

4. We recommend that the Coconino National Forest work with us to develop a programmatic environmental assessment and biological opinion to cover tank renovation and maintenance on the Coconino National Forest.

5. We recommend that the Coconino National Forest continue to identify factors that limit the recovery potential of Chiricahua leopard frogs on lands under their jurisdiction and work to correct them.

In order for the FWS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

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

Thank you for your continued coordination. In all future correspondence on this project, please refer to the consultation number 22410-2007-F-0197-R002. We also encourage you to coordinate the review of this project with the AGFD. Should you require further assistance or if you have any questions, please contact Shaula Hedwall at (928) 556-2118 or Brenda Smith at (928) 556-2157.

Sincerely,

/s/ Brenda Smith for

Steven L. Spangle
Field Supervisor

cc (electronic copy):
Chief, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ
Regional Supervisor, Arizona Game and Fish Department, Flagstaff, AZ
District Ranger, Red Rock Ranger District, Sedona, AZ
Forest Biologist, Coconino National Forest, Supervisor's Office, Flagstaff, AZ
District Biologist, Red Rock Ranger District, Sedona, AZ
Assistant Field Supervisor, Fish and Wildlife Service, Tucson, AZ (Attn: Jeff Servoss)
Assistant Field Supervisor, Fish and Wildlife Service, Phoenix, AZ

C:\Documents and Settings\shedwall\My Documents\My Documents\Fossil Creek AMP BO May 2013.docx

APPENDIX A – CONCURRENCES

This appendix contains our concurrences with your "may affect, not likely to adversely affect" determinations for the threatened Mexican spotted owl and its critical habitat, the endangered southwestern willow flycatcher, the endangered razorback sucker and its critical habitat, the endangered loach minnow and its critical habitat, the endangered spikedace and its critical habitat, and the endangered Gila topminnow. In addition, this appendix, also contains your "not likely to jeopardize determinations" for the candidate yellow-billed cuckoo, Northern Mexican gartersnake, roundtail chub, and headwater chub.

Mexican spotted owl and critical habitat

We concur with your determination that the proposed action may affect, but is not likely to adversely affect the threatened Mexican spotted owl and its critical habitat. We base this concurrence on the following:

- Within the action area, there are no designated Mexican spotted owl protected activity centers (PACs). Therefore, no human disturbance or construction activities associated with livestock grazing will occur in PACs (occupied habitat) during the breeding season (March 1 through August 30).

- The key habitat components of Mexican spotted owl protected and recovery habitat and the primary constituent elements of spotted owl critical habitat will not be adversely affected. Livestock grazing and management activities will provide for levels that provide the woody and herbaceous vegetation necessary for prey species habitat, the residual biomass that will support prescribed natural and ignited fires, and the regeneration of riparian trees.

- The conservation measures the Forest Service intends to attach to the AOI will aid in improving and protecting prey habitat and protect owls from disturbance.

Southwestern willow flycatcher

We concur with your determination that the proposed action may affect, but is not likely to adversely affect the endangered southwestern willow flycatcher. We base this concurrence on the following:

- There is no critical habitat, occupied habitat, or suitable habitat within the action area. Therefore, we believe that effects to the southwestern willow flycatcher are insignificant and discountable.

Surveys conducted in the 1990's did not detect southwestern willow flycatchers in Fossil Creek and habitat was determined to be unsuitable. However, due to the restoration of full flows in 2005, habitat may be developing in Fossil Creek and it is possible that suitable habitat may develop. Under the proposed action, there is no grazing along the Verde River and livestock use in Fossil Creek will be limited to a small area of potential flycatcher habitat at the Boulder water

gap. Use of this area will occur for short periods of time and utilization of woody riparian vegetation will be limited to 20% maximum utilization. Therefore, in accordance with the Southwestern Willow Flycatcher Recovery Plan (USFWS 2002, appendix G), there will be either no grazing, or provisional grazing (water lanes), in restorable or regenerating habitat as part of the proposed action.

Razorback sucker and critical habitat, loach minnow and critical habitat, spikedace and critical habitat, Gila topminnow

We concur with your determination that the proposed action may affect, but will not likely adversely affect, the razorback sucker and designated critical habitat, the loach minnow and its critical habitat, the spikedace and its critical habitat, and the Gila topminnow. We base our concurrence on the following:

- Conservation measures and best management practices will be implemented to minimize potential sedimentation from project activities to aquatic habitats. Therefore, the increase in sedimentation as a result of implementing the FCRA EA to Fossil Creek and the Verde River is likely to be minor, and therefore, insignificant and discountable to these species' habitats.

- Razorback suckers, loach minnow, spikedace, and Gila topminnow all currently occur or could occur during the life of this project in Fossil Creek. Livestock will have only one access point to Fossil Creek (Boulder Water Gap) for a limited time each year; therefore, direct effects to these fishes from the proposed action will be insignificant and discountable.

- Effects to primary constituent elements as defined in the 1994 critical habitat rule for the razorback sucker (59 FR 13374) would be insignificant and discountable because effects to the water (such as temperature, dissolved oxygen, turbidity, etc.), physical habitat, and biological environment (such as food supply, predation, competition) would not be measurable.

- Effects to primary biological factors defined in the 2012 critical habitat rule for spikedace and loach minnow critical habitat (75 FR 66482) would be insignificant and discountable because effects to water quality and quantity, temperature, habitat and flows in designated critical habitat would not be measurable.

Yellow-billed cuckoo

We concur with your determination that the proposed action is not likely to contribute in a trend toward Federal listing, loss of viability, or jeopardize the continued existence of the yellow-billed cuckoo. We base this concurrence on the following:

- Under the proposed action, there will be no grazing along the Verde River; therefore, there will be no effects to yellow-billed cuckoos or their habitat on the Verde River.

- Potential habitat for cuckoos exists on Fossil Creek, as well as within other riparian corridors (Boulder Canyon, Sally May Wash, Hackberry Canyon, Cimarron Creek, and Doren's Defeat Canyon) on the FCRA. However, there is limited livestock access to most of these areas and impacts to riparian vegetation from the proposed action should be insignificant and discountable.

Northern Mexican gartersnake

We concur with your determination that the proposed action is not likely to contribute in a trend toward Federal listing, loss of viability, or jeopardize the continued existence of the northern Mexican gartersnake in Fossil Creek. We base this concurrence on the following:

- The FCRA livestock management plan described in the EA is designed to protect both riparian and upland habitats that the northern Mexican gartersnake is dependent upon. Efforts to reduce soil erosion and minimize impacts to gartersnake habitat in and adjacent to Fossil Creek will result in insignificant and discountable effects.

Roundtail chub and headwater chub

We concur with your determination that the proposed action is not likely to contribute in a trend toward Federal listing, loss of viability, or jeopardize the continued existence of the roundtail chub and headwater chub in Fossil Creek. We base this concurrence on the following:

- Livestock will have only one access point to Fossil Creek (Boulder Water Gap) for a limited time each year; therefore, direct effects to roundtail and headwater chub from the proposed action will be insignificant and discountable.

- Conservation measures and best management practices will be implemented to minimize potential sedimentation from project activities to aquatic habitats. Therefore, the increase in sedimentation as a result of implementing the FCRA EA to Fossil Creek is likely to be minor, and therefore, insignificant and discountable to these species' habitats.

LITERATURE CITED FOR APPENDIX A

U.S. Fish and Wildlife Service (USFWS). 2002. Southwestern Willow Flycatcher Recovery Plan. Albuquerque, New Mexico. i-ix+ 210 pp., Appendices A-O

LITERATURE CITED FOR BIOLOGICAL OPINION

Akins, N., and H.W. Wofford. 1999. The effects of s-methoprene on the development of the leopard frog (*Rana pipiens*) tadpole. Journal of the Tennessee Academy of Science 73(3/4):107.

Bartelt, P. E. 1998. Bufo boreas (Western Toad) mortality. Herpetological Review 29(2):96.

Belsky, A.J., A. Matzke, and S. Uselman. 1999. Survey of livestock influences on stream and riparian ecosystems in the Western United States. Journal of Soil and Water Conservation 54:419-431.

Benedict, N., and T.W. Quinn. 1999. Identification of Rio Grande leopard frogs by mitochondrial DNA analysis: a tool for monitoring the spread of a non-native species. Department of Biological Sciences, University of Denver, CO.

Berg, F. and S. Wyman. 2001. Livestock water access and ford stream crossings. Engineering Technical Note MT-13. U.S. Department of Agriculture, Natural Resources Conservation Service, February 2001. 10pp.

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

Blaustein, A.R, and P. T. J. Johnson. 2010. When an infection turns lethal. Nature 465:881-882.

Blaustein, A.R., D.B. Wake, and W.P. Sousa. 1994. Amphibian declines: judging stability, persistence, and susceptibility of populations to local and global extinction. Conservation Biology 8(1):60-71.

Boone, M.D. and C.M. Bridges. 2003. Effects of carbaryl on green frog (Rana clamitans) tagpoles: timing of exposure versus multiple exposures. Environmental Toxicology and Chemistry 22(11):2695-2702.

Bradford, D.F. 1989. Allotopic distribution of native frogs and introduced fishes in high Sierra Nevada lakes of California; Implications of the negative effect of fish introductions. Copeia 1898:775-778.

Bradford, D.F., F. Tabatabai, and D.M. Graber. 1993. Isolation of remaining ppopulations of the native frog, *Rana muscosa*, by introduced fishes in Sequioa and Kings Canyon national Parks, California. Conservation Biology 7(4):882-888.

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

Britt, K.D., Jr. 1982. The reproductive biology and aspects of life history of Tiaroga cobitis in southwestern New Mexico. Unpublished M.S. thesis. New Mexico State University, Las Cruces. 56 pp.

Brown, D.E. 1982. Madrean evergreen woodlands. Pages 59-65 *in* D.E. Brown (ed.), Biotic Communities of the American Southwest – United States and Mexico. Desert Plants 4(1-4).

Calfee, R.D. and E.E. Little. 2003. Effects of ultraviolet-B radiation on the toxicity of the fire-fighting chemicals. Environmental Toxicology and Chemistry 22(7):1525-1531.

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

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

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

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

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

Crother, B.I. (ed.). 2008. Scientific and Common Names for Amphibians and Reptiles of North America North of México. Society for the Study of Amphibians and Reptiles, Herpetological Circular No. 37:1-84

Dahms, C.W., and B.W. Geils (tech. eds). 1997. An assessment of forest ecosystem health in the Southwest. General Technical Report RM-GTR-295. Fort Collins, CO, US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Danzer, S.R., C.H. Baisan, and T.W. Swetnam. 1997. The influence of fire and land-use history on stand dynamics in the Huachuca Mountains of southeastern Arizona. Appendix D in Robinett, D., R.A. Abolt, and R. Anderson, Fort Huachuca Fire Management Plan. Report to Fort Huachuca, AZ.

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

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

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

DeBano, L.F., and D.G. Neary. 1996. Effects of fire on riparian systems. Pages 69-76 *in* P.F. Ffolliott, L.F. DeBano, M.B. Baker, G.J. Gottfried, G. Solis-Garza, C.B. Edminster, D.G Neary, L.S. Allen, and R.H Hamre (tech. coords.). Effects of fire on Madrean province ecosystems, a symposium proceedings. USDA Forest Service, General Technical Report RM-GTR-289.

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

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

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

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

Dole, J.W. 1972. Evidence of celestial orientation in newly-metamorphosed *Rana pipiens*. Herpetologica 28:273-276.

Eigenbrod, F., S. J. Hecnar, and L. Fahrig. 2009. Quantifying the road-effect zone: threshold effects of a motorway on anuran populations in Ontario, Canada. Ecology and Society 14(1): 24.

Fellers, G.M., D.E. Green, and J.E. Longcore. 2001. Oral chytridiomycosis in the mountain yellow-legged frog (*Rana muscosa*). Copeia 2000(4):945-953.

Fellers, G.M., L.L. McConnell, D. Pratt, and S. Datta. 2004. Pesticides in mountain yellow-legged frogs (*Rana muscosa*) from the Sierra Nevada Mountains of California, USA. Environmental Toxicology and Chemistry 23(9):2170-2177.

Fellers, G.M., K.L. Pope, J.E. Stead, M.S. Koo, and H.H. Welsh, Jr. 2007. Turning population trend monitoring into active conservation: Can we save the Cascades frog (*Rana cascadae*) in the Lassen region of California. Herpetological Conservation and Biology 3(1):28-39.

Fernandez, P.J. and J.T. Bagnara. 1991. Effect of background color and low temperature on skin color and circulating ά-MSH in two species of leopard frog. General and Comparative Endocrinology 83:132-141.

Fernandez, P.J. and J.T. Bagnara. 1993. Observations on the development of unusual melanization of leopard frog ventral skin. Journal of Morphology 216:9-15.

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

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

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

Fleischner, T.F. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology 8:629-644.

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

Frost, D.R. 2004. Amphibian Species of the World: an Online Reference. Version 3.0 (22 August, 2004). Electronic Database accessible at http://research.amnh.org/herpetology/amphibia/index.php. American Museum of Natural History, New York, USA.

Fulé, P.Z. Wildfire ecology and management at Grand Canyon USA: tree ring applications in forest fire history and modeling Pgs. 365-381 *In* M. Stoffel et al. (eds.), Tree rings and natural hazards: a state-of-the-art identifier. Advances in global climate change research 41. Springer Services and Business Media.

Gingrich, R.W. 2003. The political ecology of deforestation in the Sierra Madre Occidental of Chihuahua. Online publication.

Goldberg, C.S., K.J. Field, and M.J. Sredl. 2004. Mitochondrial DNA sequences do not support species status of the Ramsey Canyon leopard frog (*Rana subaquavocalis*). Journal of Herpetology 38(3):313-319.

Green, D.E., and C.K. Dodd, Jr. 2007. Presence of amphibian chytrid fungus *Batrochochytrium dendrobatidis* and other amphibian pathogens at warm-water fish hatcheries in southeastern North Ameroca. Herpetological Conservation and Biology 2(1):43-47.

Gregory, S.V., F.J. Swanson, W.A. Mckee, and K.W. Cummins. 1991. An Ecosystem Perspective of Riparian Zones. Bioscience 41: 540-551.

Guido, Z. 2008. Understanding the southwestern monsoon. Southwest Climate Outlook July 2008:3-5.

Hale, S.F. 2001. The status of the Tarahumara frog in Sonora, Mexico based on a re-survey of selected localities, and search for additional populations. Report to the U.S. Fish and Wildlife Service, Phoenix, Arizona.

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

Hanski, I., and M. Gilpin. 1991. Metapopulation dynamics: brief history and conceptual domain. Biological Journal of the Linnean Society 42:3-16.

Harding, J.H. 1997. Amphibians and Reptiles of the Great Lakes Region. The University of Michigan Press, Ann Arbor.

Harris, R.N., T.Y. James, A. Lauer, M.A. Simon, and A. Patel. 2006. Amphibian pathogen *Batrachochytrium dendrobatidis* is inhibited by the cutaneous bacteria of amphibian species. EcoHealth 3(1):53-56.

Harris, R.N., R.M. Brucker, J.B. Walke, M.H. Becker, C.R. Schwantes, D.C. Flaherty, B.A. Lam, D.C. Woodhams, C.L. Briggs, V.T. Vredenburg, and K.P.C. Minbiole. 2009. Skin microbes on frogs prevent morbidity caused by lethal skin fungus. The ISME Journal (2009):1-7.

Hendrickson, D.A., and W.L. Minckley. 1984. Cienegas - vanishing climax communities of the American Southwest. Desert Plants 6(3):131-175.

Herrmann, H-W, E. Mujica, and M. Culver. 2009. Chiricahua leopard frog conservation genetics. University of Arizona, Tucson, AZ.

Hillis, D.M., J.S. Frost, and D.A. Wright. 1983. Phylogeny and biogeography of the *Rana pipiens* complex: a biochemical evaluation. Systematic Zoology 32(2):132-143.

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

Hoffman, E.A. and M.S. Blouin. 2004. Evolutionary history of the northern leopard frog: reconstruction of phylogeny, phylogeography, and historical changes in population demography from mitochondrial DNA. Evolution 58(1):145-159.

Intergovernmental Panel on Climate Change. 2007. Summary for policymakers of the synthesis report of the IPCC fourth assessment report. Draft copy, 16 November 2007.

Jaeger, J.R., B.R. Riddle, R.D. Jennings, and D.F. Bradford. 2001. Rediscovering *Rana onca*: Evidence for phylogenetically distinct leopard frogs from the border region of Nevada, Utah, and Arizona. Copeia 2001: 339-354.

Jancovich, J.K., E.W. Davidson, J.F. Morado, B.L. Jacobs, J.P. Collins. 1997. Isolation of a lethal virus from the endangered tiger salamander Ambystoma tigrinum stebbinsi. Diseases of Aquatic Organisms 31:161-167.

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

Jennings, R.D. 1995. Investigations of recently viable leopard frog populations in New Mexico: *Rana chiricahuensis* and *Rana yavapaiensis*. New Mexico Game and Fish Department, Santa Fe.

Jennings, R.D. and N.J. Scott. 1991. Global amphibian population declines: insights from leopard frogs in New Mexico. Report to the New Mexico Department of Game and Fish, Albuquerque, New Mexico. 43 pp. + appendices, figures, and tables.

Jones, A. 2000. Effects of cattle grazing on North American arid ecosystems: a quantitative review. Western North American Naturalist 60(2):155-164.

Knapp, R.A., and K.R. Mathews. 2000. Nonnative fish introductions and the decline of the Mountain yellow-legged frog from within protected areas. Conservation Biology 14(2):428-438.

Lemos-Espinal, J.A., and H.M. Smith. 2007. Anfibios y Reptiles del Estado de Chihuahua, México/Amphibians and Reptiles of the State of Chihuahua, México. Universidad Nacional Autonoma de México y CONABIO, México D.F.

Little, E.E. and R.D. Calfee. 2008. Toxicity of herbicides, piscicides, and metals to the threatened Chiricahua leopard frog (*Rana chiricahuensis*). U.S. Geological Survey, Columbia Environmental Research Center, Columbia, Missouri.

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

MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, L.L. Bailey, and J.E. Hines. 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Elsevier Inc., San Diego, CA. 324 pp.

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

Mendelson, J.R. III, *et al.* 2006. Confronting amphibian declines and extinctions. Science 313:48.

Miller, D. J., and L. E. Benda. 2000. Effects of punctuated sediment supply on valley-floor landforms and sediment transport. GSA Bulletin 112: 1814-1824.

Monsen, K.J. and M.S. Blouin. 2003. Genetic structure in a montane ranid frog: restricted gene flow and nuclear-mitochondrial discordance. Molecular Ecology 12:3275-3286.

Monson, P.D., D.J. Call, D.A. Cox, K. Liber, and G.T. Ankley. 1999. Photoinduced toxicity of fluoranthene to northern leopard frogs (*Rana pipiens*). Environmental Toxicology and Chemistry 18(2):308-312.

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

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

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

Pauly, G.B., D.M. Hillis, and D.C. Cannatella. 2009. Taxonomic freedom and the role of official lists of species names. Herpetologica 65(2):115-128.

Picco, A.M., and J.P. Collins. 2008. Amphibian commerce as a likely source of pathogen pollution. Conservation Biology 22(6):1582-1589.

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

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

Platz, J.E., and J.S. Mecham. 1984. *Rana chiricahuensis*. Catalogue of American Amphibians and Reptiles 347.1.

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

Rathbun, N.L. 1969. Investigation of fish killed. 10 July 1969 memorandum from N.L. Rathbun, Water Quality Analyst, to Jim Bruce, Cold Water Supervisor. Arizona Game and Fish Department, Region VII, Pima, Arizona. 7 pp.

Reaser, J.K., and D.S. Pilliod. 2005. *Rana luteiventris* Thompson 1913. Columbia spotted frog. Pp. 559-563 *in* M.J. Lannoo (ed), Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

Relyea, R.A. 2004. Synergistic impacts of malathion and predatory risk on six species of North American tadpoles. Environmental Toxicology and Chemistry 23(4):1080-1084.

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

Rice, S.P., M.T. Greenwood, and C.B. Joyce. 2001. Tributaries, sediment sources, and the longitudinal organisation of macroinvertebrate fauna along river systems. Canadian Journal of Fisheries and Aquatic Sciences 58: 824-840.

Rollins-Smith, L.A., and J.M. Conlon. Antimicrobial peptide defenses against chytridiomycosis, an emerging infectious disease of amphibian populations. Developmental and Comparative Immunology 29 (2005):589-598.

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

Rorabaugh, J.C. 2008. An introduction to the herpetofauna of mainland Sonora, México, with comments on conservation and management. Journal of the Arizona-Nevada Academy of Science 40(1):20-65.

Rorabaugh, J. 2010. A comparison of the status of the Chiricahua leopard frog (*Lithobates chiricahuensis*) in Arizona from 2002 to 2009. U.S. Fish and Wildlife Service. Ecological Services. Tucson, Arizona. January 2010. 30 pp.

Rosen, P.C., and C. Melendez. 2006. Observations on the status of aquatic turtles and ranid frogs in northwestern Mexico. Pp. 104-106 *in* Extended Abstracts, Proceedings of the Sizth Conference on Research and Resource Management in the Southwestern Deserts. USGS Southwest Biological Science Center, Sonoran Desert Research Station, Tucson, AZ.

Rosen, P.C., and C. Melendez. 2010. Observations on the status of aquatic turtles and the occurrence of ranid frogs and other aquatic invertebrates in northwestern Mexico. Pages 205-224 *in* W. Halvorson, C. Schwalbe, and C. van Riper III (eds), Southwestern Desert Resources. University of Arizona Press, Tucson.

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

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

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

Ross, D.A., J.K. Reaser, P. Kleeman, and D.L. Drake. 1999. *Rana luteiventris* (Columbia spotted frog). Mortality and site fidelity. Herpetological Review 30(3):163.

Ruibal, R. 1959. The ecology of a brackish water population of *Rana pipiens*. Copeia 1959 (4):315-322.

Seager, R., M. Ting, T. Held, Y. Kushnir, J. Lu, G. Vecchi, H. Huang, N. Harrnik, A. Leetmaa, N. Lau, C. Li, J. Velez, and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. Science 316:1181-1184.

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

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

Skerratt, L.F., L. Berger, and R. Speare. 2007. Natural history of Bd. Abstract in Program for the Conference, Amphibian Declines and Chytridomycosis: Translating Science into Urgent Action, Tempe, AZ.

Smith, H.M., and D. Chiszar. 2003. Distributional and variational data on the frogs of the genus *Rana* in Chihuahua, Mexico, including a new species. Bulletin of the Maryland Herpetological Society 39:59-66.

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

Sparling, D.W. 2003. A review of the role of contaminants in amphibian declines. Pages 1099-1128 *in* D.J. Hoffman *et al.* (eds), Handbook of Ecotoxicology, Lewis Publishers, Boca Raton, Florida. 1290 pp.

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

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

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

Sredl, M.J., J.M. Howland, J.E. Wallace, and L.S. Saylor. 1997. Status and distribution of Arizona's native ranid frogs. Pages 45-101 *in* M.J. Sredl (ed). Ranid frog conservation and management. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program, Technical Report 121.

Sredl, M.J., and R.D. Jennings. 2005. *Rana chiricahuensis*: Chiricahua leopard frogs. Pages 546-549 *in* M.J. Lannoo (ed), Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

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

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

Sumida, M., H. Kaneda, Y. Kato, Y. Kanamori, H. Yonekawa, and M. Nishioka. 2000. Sequence variation and structural conservation in the D-loop region and flanking genes of mitochondrial DNA from Japanese pond frogs. Genes and Genetic Systems 75:79-92.

Swetnam, T.W., and C.H. Baisan. 1996. Fire histories of montane forests in the Madrean Borderlands. Pages 15-36 *in* P.F. Ffolliott *et al.* (Tech. Coord.), Effects of fire on Madrean Province ecosystems. USDA Forest Service, General Technical Report, RM-GTR-289.

Todd, B.D. and K.M. Andrews. 2008. Response of a reptile guild to forest harvesting. Conservation Biology 22(3):753-761.

U.S. Environmental Protection Agency. 2009. Proposed endangerment and cause or contribute findings for greenhouse gases under section 202(a) of the Clean Air Act. Federal Register 74(78):18886-18910.

U.S. Fish and Wildlife Service (USFWS). 2002a. Endangered and threatened wildlife and plants; listing of the Chiricahua leopard frog (*Rana chiricahuensis*); final rule. Federal Register 67(114):40790-40811.

U.S. Fish and Wildlife Service (USFWS). 2005. Programmatic biological and conference opinion on the continued implementation of the land and resource implementation plans for the eleven national forests and national grasslands of the Southwest Region. 830 pp. + Appendices A-D.

U.S. Fish and Wildlife Service (USFWS). 2007. Chiricahua leopard frog (*Rana chiricahuensis*) recovery plan. Region 2, U.S. Fish and Wildlife Service, Albuquerque, NM.

U.S. Fish and Wildlife Service (USFWS). 2009. Endangered and threatened wildlife and plants; partial 90-day finding on a petition to list 475 species in the Southwestern United States as threatened or endangered with critical habitat; proposed rule. Federal Register 74(240):66866-66905.

U.S. Fish and Wildlife Service (USFWS). 2010. Fossil Creek Grazing Biological Opinion, February 26, 2010.

U.S. Fish and Wildlife Service (USFWS). 2011a. Endangered and threatened wildlife and plants; listing and designation of critical habitat for the Chiricahua leopard frog: proposed rule. Federal Register 76(50):14126-14207.

U.S. Fish and Wildlife Service (USFWS). 2011b. Endangered and threatened wildlife and plants; listing and designation of critical habitat for the Chiricahua leopard frog: proposed rule; reopening of comment period. Federal Register 76(183):58441-58455.

U.S. Fish and Wildlife Service (USFWS). 2011c. Chiricahua leopard frog (*Lithobates* [=*Rana] chiricahuensis*) 5-Year Review: Summary and Evaluation. Arizona Ecological Services Office, Phoenix, Arizona.

U.S. Fish and Wildlife Service (USFWS). 2012. Endangered and threatened wildlife and plants; listing and designation of critical habitat for the Chiricahua leopard frog; final rule. Federal Register 77(54):16324-16423.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 1998. Consultation handbook: procedures for conducting consultation and conference activities under section 7 of the Endangered Species Act.

van Mantgem, P.J., N.L. Stephenson, J.C. Byrne, L.D. Daniels, J.F. Franklin, P.Z. Fule, M.E. Harmon, A.J. Larson, J.M. Smith, A.H. Taylor, and T.T. Veblen. 2009. Widespread increase of tree mortality rates in the western United States. Science 323:521-524.

Voyles, J., S. Young, L. Berger, C. Campbell, W.F. Voyles, A. Dinudom, D. Cook, R. Webb, R.A. Alford, L.F. Skerratt, R. Speare. 2009. Pathogenesis of chytridiomycosis, a cause of catastrophic amphibian declines. Science 326:582-585.

Vredenburg, V., G.M. Fellers, and C. Davidson. 2005. *Rana muscosa* Camp 1917b. Mountain yellow-legged frog. Pp. 563-566 *in* M.J. Lannoo (ed), Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

Vredenburg, V. T., Knapp, R. A., Tunstall, T. S. & Briggs, C. J. 2010. Dynamics of an emerging disease drive large-scale amphibian population extinctions. Proc. Natl Acad. Sci. USA 107:9689–9694.

Wallace, E. 2003. Status assessment of lowland leopard frogs in mountains of Coronado National Forest – Santa Catalina Ranger District. Purchase Order 43-8197-3-0058. Coronado national Forest, Tucson, AZ.

Watkins-Colwell, K.A. and Watkins-Colwell, G.J. 1998. Differential survivorship of larval leopard frogs (*Rana pipiens*) exposed to temporary and permanent reduced pH conditions. Bulletin of the Maryland Herpetological Society 7 34:64-75.

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

White, J.A. 2004. Recommended protection measures for pesticide applications in Region 2 of the U.S. Fish and Wildlife Service. U.S. Fish and Wildlife Service, Austin, Texas. 201 pp. + appendices.

Witte, C.L., M.J. Sredl, A.S. Kane, and L.L. Hungerford. 2008. Epidemiological analysis of factors associated with local disappearances of native ranid frogs in Arizona. Conservation Biology 22(2):375-383.

Wood, P. J., and P. D. Armitage. 1997. Biological effects of fine sediment in the lotic environment. Environmental Management 21: 203-217.

Zug, G. R., L. J. Vittand J. P. Caldwell. 2001. Herpetology: An Introductory Biology of Amphibians and Reptiles, 2nd edition. Academic Press, San Diego, California.